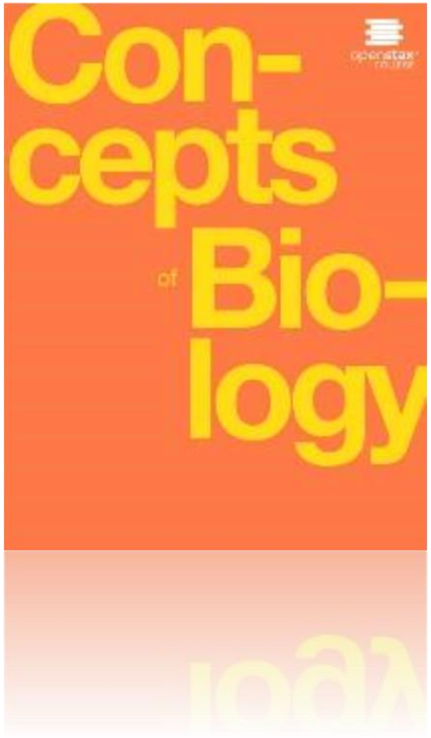
CONCEPTS OF BIOLOGY

Chapter 19 POPULATION AND COMMUNITY ECOLOGY

PowerPoint Image Slideshow



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Picture slides by Spuddy Mc Spare
Information slides by Amanda Brammer, M.S. Associate Professor, NTCC

INTRODUCTION

- Figure 19.1 shows the Asian carp, a fish that has been farmed and eaten in China for over 1,000 years.
- It is one of the most important aquaculture food resources worldwide.
- In the United States, however, Asian carp is considered a dangerous invasive species that threatens native species.
- The effects of invasive species are just one aspect of what ecologists study to understand how populations interact.

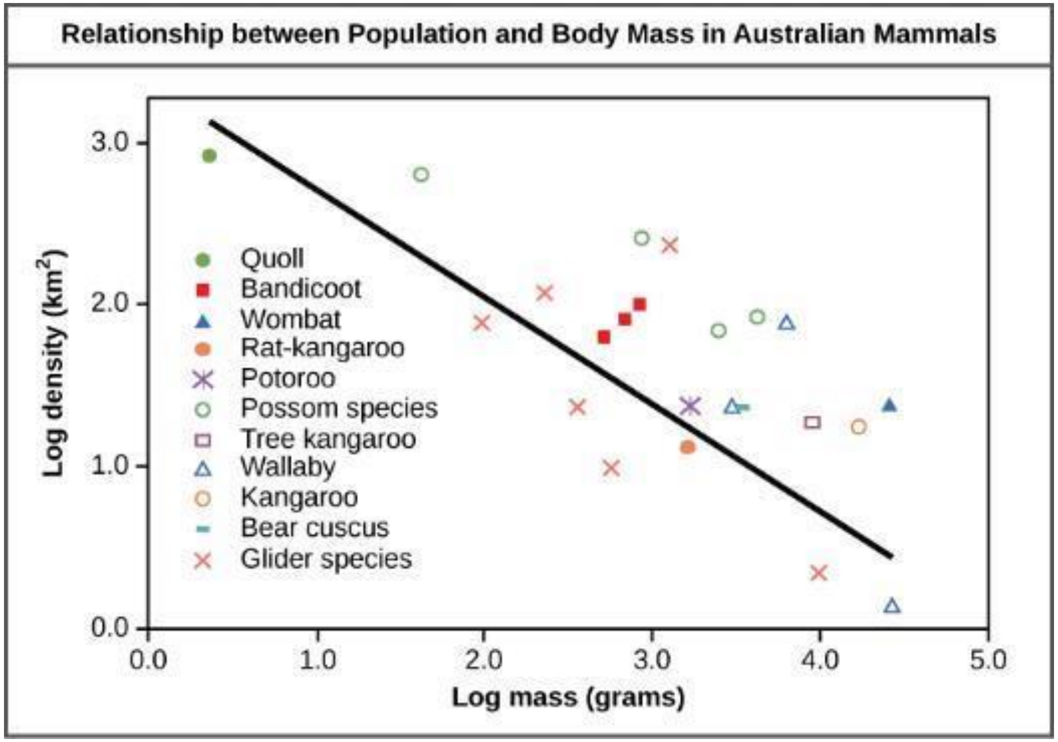
FIGURE 19.1 ASIAN CARP, AN INVASIVE SPECIES IN THE UNITED STATES

Asian carp jump out of the water in response to electrofishing. The Asian carp in the inset photograph were harvested from the Little Calumet River in Illinois in May, 2010, using rotenone, a toxin often used as an insecticide, in an effort to learn more about the population of the species. (credit main image: modification of work by USGS; credit inset: modification of work by Lt. David French, USCG)

POPULATION DEMOGRAPHICS AND DYNAMICS (19.1)

- Populations are dynamic entities. Their size and composition fluctuate in response to numerous factors.
- The statistical study of populations is called **demography**: a set of mathematical tools designed to describe populations and investigate how they change.
- Populations are characterized by their **population size** (total number of individuals) and their **population density** (number of individuals per unit area).
    - A population may have a large number of individuals that are distributed densely, or sparsely.
    - There are also populations with small numbers of individuals that may be dense or very sparsely distributed in a local area.
    - Smaller organisms tend to be more densely distributed than larger organisms (Figure 19.2).

FIGURE 19.2 RELATIONSHIP BETWEEN POPULATION AND BODY MASS



Australian mammals show a typical inverse relationship between population density and body size. Population density typically decreases with increasing body size. Why do you think this is?

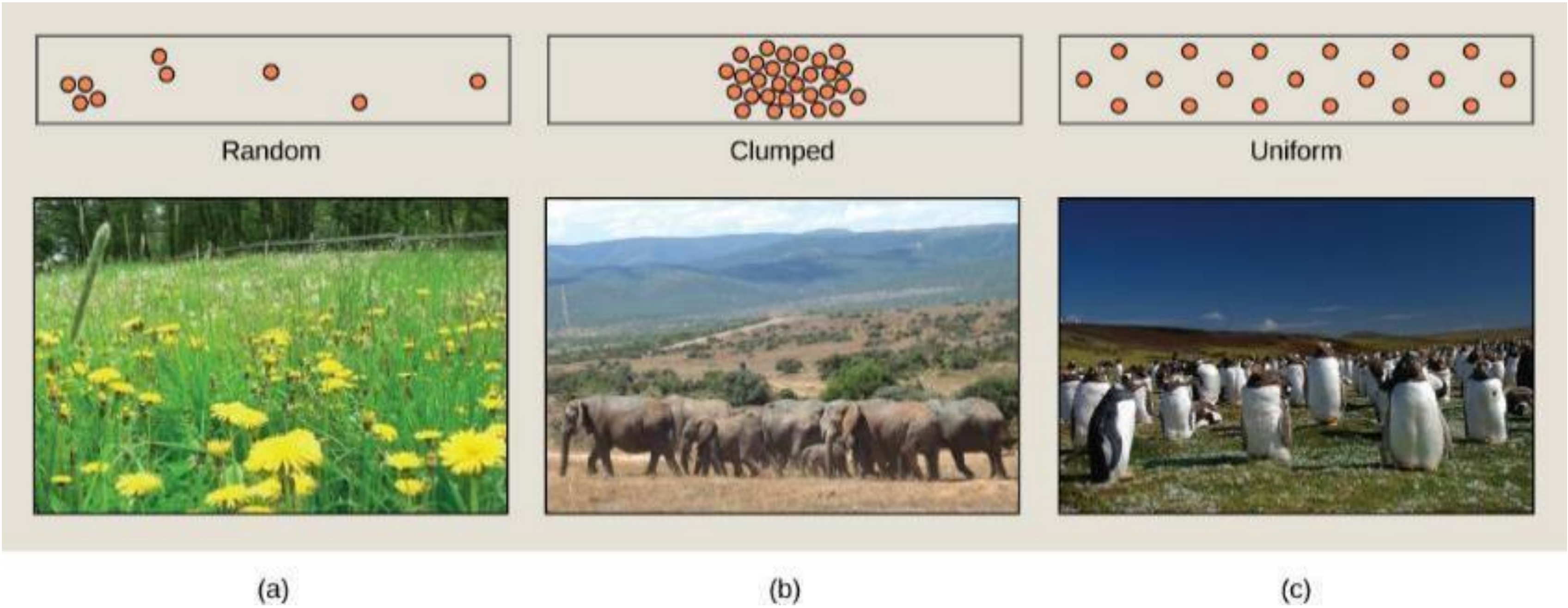
POPULATION SIZE AND DENSITY (19.1)

- The most accurate way to determine population size is to count all of the individuals within the area. However, this is usually not feasible.
- The methods used to sample populations to determine their size and density are typically tailored to the organism being studied.
- For immobile organisms, or for very small and slow-moving organisms, a quadrat may be used.
    - A **quadrat** is a wood, plastic or metal square that is randomly placed on the ground and used to count the number of individuals that lie within its boundaries.
- For smaller mobile organisms, **mark and recapture** is often used.
    - This method involves marking a sample of captured animals in some way and releasing them back into the environment; then, a new sample is captured and scientists determine how many of the marked animals are in the new sample.

SPECIES DISTRIBUTION (19.1)

- A species distribution pattern is the distribution of individuals within a habitat at a particular point in time.
- Individuals within a population can be distributed (Figure 19.3):
  - At random (**random distribution pattern**)
  - In groups (**clumped distribution pattern**)
  - Equally spaced apart (**uniform distribution pattern**)
- Different distributions reflect important aspects of the biology of the species; they also affect the mathematical methods required to estimate population sizes.
- The distribution of the individuals within a population provides more information about how they interact with each other than does a simple density measurement.

FIGURE 19.3 DISTRIBUTION PATTERNS WITH EXAMPLES



Species may have a random, clumped, or uniform distribution. Plants such as (a) dandelions with wind-dispersed seeds tend to be randomly distributed. Animals such as (b) elephants that travel in groups exhibit a clumped distribution. Territorial birds such as (c) penguins tend to have a uniform distribution. (credit a: modification of work by Rosendahl; credit b: modification of work by Rebecca Wood; credit c: modification of work by Ben Tubby)

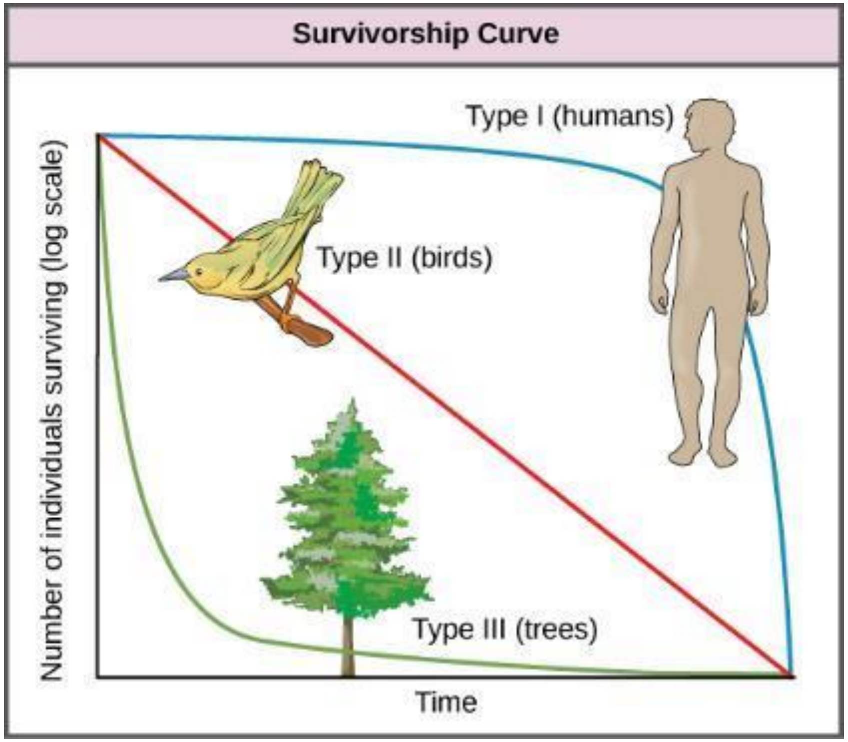
DEMOGRAPHY (19.1)

- **Demography** is the statistical study of population changes over time: birth rates, death rates, and life expectancies.
- These population characteristics are often displayed in a life table.
- **Life tables** provide important information about the life history of an organism and the life expectancy of individuals at each age.
- Life tables may include:
    - the probability of each age group dying before their next birthday,
    - the percentage of surviving individuals dying at a particular age interval (their **mortality rate**),
    - and their life expectancy at each interval.

POPULATION DEMOGRAPHICS AND DYNAMICS

- Another tool is a **survivorship curve**, which is a graph of the number of individuals surviving at each age interval versus time.
- There are three types of survivorship curves (Figure 19.4).
- In **type I** curves, mortality is low in the early years and occurs mostly in older individuals. Organisms typically produce few offspring and provide good care to the offspring (humans and other mammals).
- In **type II** curves, mortality is relatively constant throughout the entire life span, and mortality is equally likely to occur at any point in the lifespan (most birds).
- In **type III** curves, the young experience the highest mortality with much lower mortality rates for organisms that make it to advanced years. Organisms typically produce large numbers of offspring, but provide very little or no care for them (trees and many invertebrates).

FIGURE 19.4 SURVIVORSHIP CURVES



Survivorship curves show the distribution of individuals in a population according to age. Humans and most mammals have a Type I survivorship curve, because death primarily occurs in the older years. Birds have a Type II survivorship curve, as death at any age is equally probable. Trees have a Type III survivorship curve because very few survive the younger years, but after a certain age, individuals are much more likely to survive.

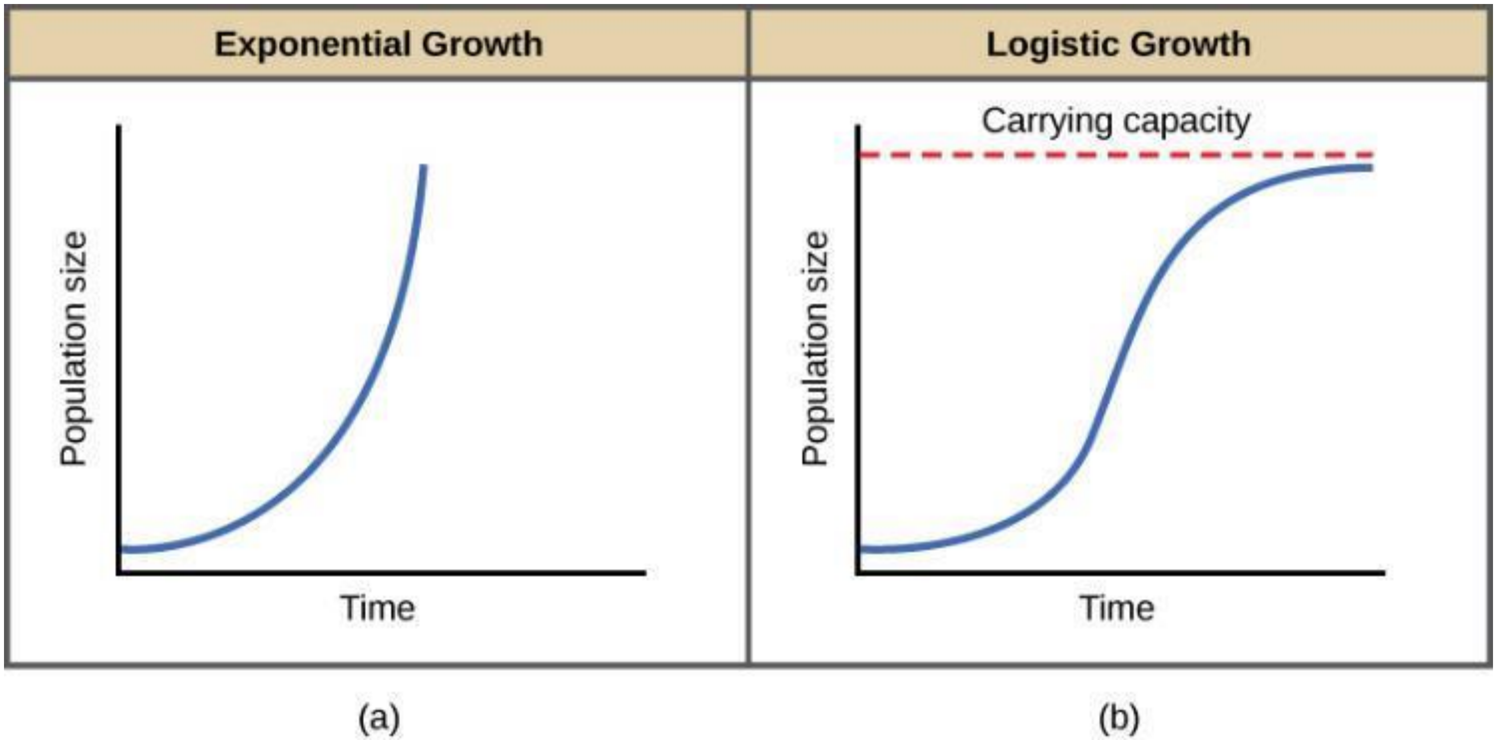
POPULATION GROWTH AND REGULATION (19.2)

- Populations with abundant natural resources grow very rapidly; however, they limit further growth by depleting their resources.
- In **exponential growth**, the growth rate—the number of organisms added in each reproductive generation—is increasing; that is, the population size is increasing at a greater and greater rate.
- The best example of exponential growth in organisms is seen in bacteria, because they are capable of dividing very quickly.
- Exponential growth produces a **J-shaped growth curve** (Figure 19.5a).
- Extended exponential growth is possible only when infinite natural resources are available; this is not the case in the real world.

LOGISTIC GROWTH 1 OF 2 (19.2)

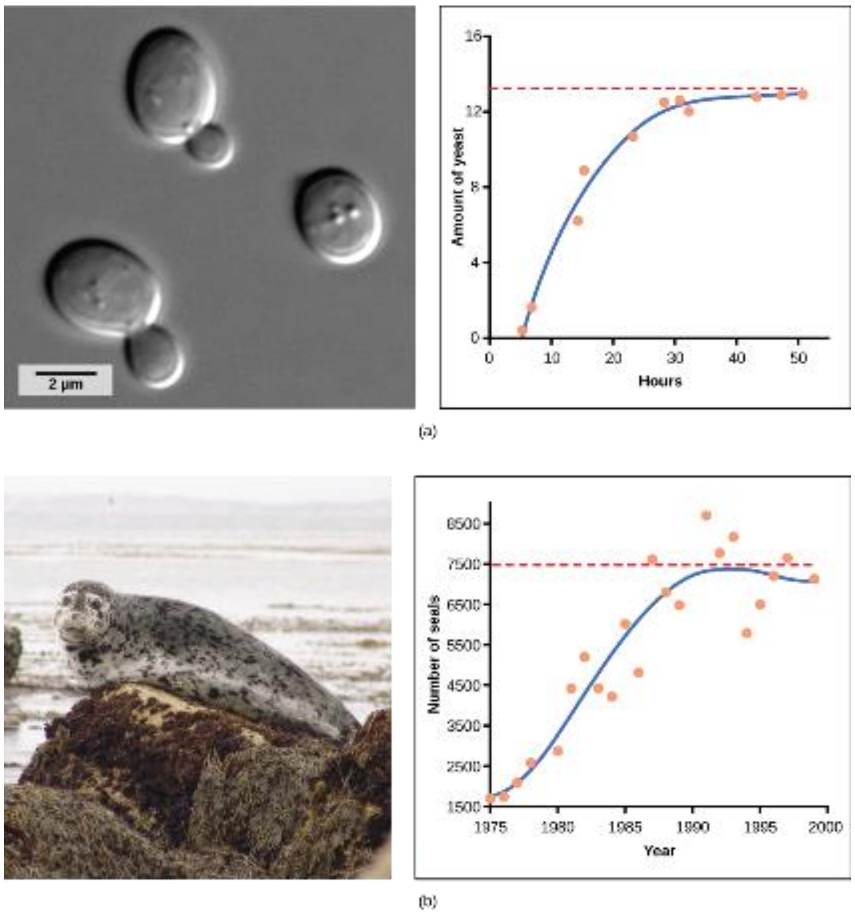
- Exponential growth may occur in environments where there are few individuals and plentiful resources, but when the number of individuals gets large enough, resources will be depleted and the growth rate will slow down.
- Eventually, the growth rate will plateau or level off (Figure 19.5b).
- This population size, which is determined by the maximum population size that a particular environment can sustain, is called the **carrying capacity**, or K.
- This model is called **logistic growth** and represents the reality of limited resources.
- Logistic growth produces a **S-shaped** growth curve (Figure 19.5b).

FIGURE 19.5 POPULATION GROWTH MODELS



When resources are unlimited, populations exhibit (a) exponential growth, shown in a J-shaped curve. When resources are limited, populations exhibit (b) logistic growth. In logistic growth, population expansion decreases as resources become scarce, and it levels off when the carrying capacity of the environment is reached. The logistic growth curve is S-shaped.

FIGURE 19.6 EXAMPLES OF GROWTH CURVES



(a) Yeast grown in ideal conditions in a test tube shows a classical S-shaped logistic growth curve, whereas (b) a natural population of seals shows real-world fluctuation. The yeast is visualized using differential interference contrast light micrography. (credit a: scale-bar data from Matt Russell)

LOGISTIC GROWTH 2 OF 2 (19.2)

- The logistic model assumes that every individual within a population will have equal access to resources and, thus, an equal chance for survival.
- In the real world, phenotypic variation among individuals within a population means that some individuals will be better adapted to their environment than others.
- The resulting competition for resources among population members of the same species is termed **intraspecific competition**.
- As population size increases, intraspecific competition increases.

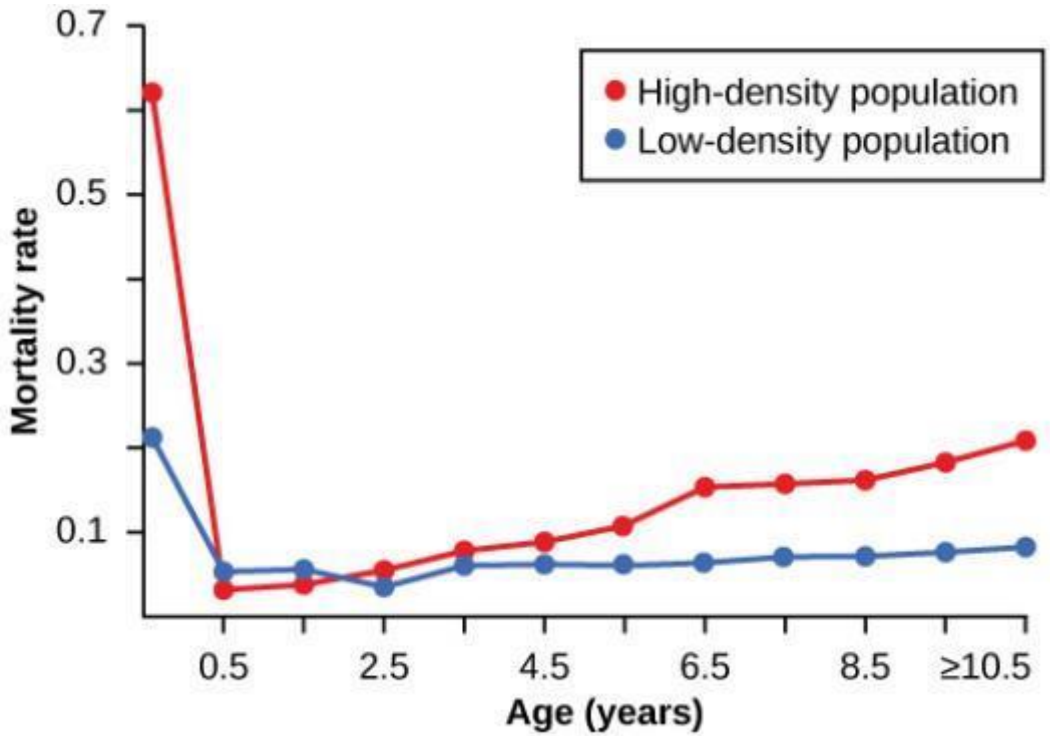
POPULATION DYNAMICS AND REGULATION (19.2)

- The logistic model of population growth, while valid in many natural populations and a useful model, is a simplification of real-world population dynamics.
- Implicit in the model is that the carrying capacity of the environment does not change, but the carrying capacity varies annually.
- Population growth is regulated in a variety of ways.
    - **Density-dependent factors**, in which the density of the population affects growth rate and mortality, and
    - **Density-independent factors**, which cause mortality in a population regardless of population density.

DENSITY-DEPENDENT REGULATION (19.2)

- Most density-dependent factors are biological in nature and include predation, inter- and intraspecific competition, and parasites.
- Usually, the denser a population is, the greater its mortality rate.
- Density dependent regulation was studied in a natural experiment with wild donkey populations on two sites in Australia (Figure 19.7).
    - On one site the population was reduced by a population control program (low density); the population on the other site received no interference (high density).
    - The juvenile mortality was much higher in the high-density population because of maternal malnutrition caused by a shortage of high-quality food.

FIGURE 19.7
DENSITY DEPENDENT REGULATION



This graph shows the age-specific mortality rates for wild donkeys from high- and low-density populations. The juvenile mortality is much higher in the high-density population because of maternal malnutrition caused by a shortage of high-quality food.

DENSITY-INDEPENDENT REGULATION AND INTERACTION WITH DENSITY-DEPENDENT FACTORS (19.2)

- Many factors that are typically physical in nature cause mortality of a population regardless of its density. These factors include weather, natural disasters, and pollution.
- In real-life situations, population regulation is very complicated and density-dependent and independent factors can interact.
- Why did the woolly mammoth go extinct (Figure 19.8)?
  - Woolly mammoths began to go extinct about 10,000 years ago, soon after paleontologists believe humans able to hunt them began to colonize North America and northern Eurasia.
  - It is commonly thought that climate change and human hunting (using only primitive hunting technology) led to their extinction.

FIGURE 19.8 WHY DID THE WOOLLY MAMMOTH GO EXTINCT?

(a) (b) (c)

The three images include: (a) 1916 mural of a mammoth herd from the American Museum of Natural History, (b) the only stuffed mammoth in the world is in the Museum of Zoology located in St. Petersburg, Russia, and (c) a one-month-old baby mammoth, named Lyuba, discovered in Siberia in 2007. (credit a: modification of work by Charles R. Knight; credit b: modification of work by “Tanapon”/Flickr; credit c: modification of work by Matt Howry)

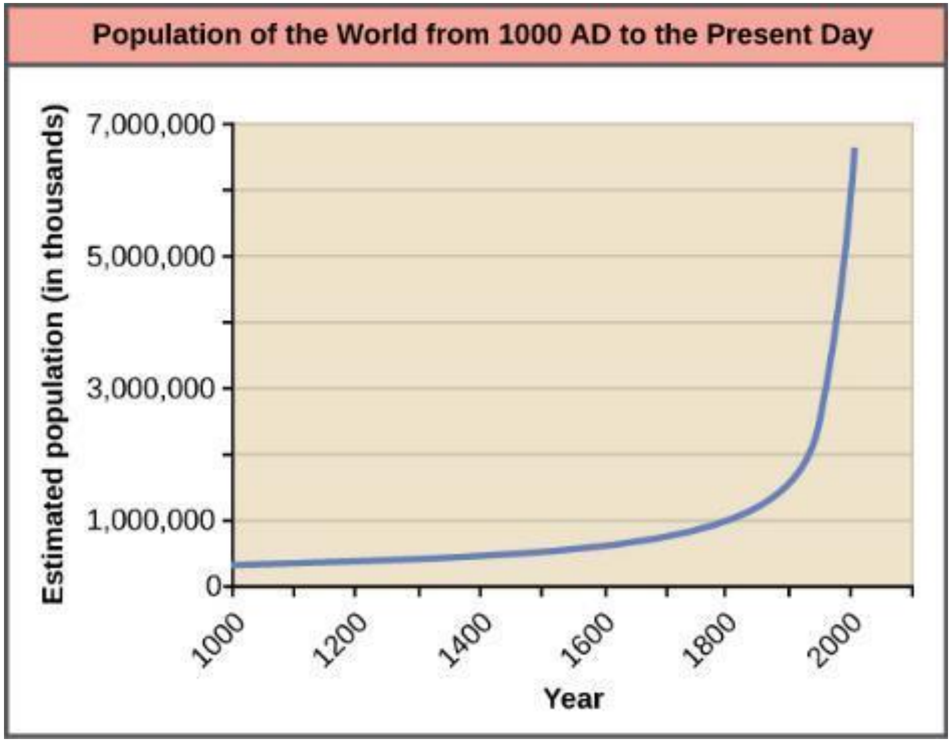
DEMOGRAPHIC BASED POPULATION MODELS (19.2)

- Population ecologists have described a continuum of life-history “strategies” with K-selected species on one end and r-selected species on the other.
- **K-selected species** tend to have larger, but fewer, offspring and contribute large amounts of resources to each offspring.
    - They are adapted to stable, predictable environments.
    - Elephants would be an example of a K-selected species.
- **r-selected species** have large numbers of small offspring and do not contribute much to parental care.
    - They are adapted to unstable, unpredictable environments.
    - Examples of r-selected species are marine invertebrates and plants.

THE HUMAN POPULATION (19.3)

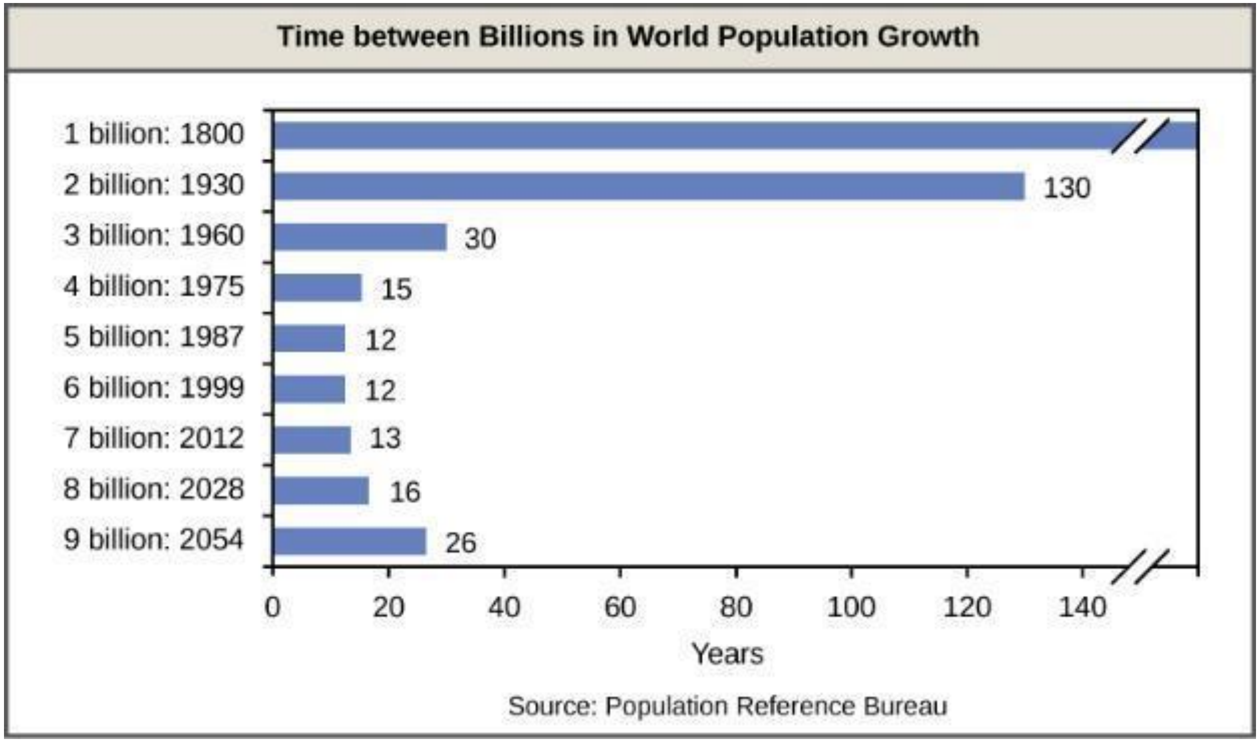
- Concepts of animal population dynamics can be applied to human population growth.
- Humans, have the ability to alter their environment to increase its carrying capacity, sometimes to the detriment of other species.
- The world’s human population is presently growing exponentially (Figure 19.9).
- Long-term exponential growth carries with it the potential risks of famine, disease, and large-scale death, as well as social consequences of crowding such as increased crime.
- The time that it takes to add a particular number of humans to the population is becoming shorter (Figure 19.10).
- The threat of overpopulation remains, because the damage caused to ecosystems and biodiversity is lowering the human carrying capacity of the planet.

FIGURE 19.9 HUMAN POPULATION GROWTH



Human population growth since 1000 AD is exponential.

FIGURE 19.10 WORLD POPULATION GROWTH



The time between the addition of each billion human beings to Earth decreases over time. (credit: modification of work by Ryan T. Cragun)

CONCEPT IN ACTION

Click through this interactive view of how human populations have changed over time.

[Launch Interactive](#)

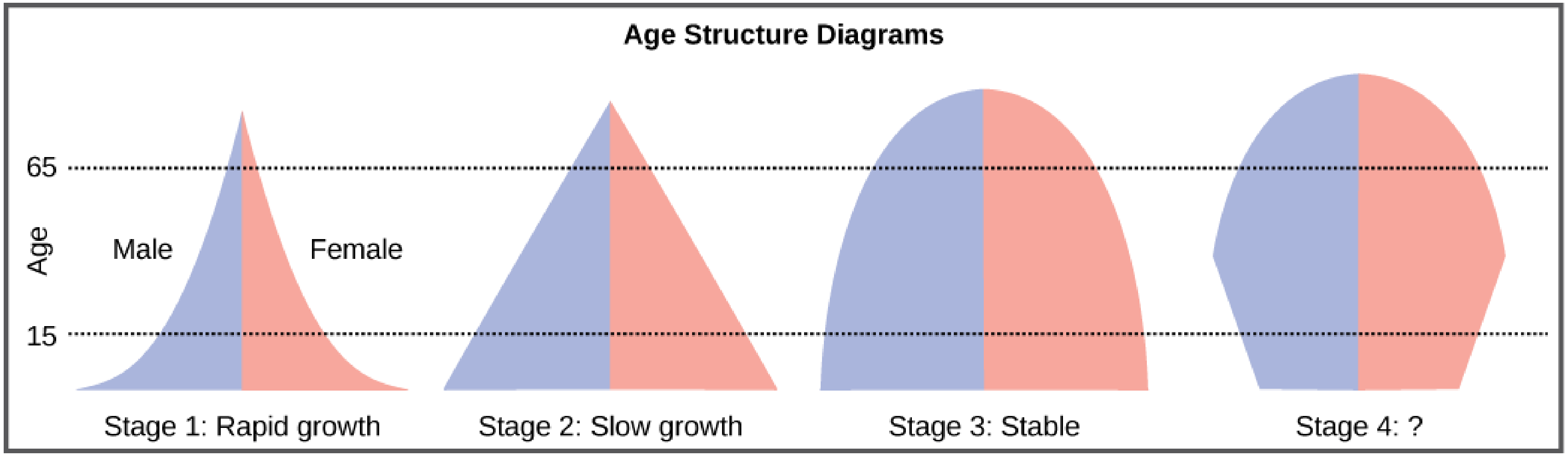
OVERCOMING DENSITY-DEPENDENT REGULATION (19.3)

- Humans are unique in their ability to alter their environment in many ways.
- Much of this ability is related to human intelligence, society, and communication.
- Other factors in human population growth are migration and public health.
    - Humans originated in Africa, but we have since migrated to nearly all inhabitable land on Earth, thus, increasing the area that we have colonized.
    - Public health, sanitation, and the use of antibiotics and vaccines have decreased the ability of infectious disease to limit human population growth in developed countries.

AGE STRUCTURE, POPULATION GROWTH AND ECONOMIC DEVELOPMENT (19.3)

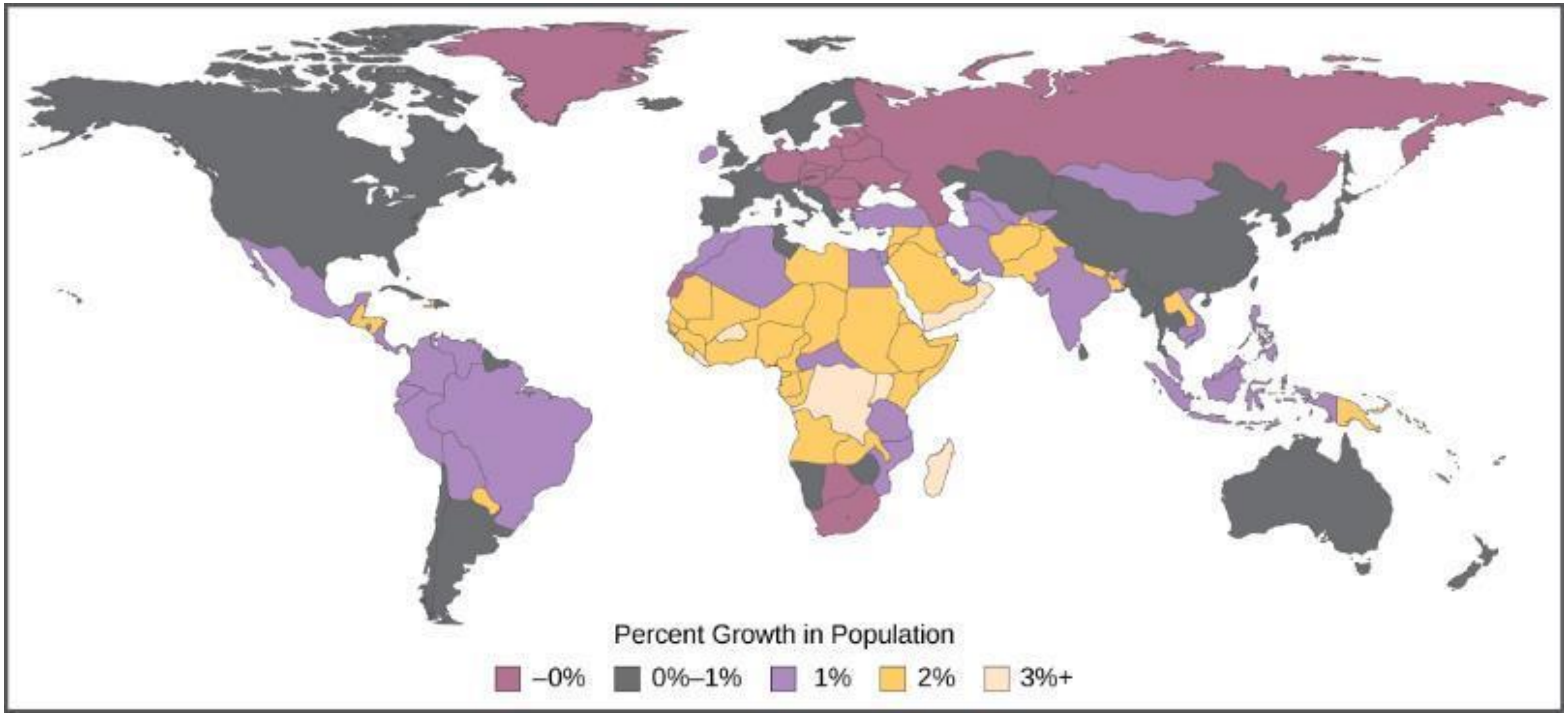
- **Age structure** is the proportion of a population in different age classes (Figure 19.11).
- Countries with rapid growth have a pyramidal shape showing a lot of younger individuals, many of whom are of reproductive age.
    - This pattern is most often seen in underdeveloped countries such as countries in Africa and Asia.
- Countries with slow growth, still have a pyramidal structure, but with many fewer young and reproductive-aged individuals and a greater proportion of older individuals.
    - This pattern is most often seen in developed countries such as the United States.
- Other developed countries, such as Italy, have zero population growth. The age structure of these populations is more conical, with an even greater percentage of middle-aged and older individuals.
- Figure 19.12 shows actual growth rates of countries.

FIGURE 19.11 AGE STRUCTURE DIAGRAMS



Typical age structure diagrams are shown. The rapid growth diagram narrows to a point, indicating that the number of individuals decreases rapidly with age. In the slow growth model, the number of individuals decreases steadily with age. Stable population diagrams are rounded on the top, showing that the number of individuals per age group decreases gradually, and then increases for the older part of the population.

FIGURE 19.12 ACTUAL GROWTH RATES



The percent growth rate of population in different countries is shown. Notice that the highest growth is occurring in less economically developed countries in Africa and Asia.

LONG TERM CONSEQUENCES OF EXPONENTIAL HUMAN POPULATION GROWTH 1 OF 2 (19.3)

- Many dire predictions have been made about the world's population leading to a major crisis called the "population explosion."
- The laws of exponential population growth are in effect, and unchecked human population growth cannot continue indefinitely.
- Efforts to moderate population control led to the one-child policy in China, which imposes fines on urban couples who have more than one child.
    - The effectiveness of the policy in limiting overall population growth is controversial, as is the policy itself.
- Family planning education programs in other countries have had highly positive effects on limiting population growth rates and increasing standards of living.

LONG TERM CONSEQUENCES OF EXPONENTIAL HUMAN POPULATION GROWTH2 OF 2 (19.3)

- In spite of population control, the human population continues to grow.
- Another consequence of population growth is the change and degradation of the natural environment, such as climate change caused by greenhouse emissions.
- Many countries have attempted to reduce the human impact on climate change by limiting their emission of greenhouse gases.

POPULATION GROWTH CONCEPT IN ACTION

Visit this website and select “Launch the movie” for an animation discussing the global impacts of human population growth.

Link to Video

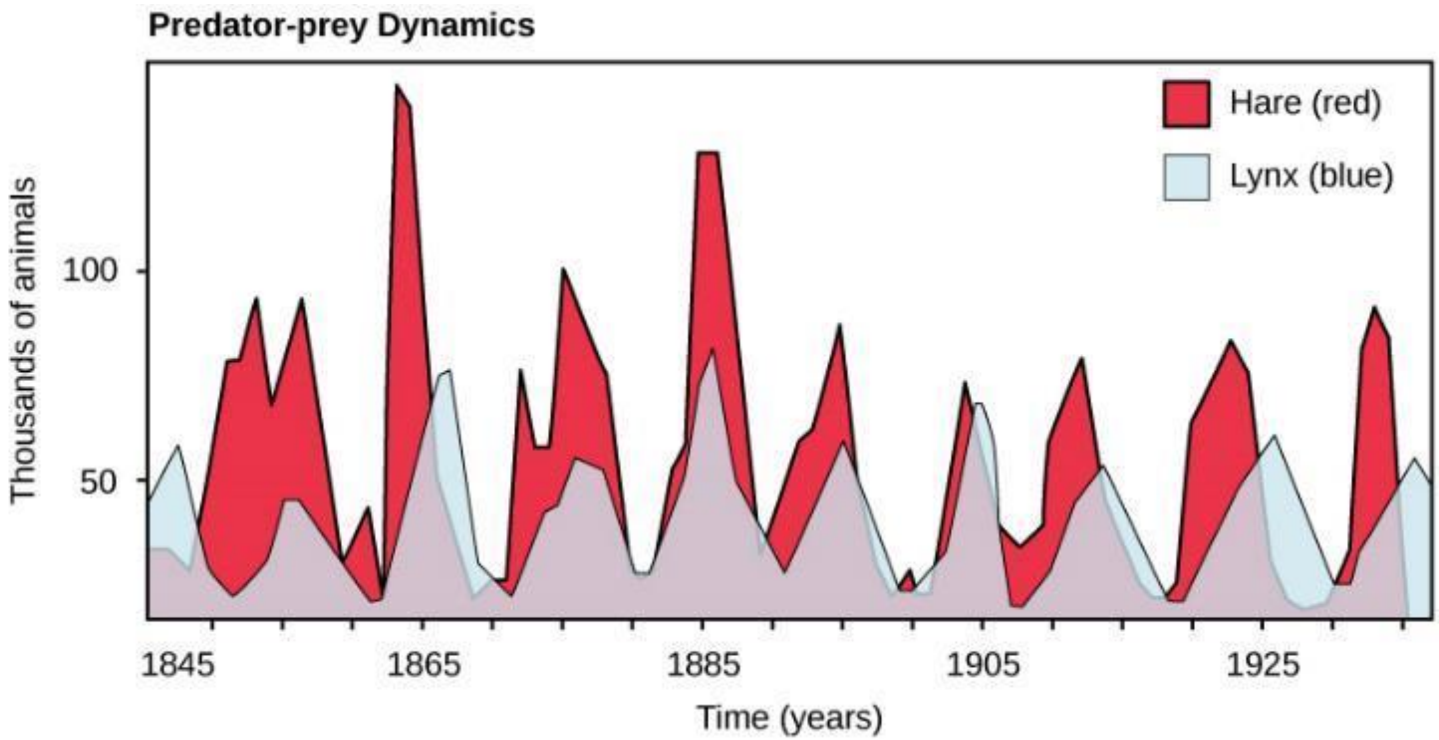
COMMUNITY ECOLOGY (19.4)

- In general, populations of one species never live in isolation from populations of other species.
- The interacting populations occupying a given habitat form an ecological **community**.
- The number of species occupying the same habitat and their relative abundance is known as the **diversity** of the community.

PREDATION AND HERBIVORY (19.4)

- The **predator-prey interaction** describes individuals of one population that kill and then consume the individuals of another population.
- Population sizes of predators and prey in a community are not constant over time, and they may vary in cycles that appear to be related.
- The most often cited example of predator-prey population dynamics is seen in the cycling of the lynx (predator) and the snowshoe hare (prey), using 100 years of trapping data from North America (Figure 19.13).
    - This cycling of predator and prey population sizes has a period of approximately ten years, with the predator population lagging one to two years behind the prey population.

FIGURE 19.13 PREDATOR-PREY DYNAMICS



The cycling of snowshoe hare and lynx populations in Northern Ontario is an example of predator-prey dynamics.

PREDATION AND HERBIVORY 1 OF 3(19.4)

- Predation and predator avoidance are strong selective agents.
    - A heritable trait that allows prey to avoid predators should become more common in the population.
    - A heritable trait that allows predators to locate and capture prey should become more common in the population.
- Species have evolved numerous mechanisms to escape predation and **herbivory** (the consumption of plants for food). Defenses may be mechanical, chemical, physical, or behavioral.
- Mechanical defenses, such as the presence of armor in animals or thorns in plants, discourage predation and herbivory by discouraging physical contact (Figure 19.14a).
- Many plant species produce secondary plant compounds that serve no function for the plant except that they are toxic to animals and discourage consumption. For example, the foxglove plant (Figure 19.14b).

FIGURE 19.14 DEFENSES AGAINST HERBIVORY

(a) (b)

The (a) honey locust tree uses thorns, a mechanical defense, against herbivores, while the (b) foxglove uses a chemical defense: toxins produces by the plant can cause nausea, vomiting, hallucinations, convulsions, or death when consumed. (credit a: modification of work by Huw Williams; credit b: modification of work by Philip Jägenstedt)

PREDATION AND HERBIVORY 2 OF 3 (19.4)

- Many species use their body shape and coloration to avoid being detected by predators.
    - The tropical walking stick is an insect with the coloration and body shape of a twig. (Figure19.15a).
    - The chameleon can change its color to match its surroundings (Figure 19.15b).
- Some species use coloration as a way of warning predators that they are distasteful or poisonous.
    - The monarch butterfly caterpillar sequesters poisons from milkweed plants to make itself poisonous or distasteful to potential predators. The caterpillar is bright yellow and the adult is red and black.
    - Fire-bellied toads produce toxins that make them distasteful to their potential predators. They have bright red or orange coloration on their bellies, to advertise toxicity (Figure 19.16).

FIGURE 19.15 DEFENSES AGAINST PREDATION

(a)

(b)

(a) The tropical walking stick and (b) the chameleon use their body shape and/or coloration to prevent detection by predators. (credit a: modification of work by Linda Tanner; credit b: modification of work by Frank Vassen)

FIGURE 19.16 DEFENSES AGAINST PREDATION

The fire-bellied toad has bright coloration on its belly that serves to warn potential predators that it is toxic. (credit: modification of work by Roberto Verzo)

PREDATION AND HERBIVORY 3 OF 3 (19.4)

- In **mimicry**, a harmless species imitates the warning coloration of a harmful species.
    - Assuming they share the same predators, this coloration then protects the harmless ones.
    - Many insect species mimic the coloration of wasps, which are stinging, venomous insects, thereby discouraging predation (Figure 19.17).
- In other cases of mimicry, multiple species share the same warning coloration, but all of them actually have defenses. The commonness of the signal improves the compliance of all the potential predators (Figure 19.18).

FIGURE 19.17 MIMICRY

(a)

(b)

One form of mimicry is when a harmless species mimics the coloration of a harmful species, as is seen with the (a) wasp (*Polistes* sp.) and the (b) hoverfly (*Syrphus* sp.). (credit: modification of work by Tom Ings)

FIGURE 19.18 MIMICRY

Several unpleasant-tasting *Heliconius* butterfly species share a similar color pattern with better-tasting varieties, an example of mimicry. (credit: Joron M, Papa R, Beltrán M, Chamberlain N, MaváLrez J, et al.)

MIMICRY CONCEPT IN ACTION

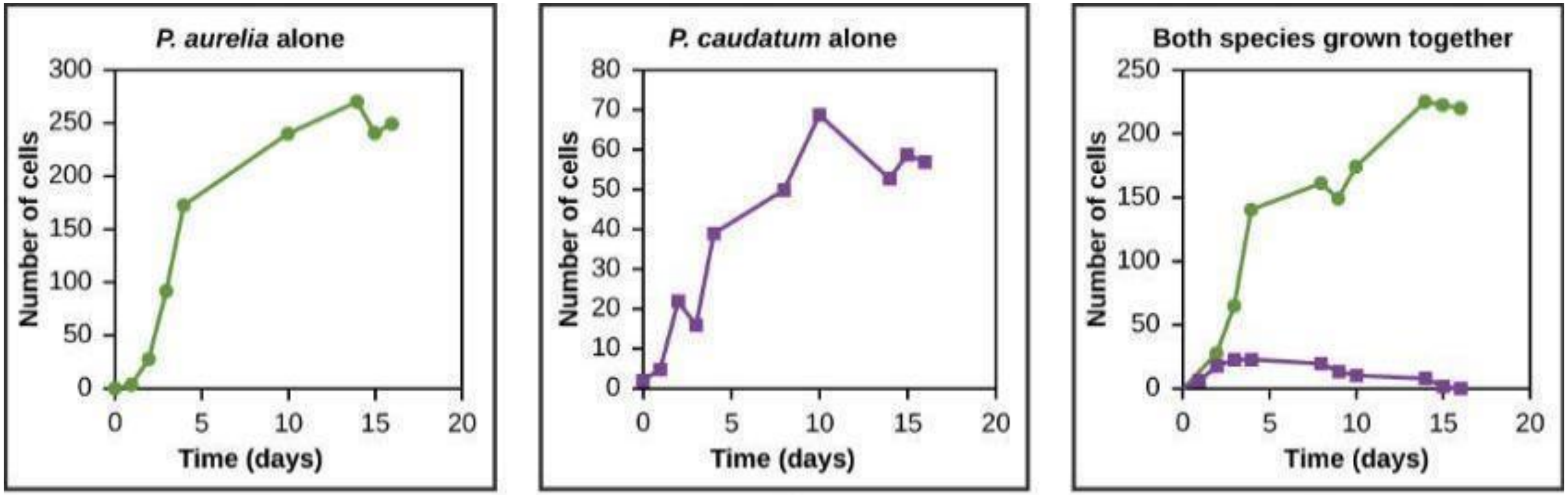
Go to this website to view stunning examples of mimicry

Link to Website

COMPETITIVE EXCLUSION PRINCIPLE (19.4)

- A **niche** is the unique set of resources used by a species, which includes its interactions with other species.
- The **competitive exclusion** principle states that two species cannot occupy the same niche in a habitat.
    - Different species cannot coexist in a community if they are competing for all the same resources.
- An experimental example of this principle is shown in Figure 19.19.
    - When grown individually in the laboratory, both species of *Paramecium* thrive.
    - But when they are placed together in the same test tube (habitat), *P. aurelia* outcompetes *P. caudatum* for food, leading to the latter’s eventual extinction.

FIGURE 19.19 COMPETITIVE EXCLUSION



(a) (b) (c)

Paramecium aurelia and *Paramecium caudatum* grow well individually, but when they compete for the same resources, the *P. aurelia* outcompetes the *P. caudatum*.

SYMBIOSIS 1 OF 2 (19.4)

- **Symbiotic relationships** are close, long-term interactions between individuals of different species.
- A **commensalism** occurs when one species benefits from a close prolonged interaction, while the other neither benefits nor is harmed.
    - Birds nesting in trees provide an example of a commensal relationship (Figure 19.20).
- A **mutualism**, is a symbiotic relationship in which two species benefit from their interaction.
    - Termites have a mutualistic relationship with protists that live in the insect's gut (Figure 19.21a).
    - Lichen are a mutualistic relationship between a fungus and photosynthetic algae or cyanobacteria (Figure 19.21b).

FIGURE 19.20 COMMENSALISM

The southern masked-weaver is starting to make a nest in a tree in Zambezi Valley, Zambia. This is an example of a commensal relationship, in which one species (the bird) benefits, while the other (the tree) neither benefits nor is harmed. (credit: “Hanay”/Wikimedia Commons)

FIGURE 19.21 MUTUALISMS

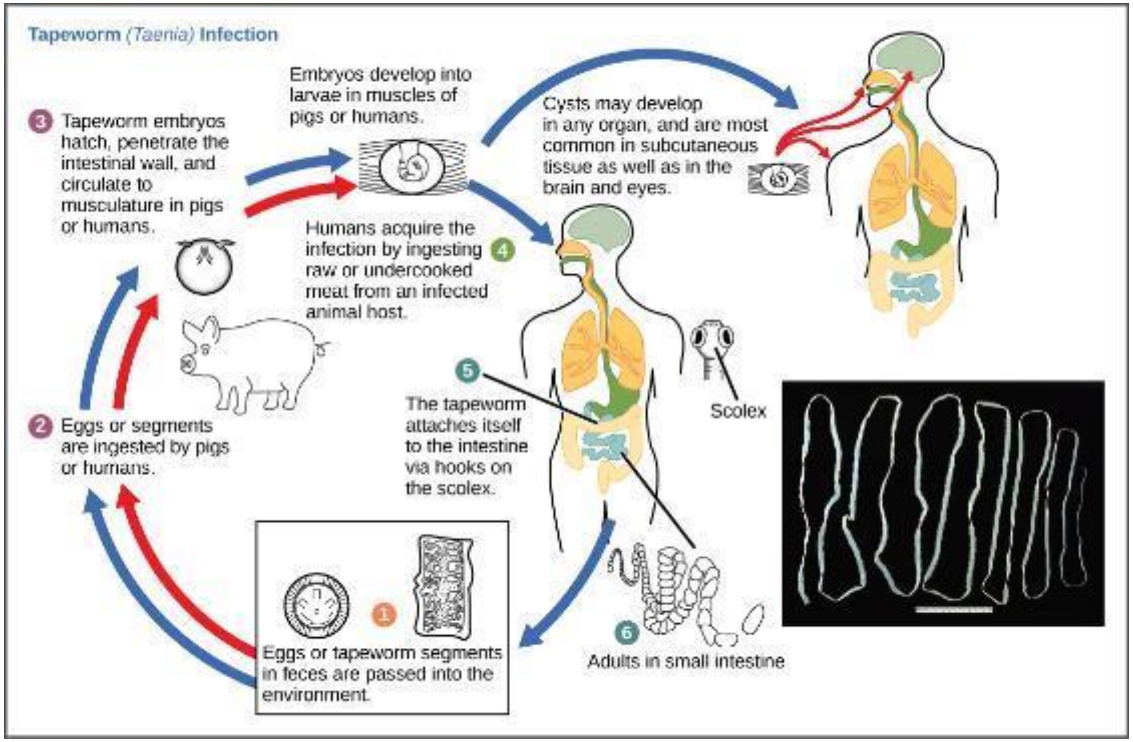
(a) (b)

- (a) Termites form a mutualistic relationship with symbiotic protozoa in their guts, which allow both organisms to obtain energy from the cellulose the termite consumes.
- (b) Lichen is a fungus that has symbiotic photosynthetic algae living in close association. (credit a: modification of work by Scott Bauer, USDA; credit b: modification of work by Cory Zanker)

SYMBIOSIS 2 OF 2 (19.4)

- A **parasite** is an organism that feeds off another without immediately killing the organism it is feeding on. In this relationship, the parasite benefits, but the organism being fed upon, the host, is harmed.
- The reproductive cycles of parasites are often very complex, sometimes requiring more than one host species.
  - A tapeworm causes disease in humans when contaminated, undercooked meat such as pork, fish, or beef is consumed (Figure 19.22).
  - *Plasmodium falciparum* is another parasite: the protists that cause malaria, a significant disease in many parts of the world.

FIGURE 19.22 PARASITISM



This diagram shows the life cycle of the tapeworm, a human worm parasite. (credit: modification of work by CDC)

SYMBIOSIS CONCEPT IN ACTION

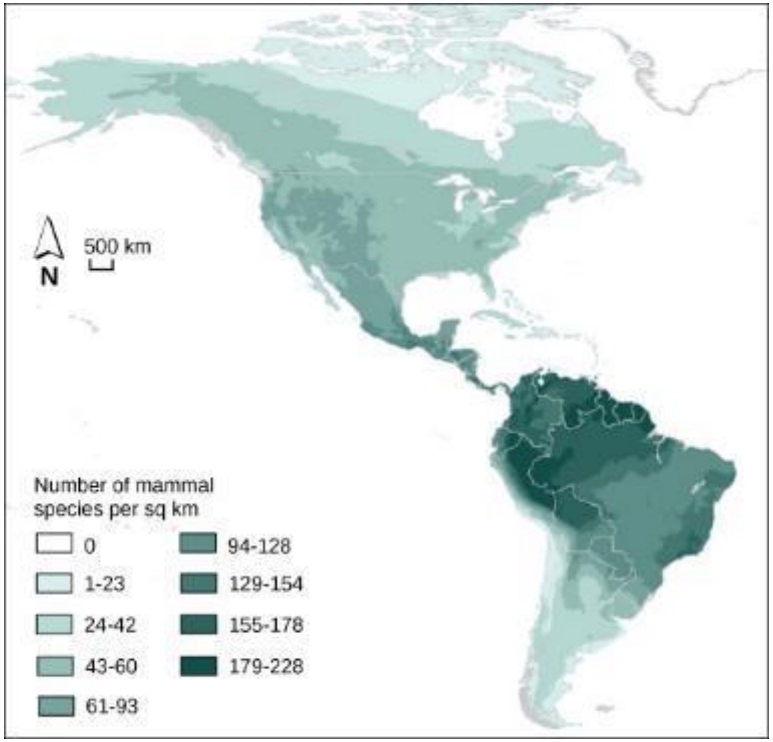
To learn more about “Symbiosis in the Sea,” watch this webisode of Jonathan Bird’s Blue World.

Link to Video

CHARACTERISTICS OF COMMUNITIES (19.4)

- One measure of biodiversity used by ecologists is the number of different species in a particular area and their relative abundance.
- **Species richness** is the term used to describe the number of species living in a habitat or other unit.
    - Species richness varies across the globe (Figure 19.23).
    - Species richness is related to latitude: the greatest species richness occurs near the equator and the lowest richness occurs near the poles.
- **Relative species abundance** is the number individuals in a species relative to the total number of individuals in all species within a system.
    - Foundation species often have the highest relative abundance of species.

FIGURE 19.23 SPECIES RICHNESS



The greatest species richness for mammals in North America is associated in the equatorial latitudes. (credit: modification of work by NASA, CIESIN, Columbia University)

CHARACTERISTICS OF COMMUNITIES 1 OF 4 (19.4)

- **Foundation species** are considered the "base" or "bedrock" of a community, having the greatest influence on its overall structure.
  - They are often primary producers, and they are typically an abundant organism.
  - For example, kelp, a species of brown algae, is a foundation species that forms the basis of the kelp forests off the coast of California.
- Foundation species may physically modify the environment to produce and maintain habitats that benefit the other organisms that use them.
  - For example, the corals of the coral reef also provide structure by physically modifying the environment (Figure19.24).

FIGURE 19.24 A FOUNDATION SPECIES

Coral is the foundation species of coral reef ecosystems. (credit: Jim E. Maragos, USFWS)

CHARACTERISTICS OF COMMUNITIES 2 OF 4 (19.4)

- A **keystone species** is one whose presence is key to maintaining biodiversity in an ecosystem and to upholding an ecological community's structure.
- The intertidal sea star, is a keystone species in the northwestern portion of the United States (Figure 19.25). It keeps the populations of mussels under control.
- Another keystone species is the banded tetra, a fish in tropical streams, which supplies nearly all of the phosphorus, a necessary inorganic nutrient, to the rest of the community.
- **Invasive species** are non-native organisms that, when introduced to an area out of its native range, alter the community they invade.
    - Examples are the Asian carp (discussed at the beginning of the chapter), the zebra mussel, common buckthorn, garlic mustard, emerald ash borer and many others.

FIGURE 19.25 A KEYSTONE SPECIES

The *Pisaster ochraceus* sea star is a keystone species. (credit: Jerry Kirkhart)

COMMUNITY DYNAMICS (19.4)

- Community dynamics are the changes in community structure and composition over time.
    - This often following environmental disturbances such as volcanoes, earthquakes, storms, fires, and climate change.
- **Succession** describes the sequential appearance and disappearance of species in a community over time after a severe disturbance.

CHARACTERISTICS OF COMMUNITIES 3 OF 4 (19.4)

- In **primary succession**, newly exposed or newly formed rock is colonized by living organisms.
    - Primary succession occurs when new land is formed, for example, following the eruption of volcanoes.
    - The first species to appear in succession are called **pioneer species** and tend to be hearty species like lichens and some plants (Figure 19.26).
- In **secondary succession**, a part of an ecosystem is disturbed and remnants of the previous community remain.
- In both cases, there is a sequential change in species until a more or less permanent community develops.

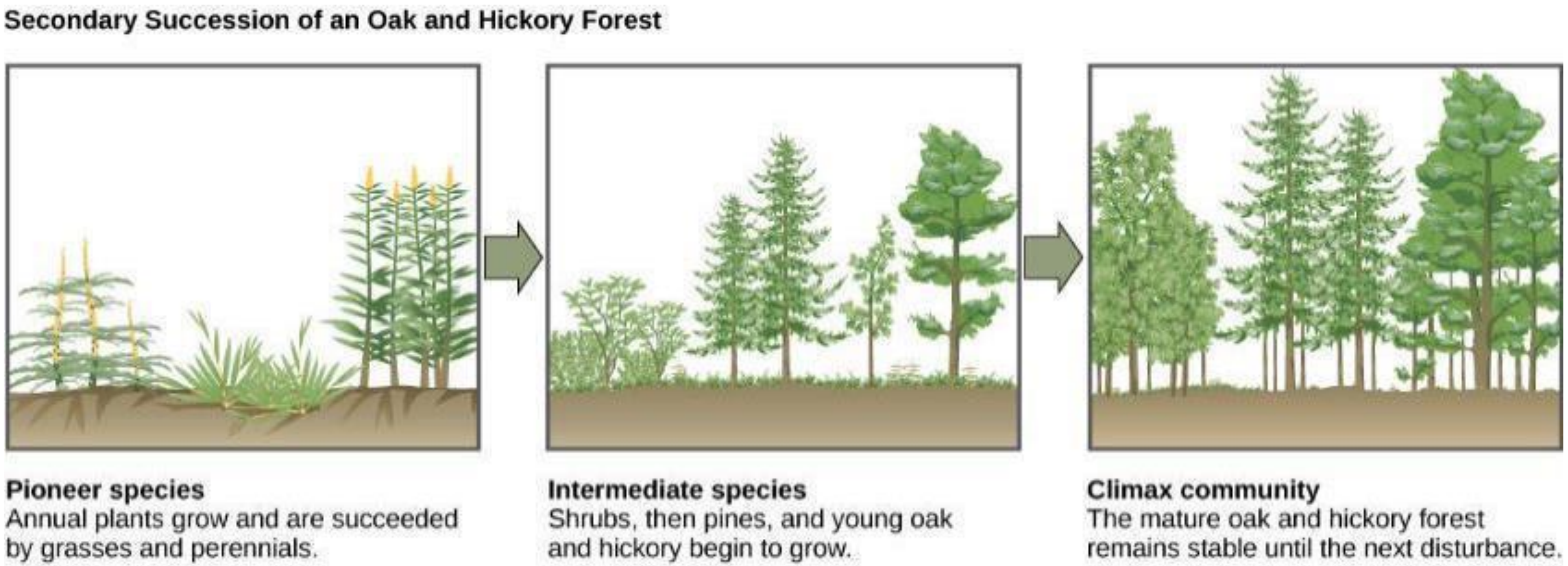
FIGURE 19.26 PIONEER SPECIES

During primary succession in lava on Maui, Hawaii, succulent plants are the pioneer species. (credit: Forest and Kim Starr)

CHARACTERISTICS OF COMMUNITIES 4 OF 4 (19.4)

- A classic example of secondary succession occurs in oak and hickory forests cleared by wildfire (Figure 19.27).
    - Before the fire, the vegetation was dominated by tall trees.
    - The first plants to colonize after the fire are annuals like grasses and other pioneer plants.
    - Over many years, shrubs emerge along with small pine, oak, and hickory trees.
    - Eventually, over 150 years, the forest will reach its equilibrium point and resemble the community before the fire.
    - This equilibrium state is referred to as the **climax community**, which will remain until the next disturbance.

FIGURE 19.27 SECONDARY SUCCESSION



Secondary succession is seen in an oak and hickory forest after a forest fire. A sequence of the community present at three successive times at the same location is depicted.

VOCABULARY 1 OF 2

- Demography
- Population size
- Population density
- Quadrat
- Mark and recapture
- Life tables
- Exponential growth
- Mortality rate
- Logistic growth
- Carrying capacity
- Intraspecific competition
- Density-dependent factors
- Density-independent factors
- K-selected species
- R-selected species
- Age structure
- Community
- Diversity

VOCABULARY 2 OF 2

- Predator-prey interaction
- Herbivory
- Mimicry
- Niche
- Competitive exclusion
- Symbiotic relationship
- Mutualism
- Commensalism
- Parasite
- Species richness
- Relative species abundance
- Foundation species
- Keystone species
- Invasive species
- Succession
- Primary succession
- Secondary succession
- Pioneer species
- Climax community