LIVING IN THE ENVIRONMENT, 18e

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5 Biodiversity, Species Interactions, and Population Control

Core Case Study: Southern Sea Otters - A Species in Recovery

- Live in giant kelp forests
- By the early 1900s they had been hunted almost to extinction
- Partial recovery since 1977
- Why care about sea otters?
  - Ethics
  - Tourism dollars
  - Keystone species

Southern Sea Otter

Left: © Xfkirsten | Dreamstime.com; Right: Paul Whitted/Shutterstock.com

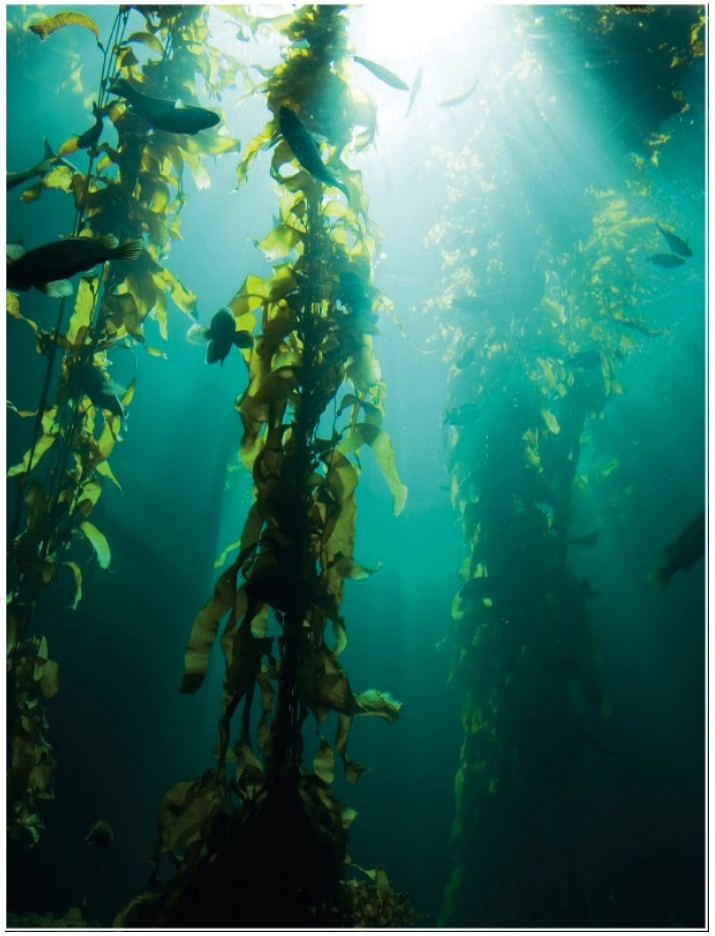


Fig. 5-1, p. 102

5-1 How Do Species Interact?

- Five types of species interactions—competition, predation, parasitism, mutualism, and commensalism—affect the resource use and population sizes of the species in an ecosystem

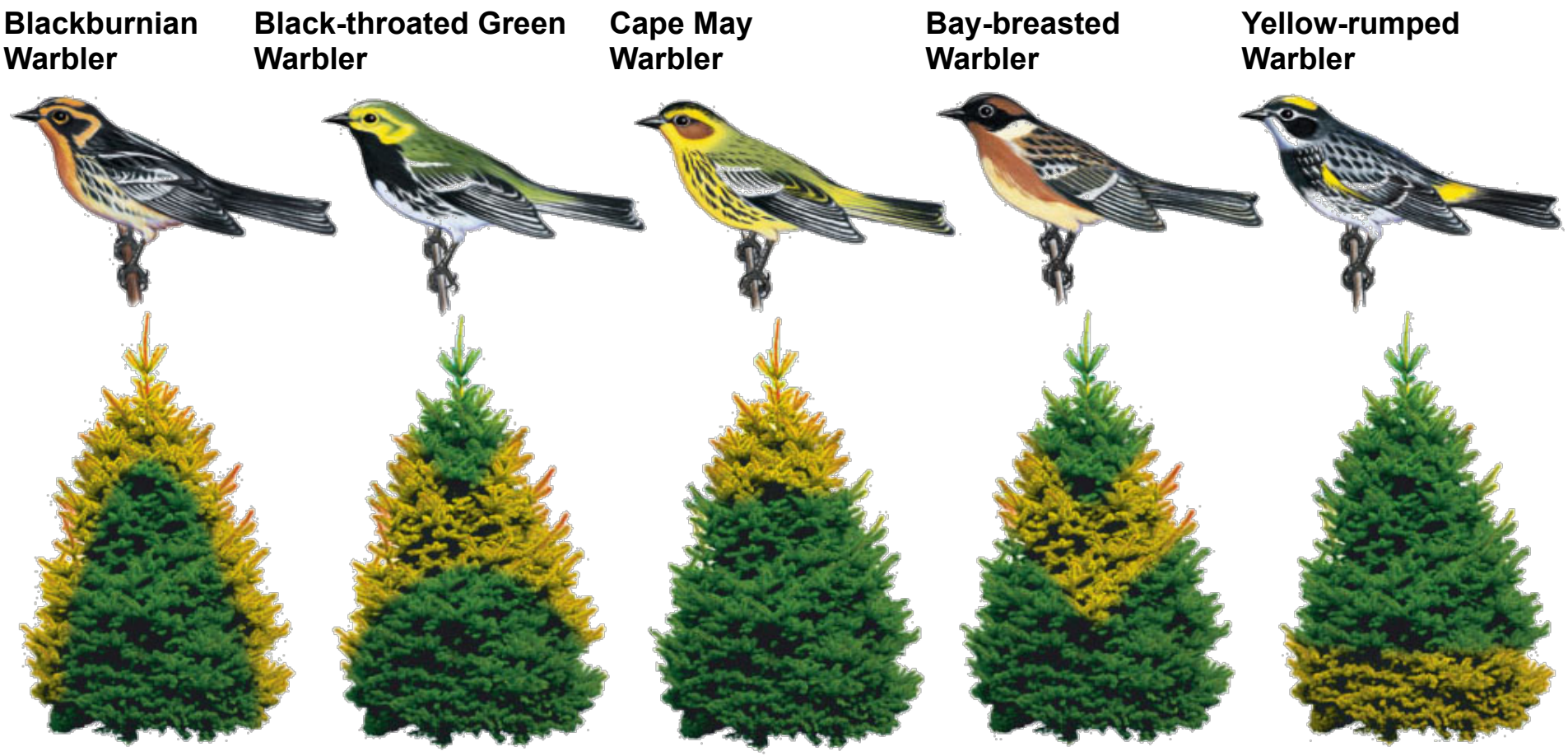
Most Species Compete with One Another for Certain Resources

- Five basic types of interactions
  - Interspecific Competition
  - Predation
  - Parasitism
  - Mutualism
  - Commensalism
- Interspecific competition
  - Compete to use the same limited resources

Some Species Evolve Ways to Share Resources

- Resource partitioning
- Species may use only parts of resource
  - At different times
  - In different ways

Sharing the Wealth



Stepped Art

Fig. 5-2, p. 103

Specialist Species of Honeycreepers

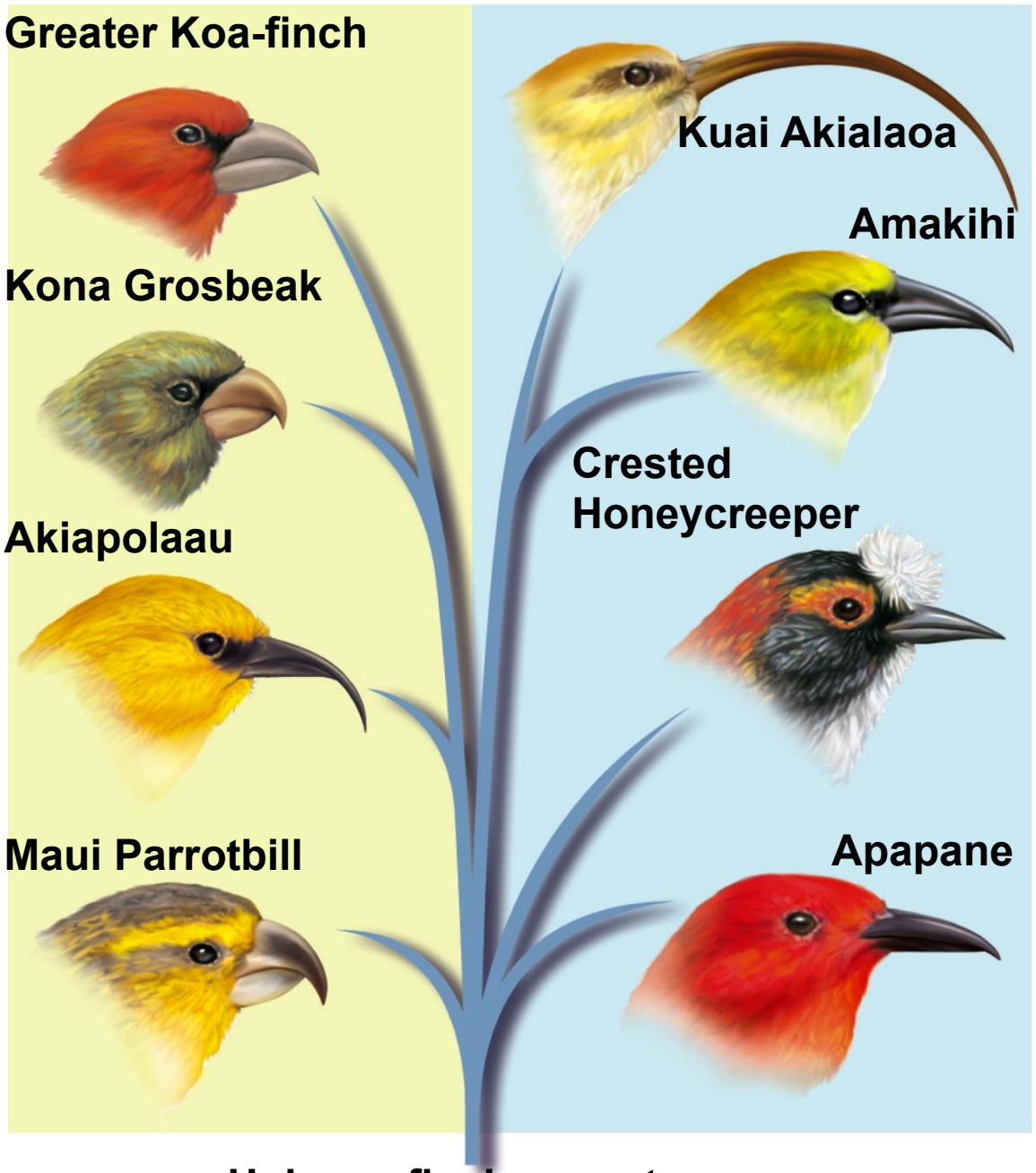


Fig. 5-3, p. 104

Consumer Species Feed on Other Species

- Predator – feeds directly on all or part of a living organism
- Carnivores
  - Pursuit and ambush
  - Camouflage
  - Chemical warfare

Consumer Species Feed on Other Species (cont'd.)

- Prey can avoid predation
  - Camouflage
  - Chemical warfare
  - Warning coloration
  - Mimicry
  - Behavioral strategies

Predator-Prey Relationships

Steve Hilebrand/U.S. Fish and Wildlife Service

Fig. 5-4, p. 104

Predator-Prey Relationships

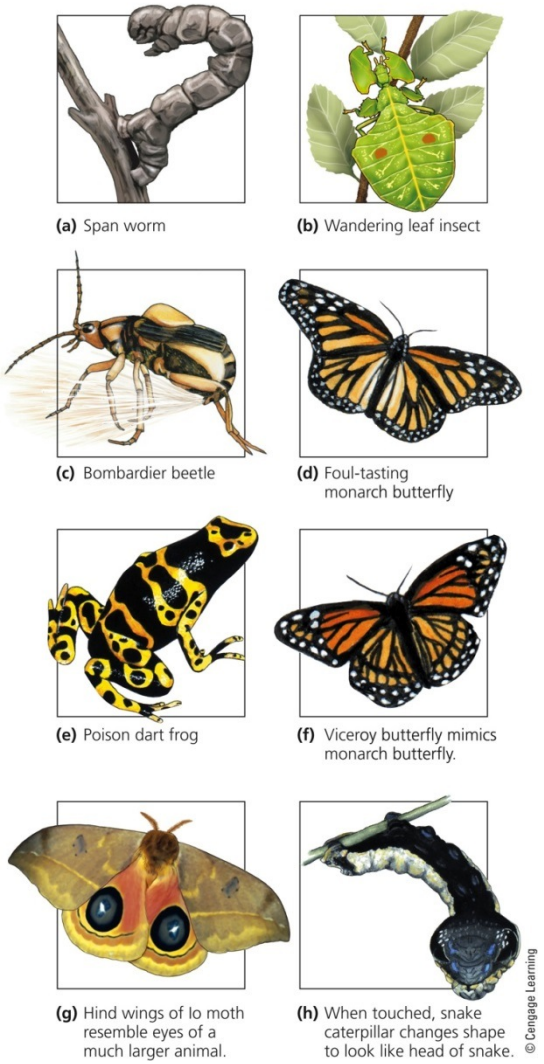


Fig. 5-6, p. 106

Interactions between Predator and Prey Species

- Intense natural selection pressures between predator and prey populations
- Coevolution
  - Interact over a long period of time
  - Changes in the gene pool of one species can cause changes in the gene pool of the other
  - Bats and moths
    - Echolocation of bats and sensitive hearing of moths

Coevolution

Fig. 5-7, p. 107

Some Species Feed off Other Species by Living on or inside Them

- Parasitism
  - Parasite is usually much smaller than the host
  - Parasite rarely kills the host
  - Parasite-host interaction may lead to coevolution

Parasitism

Fig. 5-8, p. 107

In Some Interactions, Both Species Benefit

- Mutualism
  - Nutrition and protective relationship
  - Gut inhabitant mutualism
  - Not cooperation – mutual exploitation

Mutualism

Villiers/Dreamstime.com

Fig. 5-9, p. 108

In Some Interactions, One Species Benefits and the Other Is Not Harmed

- Commensalism
  - Benefits one species and has little affect on the other
  - Epiphytes
  - Birds nesting in trees

Commensalism

Frans Lanting/National Geographic Creative

Fig. 5-10, p. 108

5-2 Responding to Changing Environmental Conditions

- How do communities and ecosystems respond to changing environmental conditions?
  - The structure and species composition of communities and ecosystems change in response to changing environmental conditions through a process called ecological succession

Communities and Ecosystems Change over Time: Ecological Succession

- Ecological succession
  - Gradual change in species composition
  - Primary succession
    - In lifeless areas
  - Secondary succession
    - Areas of environmental disturbance
  - Examples of natural ecological restoration

Primary Ecological Succession

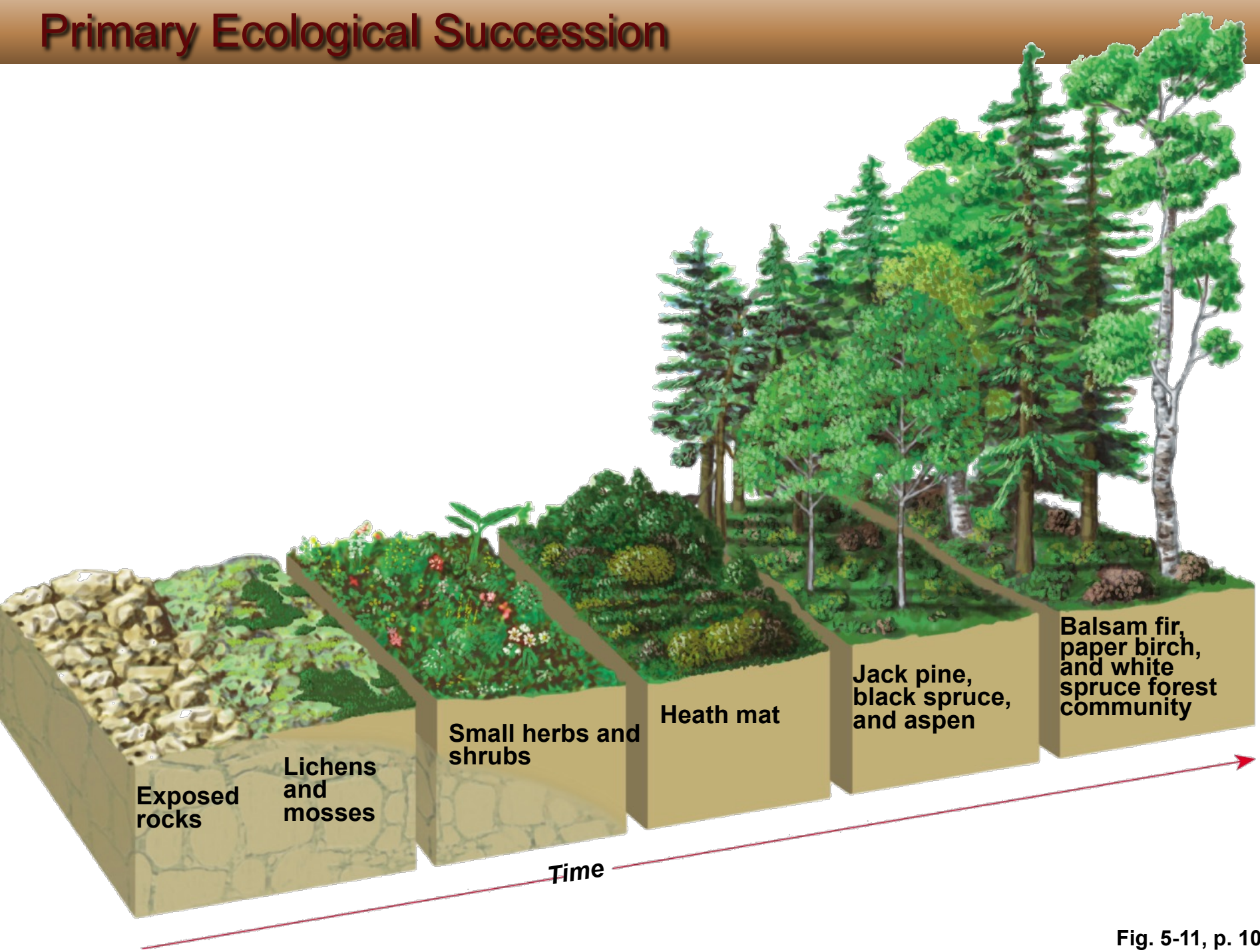


Fig. 5-11, p. 109

Natural Ecological Restoration

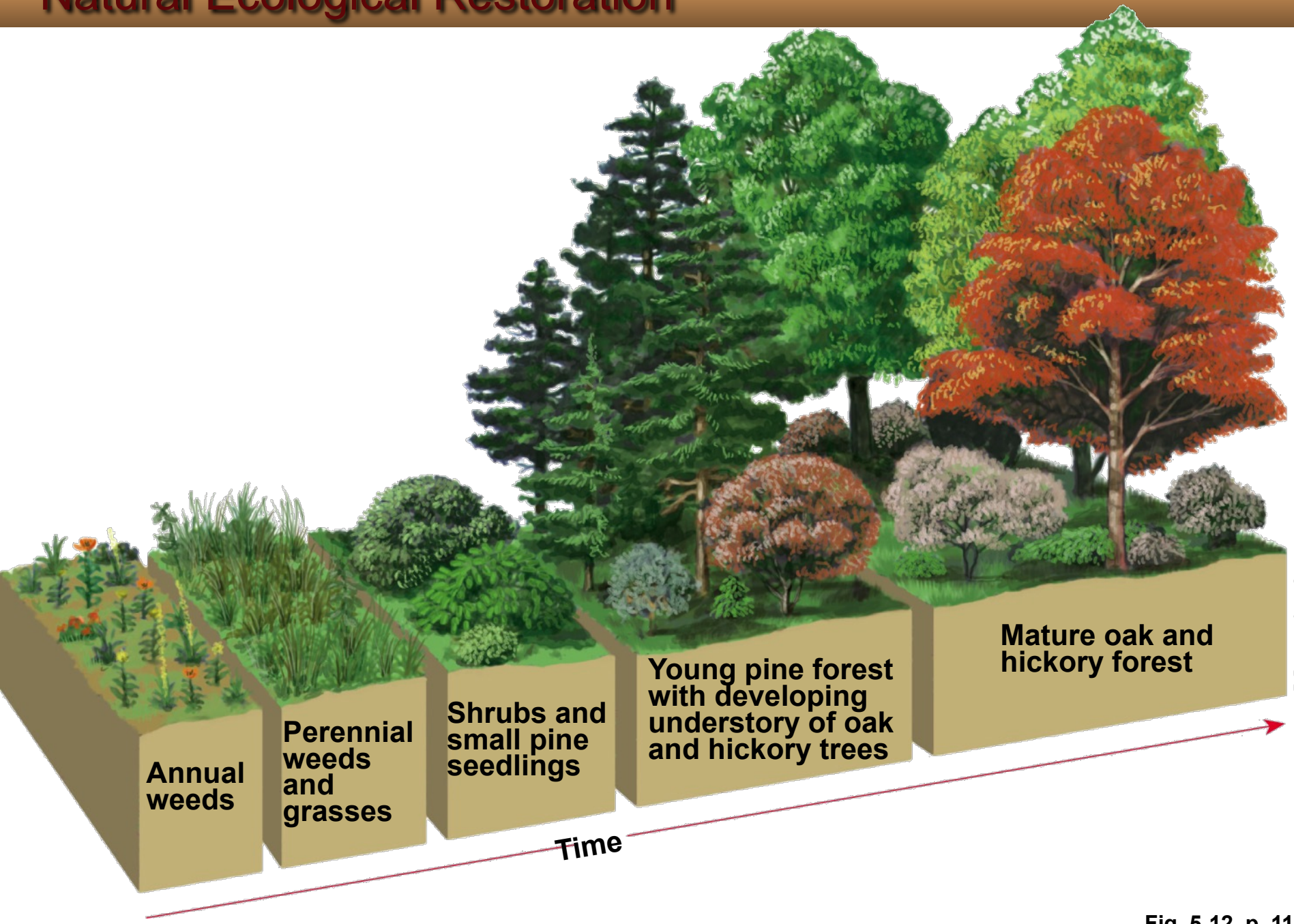


Fig. 5-12, p. 110

Ecological Succession Does Not Follow a Predictable Path

- Traditional view
  - Balance of nature and climax communities
- Current view
  - Ever-changing mosaic of patches of vegetation in different stages of succession

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

What Limits the Growth of Populations

- No population can grow indefinitely because of limitations on resources and because of competition among species for those resources

Most Populations Live in Clumps

- Population
  - Group of interbreeding individuals of the same species
- Population distribution
  - Clumping
    - Species cluster for resources
    - Protection from predators
    - Ability to hunt in packs

A School of Anthias Fish

Rich Carey/iStockphoto.com

Fig. 5-13, p. 111

Populations Can Grow, Shrink, or Remain Stable

- Population size governed by:
  - Births and deaths; immigration and emigration
- Population change = (births + immigration) – (deaths + emigration)
- Age structure
  - Pre-reproductive age
  - Reproductive age
  - Post-reproductive age

Some Factors Can Limit Population Size

- Range of tolerance
  - Variations in physical and chemical environment
  - Individuals may have different tolerance ranges

Some Factors Can Limit Population Size

- Limiting factor principle
  - Too much or too little of any physical or chemical factor can limit or prevent growth of a population, even if all other factors are at or near the optimal range of tolerance
  - Precipitation, nutrients, sunlight
- Populations density
  - Number of individuals in a given area

Trout Tolerance of Temperature

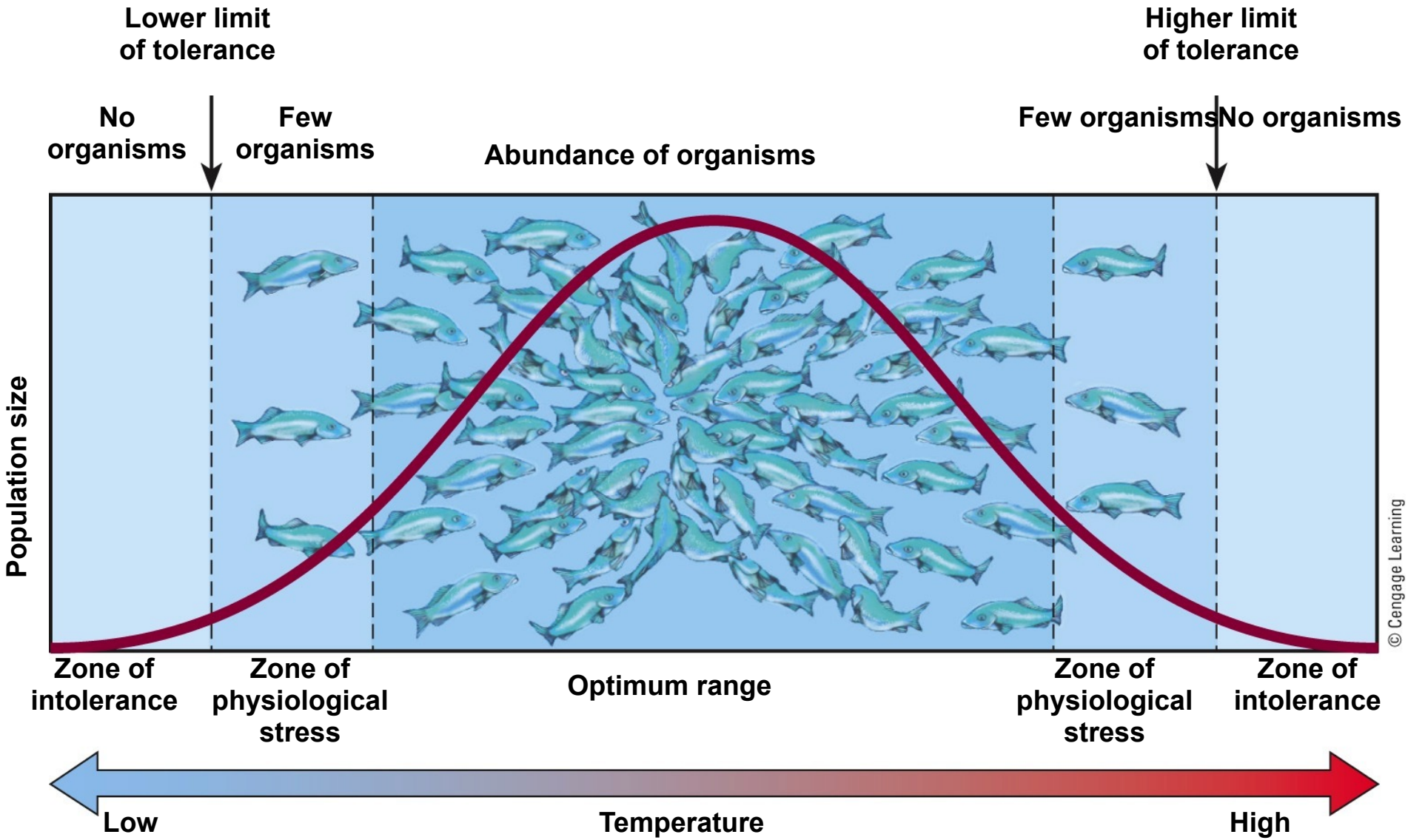


Fig. 5-13, p. 113

Different Species Have Different Reproductive Patterns

- Some species:
  - Have many small offspring
  - Little parental involvement
- Other species:
  - Reproduce later in life
  - Have small number of offspring

No Population Can Grow Indefinitely: J-Curves and S-Curves

- There are always limits to population growth in nature
- Environmental resistance – factors that limit population growth
- Carrying capacity
  - Maximum population of a given species that a particular habitat can sustain indefinitely

No Population Can Grow Indefinitely: J-Curves and S-Curves (cont'd.)

- Exponential growth
  - At a fixed percentage per year
- Logistic growth
  - Population faces environmental resistance

Growth of a Sheep Population

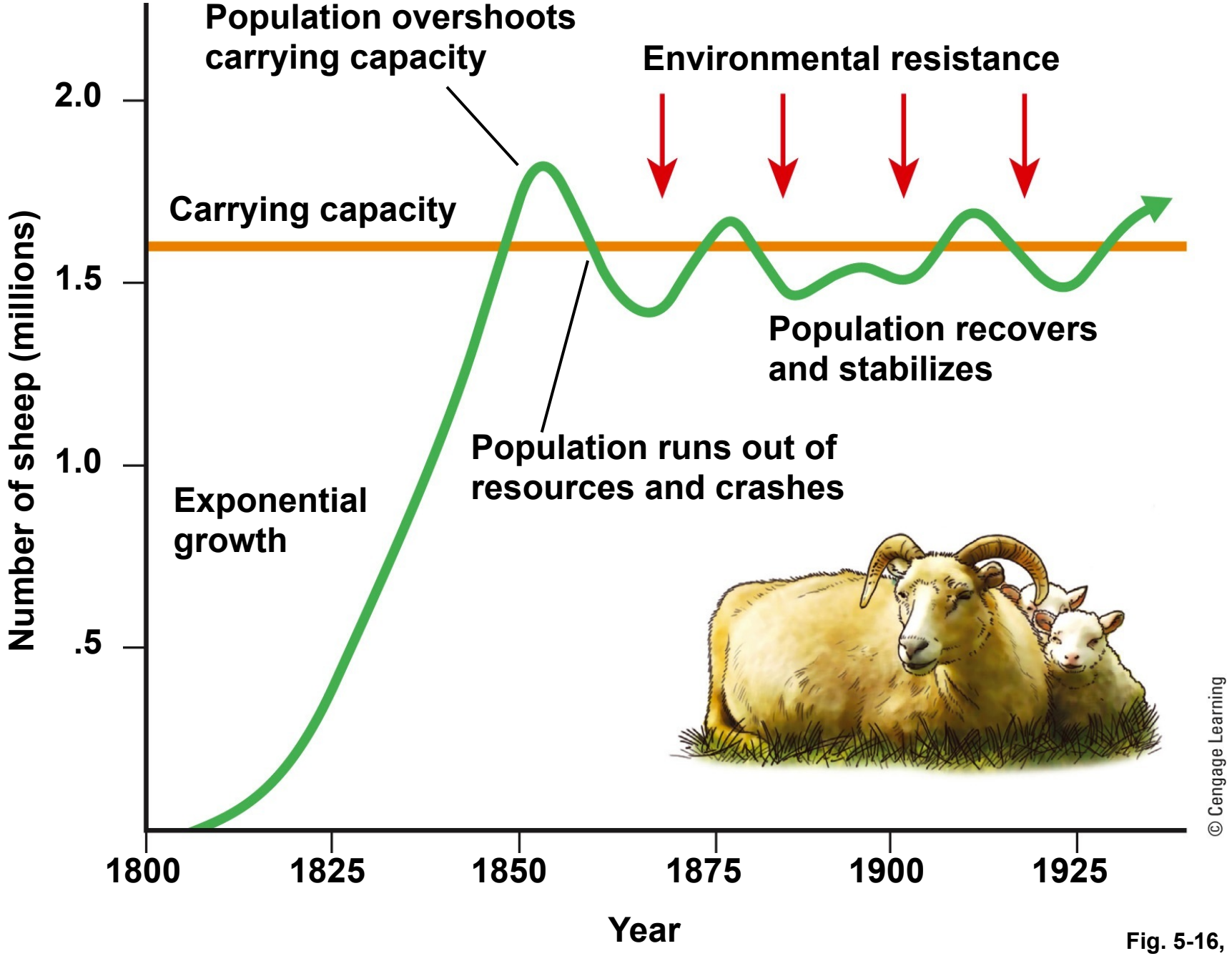


Fig. 5-16, p. 115

Case Study: Exploding White-Tailed Deer Population in the U.S.

- 1900 – deer habitat destruction and uncontrolled hunting
- 1920s–1930s – laws to protect the deer
- Current deer population explosion
  - Spread Lyme disease
  - Deer-vehicle accidents
  - Eating garden plants and shrubs
- How can we control the deer population?

White-Tailed Deer Populations

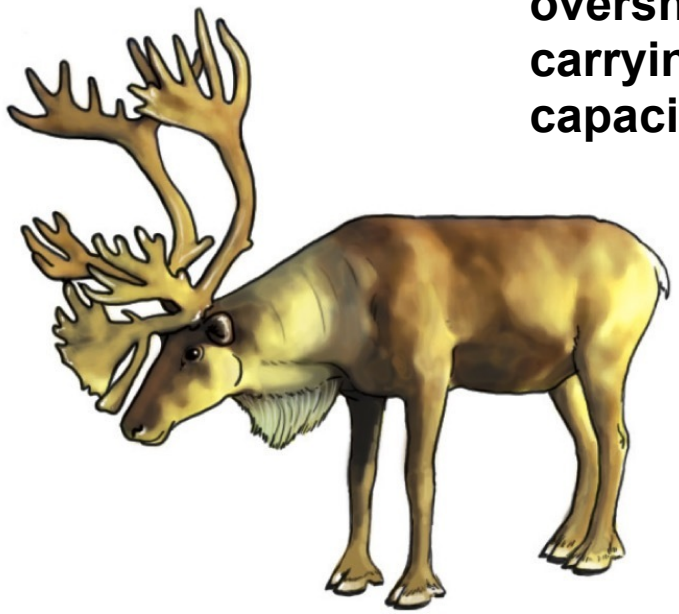
Roy Toft/National Geographic Creative

Fig. 5-17, p. 115

When a Population Exceeds Its Carrying Capacity It Can Crash

- A population exceeds the area's carrying capacity
- Reproductive time lag may lead to overshoot
  - Subsequent population crash
- Damage may reduce area's carrying capacity

Population Crash



Population overshoots carrying capacity

Population crashes

Carrying capacity

Number of reindeer

2,000

1,500

1,000

500

0

1910

1920

1930

1940

1950

Year

Fig. 5-18, p. 116

Humans Are Not Exempt from Nature's Population Controls

- Ireland
  - Potato crop in 1845
- Bubonic plague
  - Fourteenth century
- AIDS
  - Current global epidemic

Three Big Ideas

- Certain interactions among species
  - Affect their use of resources and their population sizes
- Changes in environmental conditions
  - Cause communities and ecosystems to gradually alter their species composition and population sizes (ecological succession)
- There are always limits to population growth in nature

Tying It All Together – Southern Sea Otters and Sustainability

- Before European settlers in the U.S., the sea otter ecosystem was complex
- Settlers began hunting otters
  - Disturbed the balance of the ecosystem
- Populations depend on solar energy and nutrient cycling
  - When these are disrupted biodiversity is threatened