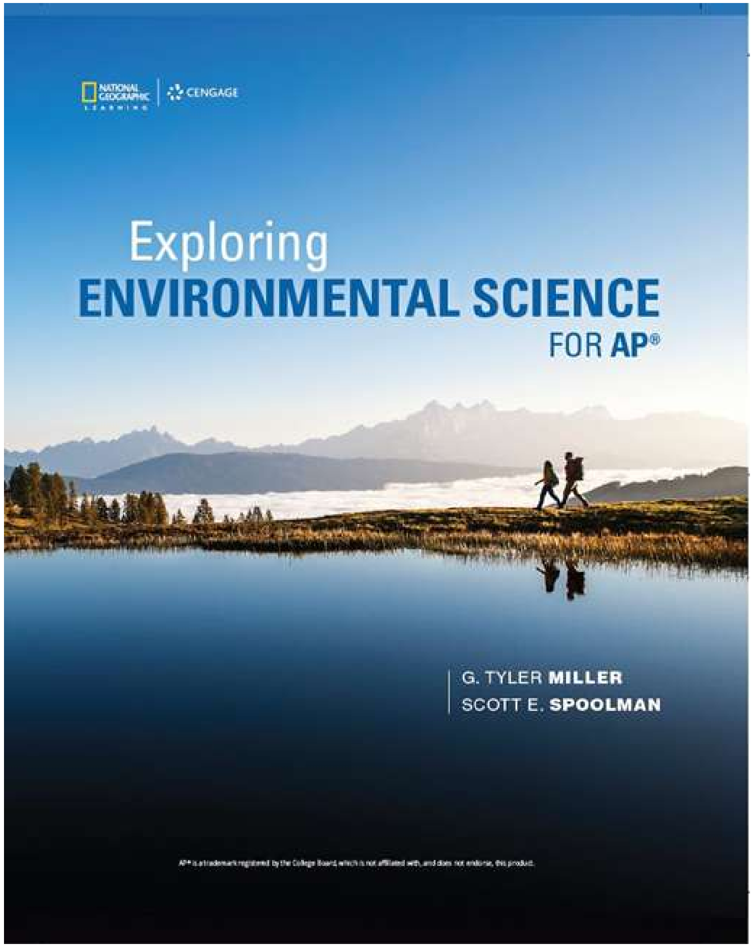
# Exploring Environmental Science for AP®

1st Edition




# Chapter 7
# Species Interactions, Ecological Succession, and Population Control

# Core Case Study: The Southern Sea Otter—A Species in Recovery

- Live in giant kelp forests on Pacific coast
- Hunted almost to extinction by early 1900s
  - Partial recovery since listed as endangered in 1977
- Reasons to care about sea otters
  - Keystone species
  - Ethics
  - Tourism dollars

# Southern Sea Otter

Left: Kirsten Wahlquist/Dreamstime.com. Right: Paul Whitted/Shutterstock.com.

# 7.1 How Do Species Interact?

- Five types of species interactions affect resource use and species population sizes in an ecosystem
  - Competition
  - Predation
  - Parasitism
  - Mutualism
  - Commensalism

# Competition for Resources (1 of 4)

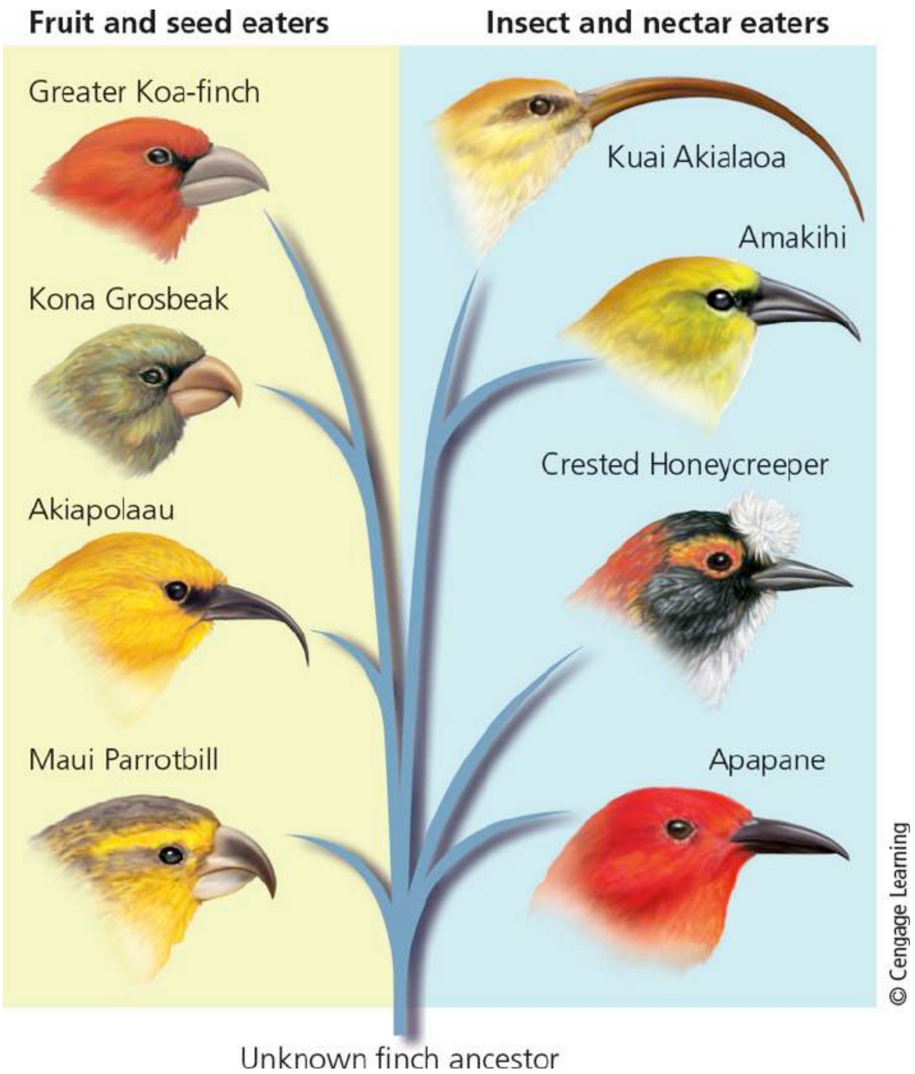
- Most common interaction is competition
- Interspecific competition
  - Competition between different species to use the same limited resources

# Competition for Resources (2 of 4)

- Resource partitioning
  - Occurs when different species evolve specialized traits that allow them to share the same resources
  - Species may use only parts of resource
    - At different times
    - In different ways

# Competition for Resources (3 of 4)

# Competition for Resources (4 of 4)



# Predation (1 of 2)

- Predator feeds directly on all or part of a member of another species (prey)
  - Strong effect on population sizes and other factors in ecosystems
- Methods of predation
  - Walk, swim, or fly
  - Camouflage
  - Chemical warfare

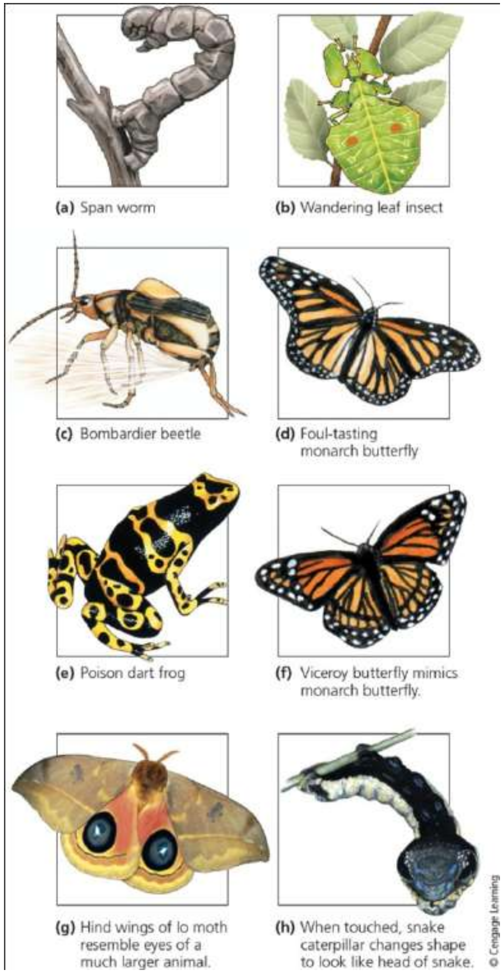
# Predation (2 of 2)

- Prey species have evolved ways to avoid predators
  - Camouflage
  - Chemical warfare
  - Warning coloration
  - Mimicry
  - Behavioral strategies

# Predator–Prey Relationships (1 of 2)

Steve Hilebrand/U.S. Fish and Wildlife Service

# Predator–Prey Relationships (2 of 2)



# Science Focus 7.1: Threats to Kelp Forests

- Giant kelp anchored to ocean floor and grow toward surface
  - Fast growing
  - Resistant to storm and wave damage
  - Support many marine plants and animals
- Sea urchins prey on kelp plants
  - Southern sea otter helps control sea urchin population
  - Ecosystem threatened by pollutants and climate change

# Coevolution

- Predation plays a role in natural selection
  - Animals with better defenses against predation tend to leave more offspring
- Coevolution
  - Changes in the gene pool of one species can cause changes in the gene pool of the other
  - Example: bats and moths
    - Echolocation of bats and sensitive hearing of moths

# Parasitism, Mutualism, and Commensalism (1 of 3)

- Parasitism
  - One species (parasite) lives on another organism
  - Parasites harm but rarely kill the host
  - Examples: tapeworms, sea lampreys, fleas, and ticks

# Parasitism

Great Lakes Fishery Commission

# Parasitism, Mutualism, and Commensalism (2 of 3)

- Mutualism
  - Interaction that benefits both species
  - Nutrition and protective relationship
  - Not cooperation—mutual exploitation
  - Example: clownfish live within sea anemones
    - Gain protection and feed on waste matter left by anemones' meals
    - Clownfish protect anemones from some predators and parasites

# Mutualism

Villiers Steyn/Dreamstime.com

# Parasitism, Mutualism, and Commensalism (3 of 3)

- Commensalism
  - Benefits one species and has little effect on the other
  - Examples:
    - Epiphytes (air plants) attach themselves to trees
    - Birds nest in trees

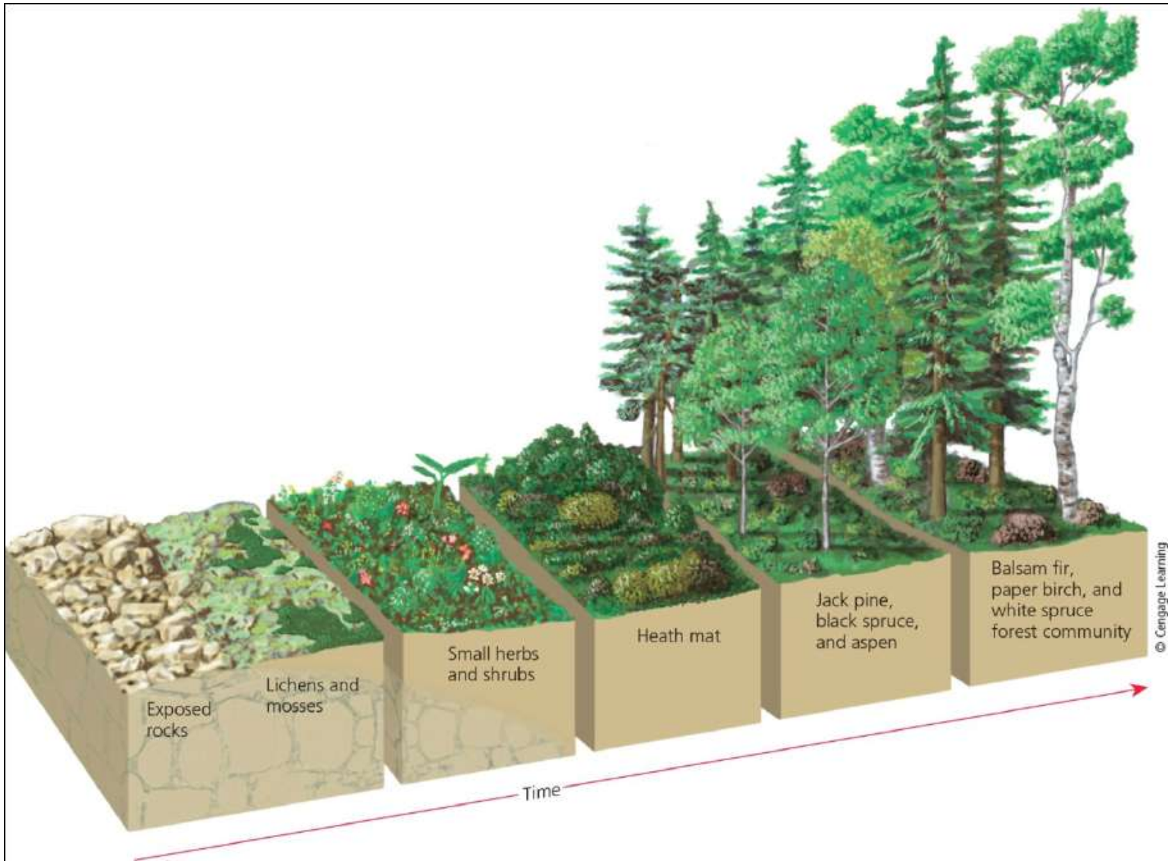
# Commensalism

parinyabinsuk/Shutterstock.com

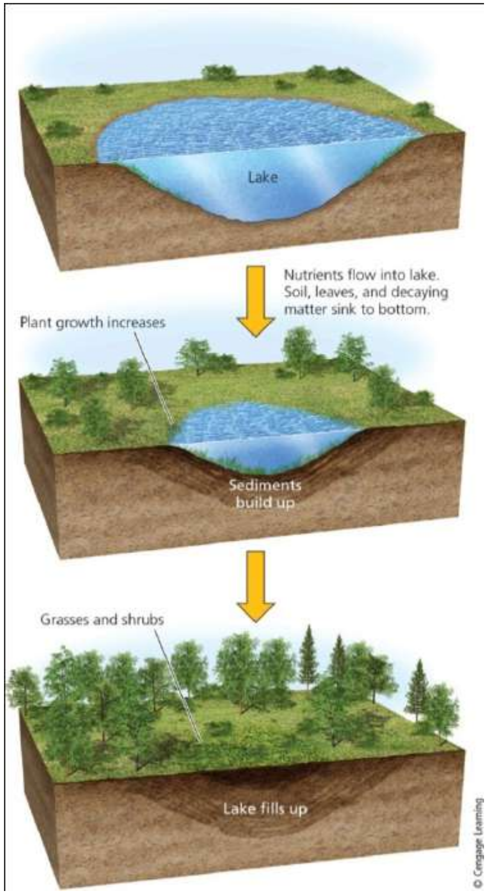
# 7.2 How Do Communities and Ecosystems Respond to Changing Environmental Conditions? (1 of 3)

- Ecological succession
  - Normally gradual change in structure and species composition in a given system
- Primary ecological succession
  - Involves gradual establishment of communities in lifeless areas
  - Need to build up fertile soil or aquatic sediments to support plant community
  - Pioneer species such as lichens or mosses

# 5.2 How Do Communities and Ecosystems Respond to Changing Environmental Conditions? (2 of 3)



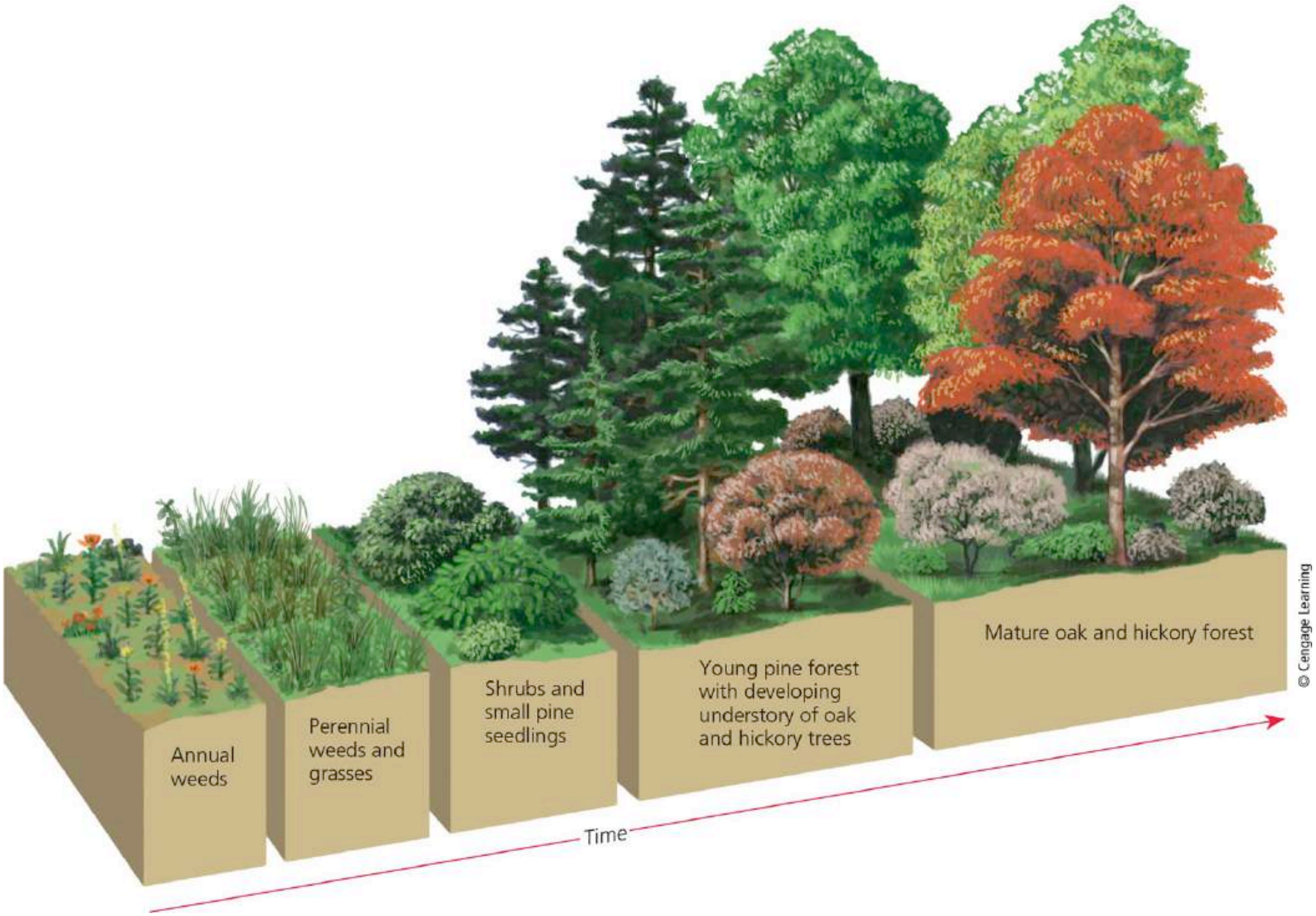
# 5.2 How Do Communities and Ecosystems Respond to Changing Environmental Conditions? (3 of 3)



# Ecological Succession Creates and Changes Ecosystems (1 of 2)

- Secondary ecological succession
  - Series of terrestrial communities or ecosystems develop in places with soil or sediment
  - Examples: abandoned farmland, burned or cut forests, and flooded land
- Factors affecting rate
  - Facilitation of area by one species for another
  - Inhibition hinders growth

# Ecological Succession Creates and Changes Ecosystems (2 of 2)



# Is There a Balance of Nature?

- Traditional view
  - Ecological succession proceeds to stable climax communities
  - Equilibrium called balance of nature
- Current view
  - Succession leads to a more complex, diverse, and resilient ecosystem
    - Can withstand changes if not too large or too sudden

# Living Systems Are Sustained through Constant Change

- Inertia
  - Ability of a living system to survive moderate disturbances
- Resilience
  - Ability of a living system to be restored through secondary succession after a moderate disturbance

# 7.3 What Limits the Growth of Populations? (1 of 3)

- Population
  - Group of interbreeding individuals of the same species
- Population size
  - May increase, decrease, or remain the same in response to changing environmental conditions
  - Scientists use sampling techniques to estimate

# What Limits the Growth of Populations? (2 of 3)

- Population distribution
  - Most populations live together in clumps or groups
    - Organisms cluster for resources
    - Protection from predators
- Variables that govern changes in population size
  - Births, deaths, immigration, and emigration
- Age Structure
  - Distribution of individuals among various age groups
    - Pre-reproductive, reproductive, and post-reproductive stages

# What Limits the Growth of Populations? (3 of 3)

a. Clumped (elephants)

b. Uniform (creosote bush)

c. Random (dandelions)

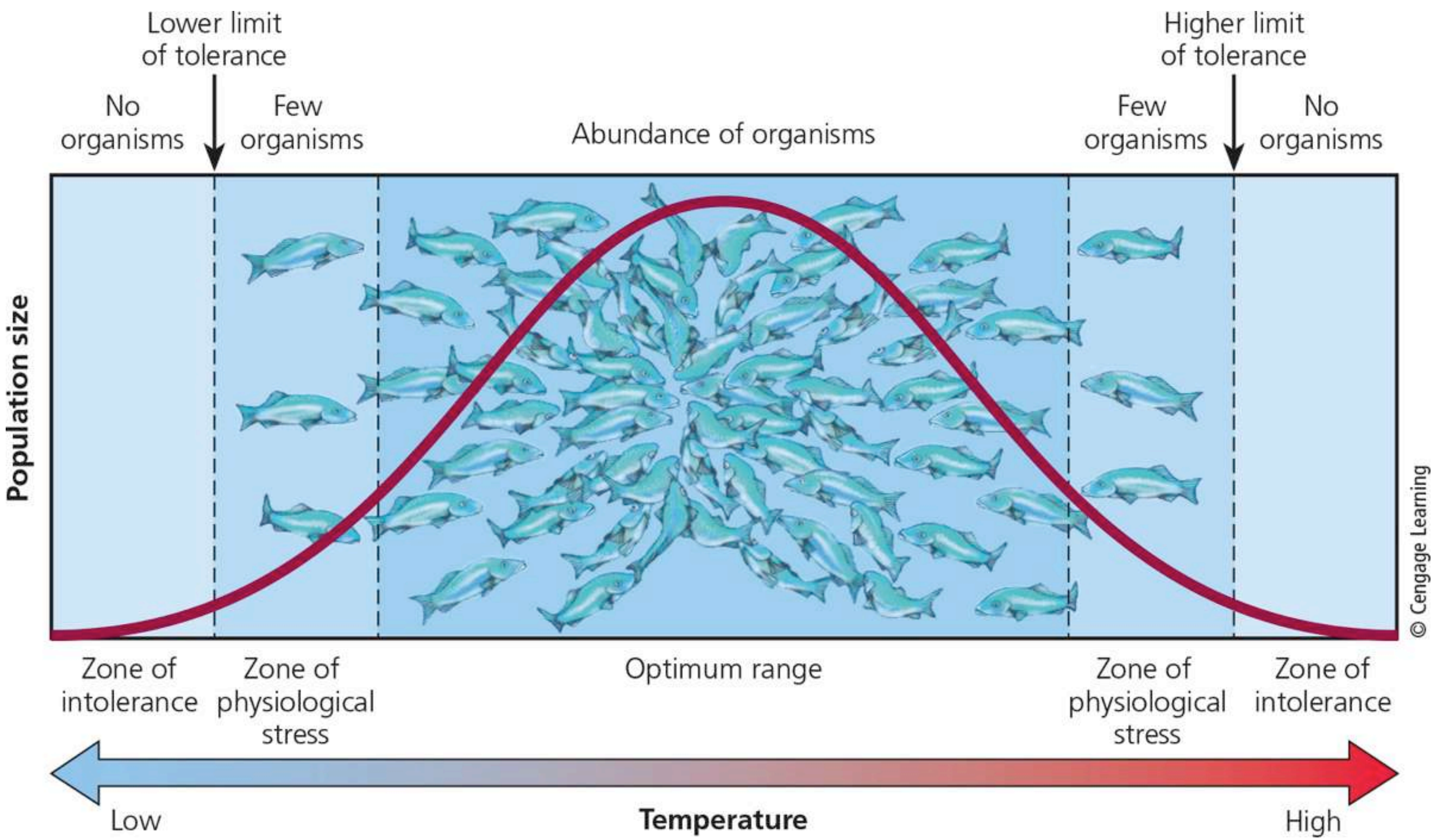
# Critical Concept: Sampling Populations

- Characterization of populations can be qualitative or quantitative
- Quadrat sampling can be used to determine abundance, density, and distribution of species
- Mark and recapture sampling is used to estimate the size of a population in a defined area

# Several Factors Can Limit Population Size (1 of 2)

- Each population has a range of tolerance
  - Variation in physical and chemical environment under which it can survive
- Limiting factors
  - Precipitation (on land)
  - Water temperature, depth, clarity, and other factors (in aquatic environments)
  - Population density
    - Density-dependent factors

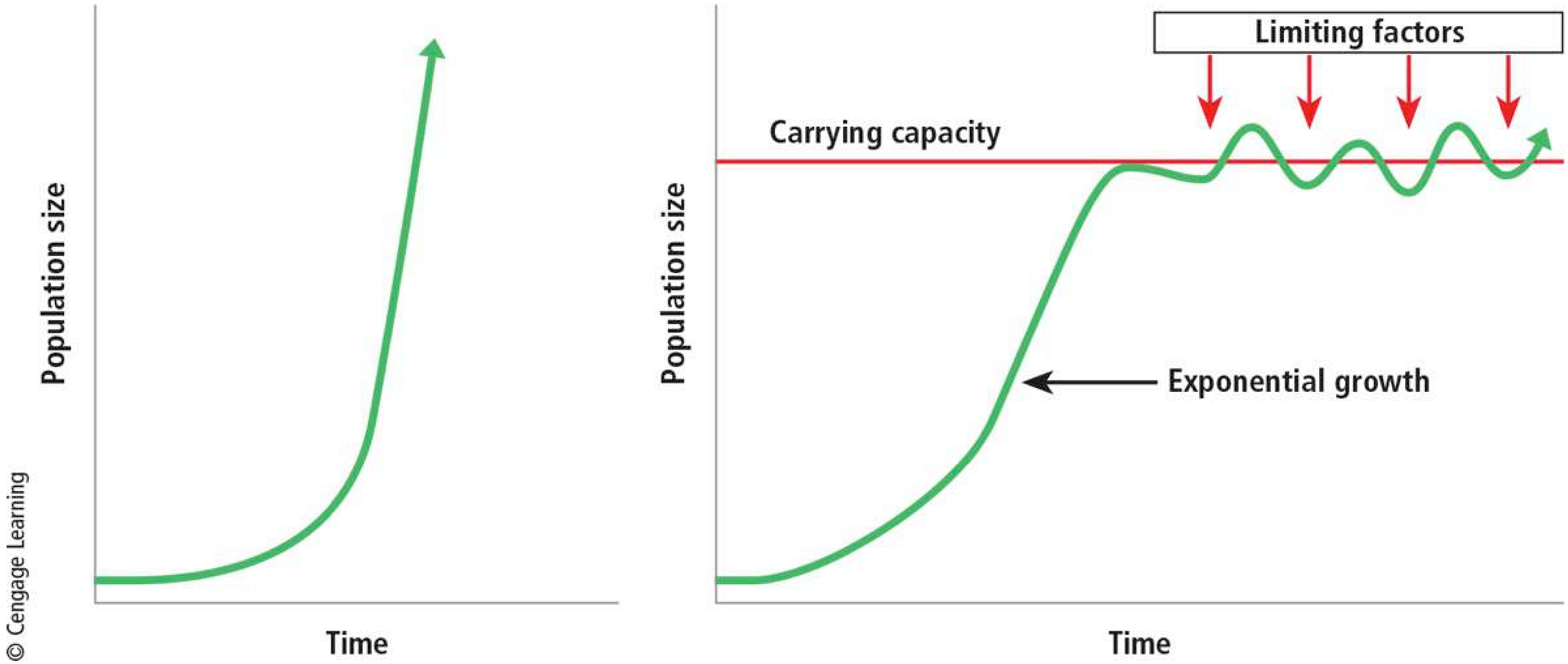
# Several Factors Can Limit Population Size (2 of 2)



# No Population Can Grow Indefinitely: J-Curves and S-Curves (1 of 4)

- Some species can reproduce exponentially
  - Reproduce at an early age
  - Have many offspring each time they reproduce
  - Short intervals in between reproductive cycles
  - Produces J-shaped curve of growth
  - Examples: bacteria and many insect species

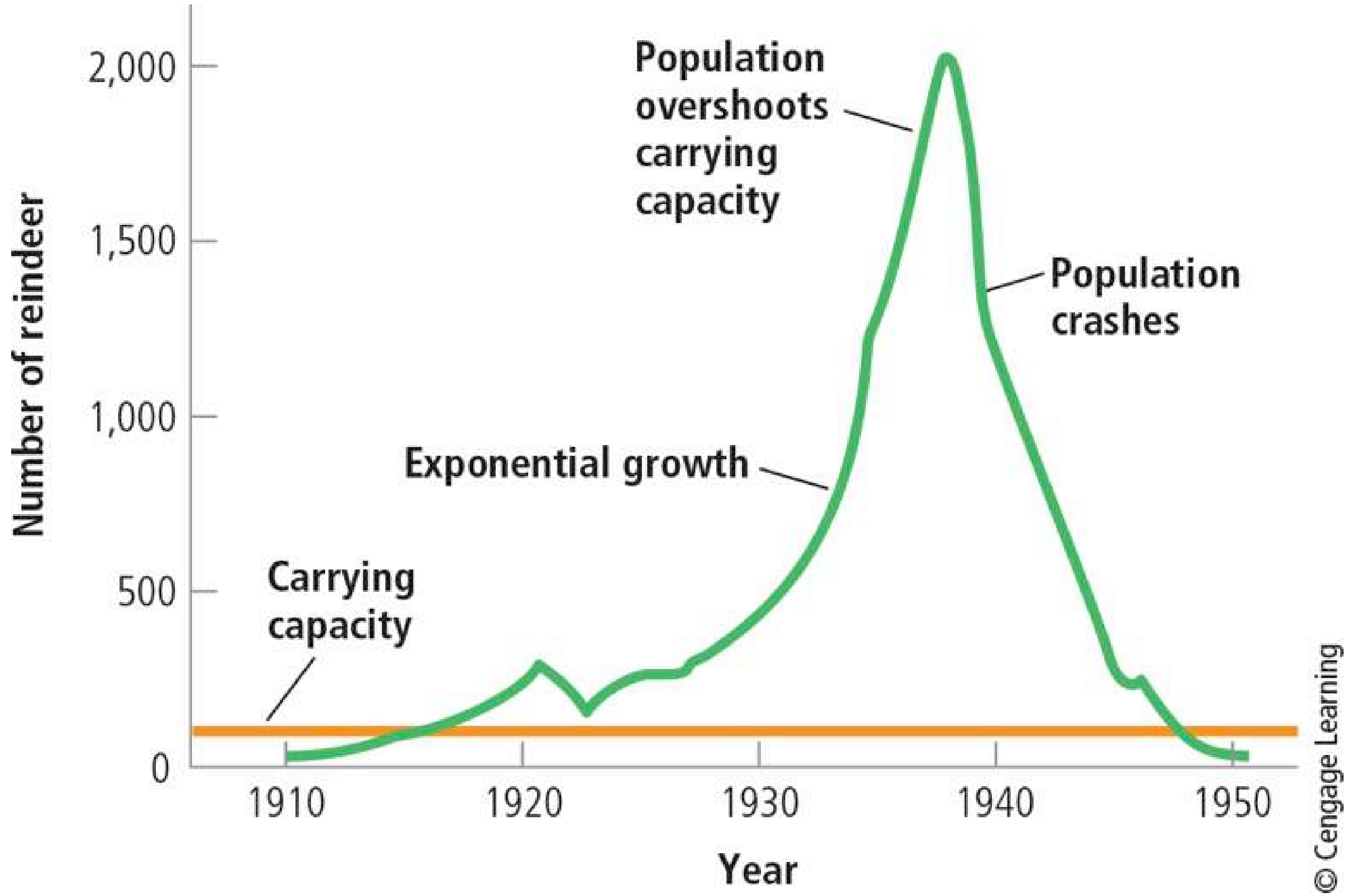
# No Population Can Grow Indefinitely: J-Curves and S-Curves (2 of 4)



# No Population Can Grow Indefinitely: J-Curves and S-Curves (3 of 4)

- Population growth in nature always limited
- Environmental resistance
  - Sum of all factors that limit population growth
- Carrying capacity
  - Maximum population of a given species that a particular habitat can sustain indefinitely
  - Overshoot results in population crash

# No Population Can Grow Indefinitely: J-Curves and S-Curves (4 of 4)



# Reproductive Patterns (1 of 3)

- *r*-Selected species
  - Species with capacity for a high rate of population growth
  - Examples: algae, bacteria, frogs, most insects, and many fish
  - May go through irregular and unstable cycles in population sizes

# Reproductive Patterns (2 of 3)

- *K*-Selected species
  - Species that reproduce later in life
  - Have few offspring
  - Have long life spans
  - Examples: large mammals, whales, humans, birds of prey, and long-lived plants
  - Can be vulnerable to extinction

# Reproductive Patterns (3 of 3)

**TABLE 5.1** Typical traits of *r*-selected and *K*-selected species

| Trait | *r* – Selected Species | *K* – Selected Species |
|---|---|---|
| Reproductive potential | High | Low |
| Population growth rate | Fast | Slow |
| Time to reproductive maturity | Short | Long |
| Number of reproductive cycles | Many | Few |
| Number of offspring | Many | Few |
| Size of offspring | Small | Larger |
| Degree of parental care | Low | High |
| Life span | Short | Long |
| Population size | Variable with Crashes | Stable, near carrying capacity |
| Role in environment | Usually prey | Usually predators |

# Case Study: Exploding White-Tailed Deer Population in the U.S. (1 of 2)

- 1900: deer habitat destruction and uncontrolled hunting
- 1920s–1930s: laws to protect deer
- Current deer population explosion in suburban areas
  - Increased deer-vehicle collisions and Lyme disease
- Various methods to control the deer population

# Case Study: Exploding White-Tailed Deer Population in the U.S. (2 of 2)


Roy Toft/National Geographic Creative

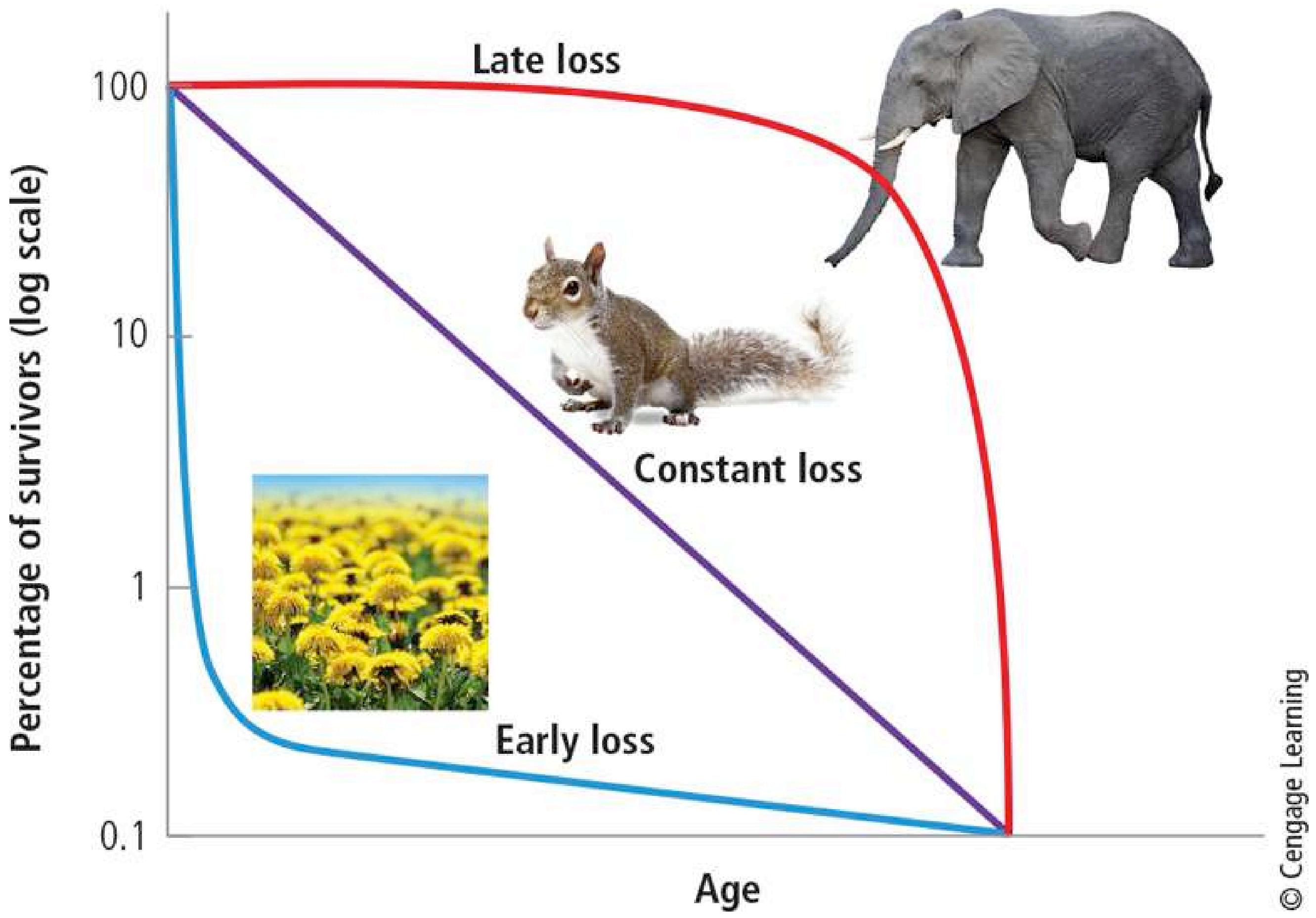
# Science Focus 5.2: The Future of California's Southern Sea Otters

- Factors in declining sea otter population
  - Increased predation by orcas
  - Toxic algae and pollutants released into the ocean
  - Low reproductive rate
  - Rising mortality rate
- Other threats: oil spills and fishing traps
- Otter population rising in last several years

# Species Vary in Their Life Spans (1 of 2)

- Survivorship curve
  - Shows the percentages of members of population surviving at different ages
    - Late loss (*K*-selected species)
    - Early loss (*r*-selected species)
    - Constant loss (many songbirds)

# Species Vary in Their Life Spans (2 of 2)



# Humans Are Not Exempt from Nature's Population Controls

- Ireland
  - Potato crop destroyed by fungus in 1845
  - Killed one million people
- Bubonic plague
  - Killed 25 million during the $14^{th}$ century
- Technological, social, and cultural changes have expanded earth's carrying capacity for the human species today