Biodiversity, Species Interactions, and Population Control

Chapter 5

Southern Sea Otter

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Core Case Study: Southern Sea Otters: Are They Back from the Brink of Extinction?

- Habitat: North American Kelp Forests
- Hunted: early 1900s
- Partial recovery
- Why care about sea otters?
  - Ethics
  - Keystone species
  - Tourism dollars

5-1 How Do Species Interact?

- ***Concept 5-1*** *Five types of species interactions—competition, predation, parasitism, mutualism, and commensalism—affect the resource use and population sizes of the species in an ecosystem.*

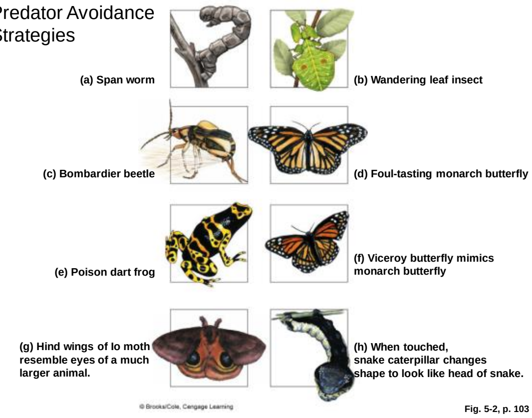
Most Consumer Species Feed on Live Organisms of Other Species (1)

- **Predators** may capture prey by
  - Walking
  - Swimming
  - Flying
  - Pursuit and ambush
  - Camouflage
  - Chemical warfare

Most Consumer Species Feed on Live Organisms of Other Species (2)

- **Prey** may avoid capture by (Fig. 5-2):
  - Camouflage
  - Chemical warfare
  - Aposematic Warning coloration
  - Mimicry
  - Deceptive looks
  - Deceptive behavior

Predator Avoidance Strategies



Batesian Mimicry

A noxious, or dangerous, organism (the model), equipped with a warning system such as conspicuous coloration, is mimicked by a harmless organism (the mimic). The mimic gains protection because predators mistake it for the model and leave it alone.

Mullerian Mimicry

Two or more distasteful species, that may or may not be closely related and share one or more common predators, have come to mimic each other's warning signals. The predator learns to avoid all creatures that share these traits.

Predator and Prey Species Can Drive Each Other's Evolution

- Intense natural selection pressures between predator and prey populations
- **Coevolution**
  - Bat hunting a moth

Symbiotic relationships

What is symbiosis?

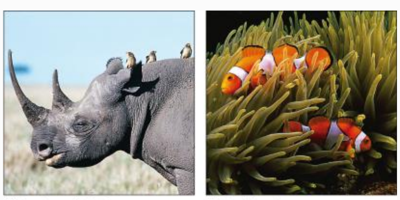
- Symbiosis (from the Greek roots sym: "together with" and bio: "living") is a close, prolonged association between organisms of different species that may benefit one or both members (parasitism; commensalism; mutualism).

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

- **Parasitism**
- Parasite-host interaction may lead to coevolution

In Some Interactions, Both Species Benefit

- **Mutualism**
- Nutrition and protection relationship
- Gut inhabitant mutualism



(a) Oxpeckers and black rhinoceros

(b) Clownfish and sea anemone

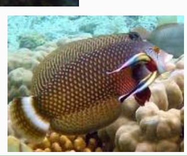
In Some Interactions, One Species Benefits and the Other Is Not Harmed

- **Commensalism**
- Man-of-war fish
- Epiphytes
- Birds nesting in trees

Evolutionary significance

- **Mutualism** and **commensalism** are hypothesized to have originated from **parasitic** relationships.
- If true, then host organisms, through evolutionary adaptation, selected traits that allowed them to take advantage of parasitic behavior, leading to mutually beneficial relationships in some cases.

Reef Cleaning Stations



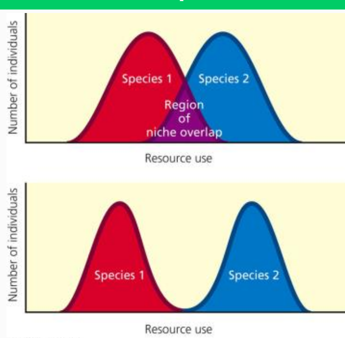
5-2 How Can Natural Selection Reduce Competition between Species?

- ***Concept 5-2*** *Some species develop adaptations that allow them to reduce or avoid competition with other species for resources.*

Some Species Evolve Ways to Share Resources

- **Resource partitioning**
- Reduce niche overlap (Fig. 5-7)
- Use shared resources at different
  - Times
  - Places
  - Ways

Competing Species Can Evolve to Reduce Niche Overlap



Avian Resource Partitioning to Share Food Resource

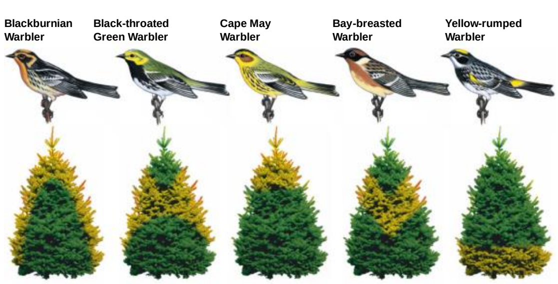


Fig. 5-8, p. 107

5-3 What Limits the Growth of Populations?

- ***Concept 5-3*** *No population can continue to grow indefinitely because of limitations on resources and because of competition among species for those resources.*

Populations Have Certain Characteristics (1)

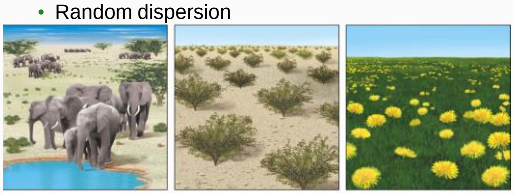
- Populations differ in
  - Distribution
  - Numbers
  - Age structure
  - Density
- **Population dynamics**

Populations Have Certain Characteristics (2)

- Changes in population characteristics due to:
  - Temperature
  - Presence of disease organisms or harmful chemicals
  - Resource availability
  - Arrival or disappearance of competing species

Most Populations Live Together in Clumps or Patches (1)

- Population distribution
  - Clumping
  - Uniform dispersion
  - Random dispersion



(a) Clumped (elephants) (b) Uniform (creosote bush) (c) Random (dandelions)

Most Populations Live Together in Clumps or Patches (2)

- Why clumping?
  - Species tend to cluster where resources are available
  - Groups have a better chance of finding clumped resources
  - Protects some animals from predators
  - Packs allow some to get prey
  - Temporary groups for mating and caring for young

Populations Can Grow, Shrink, or Remain Stable (1)

- Population size governed by
  - Births
  - Deaths
  - Immigration
  - Emigration
- Population change =
  (births + immigration) – (deaths + emigration)

Populations Can Grow, Shrink, or Remain Stable (2)

- Age structure
  - Pre-reproductive age
  - Reproductive age
  - Post-reproductive age

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

- Biotic potential
  - Low – Elephants, Blue Whales
  - High – Insects, bacteria
- **Intrinsic rate of increase (r)= rate of population growth with unlimited resources**
- Individuals in populations with high **r**
  - Reproduce early in life
  - Have short generation times
  - Can reproduce many times
  - Have many offspring each time they reproduce

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

- Size of populations limited by Environmental resistance:
  - Light
  - Water
  - Space
  - Nutrients
  - Exposure to too many competitors, predators or infectious diseases

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

- Environmental resistance (Fig 5 - 11)
  - All factors that limit pop. growth
- Carrying capacity (K)
  - Combination of biotic potential
- Exponential growth
- Logistic growth

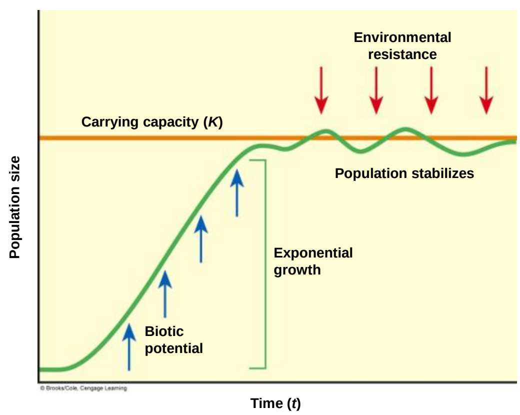


Fig. 5-11, p. 111

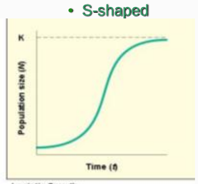
Exponential and Logistic Growth

Exponential Growth

- Few resource limitations
- 1-2% growth rate
- J-shaped cure

Logistic Growth

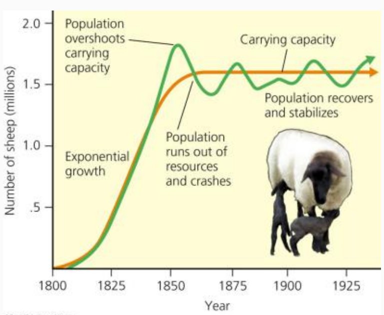
- Rapid exponential growth followed by steady decrease
- Encounters environmental resistance
- S-shaped



Animation: Logistic growth

PLAY

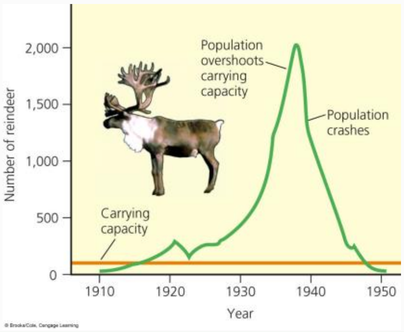
Logistic Growth of a Sheep Population on the island of Tasmania, 1800–1925



When a Population Exceeds Its Habitat's Carrying Capacity, Its Population Can Crash

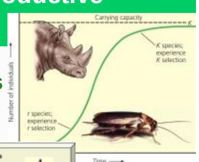
- Carrying capacity: not fixed
- **Reproductive time lag** may lead to **overshoot**
  - **Dieback (crash)**
- Damage may reduce area's carrying capacity

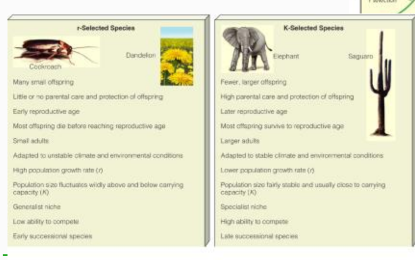
Exponential Growth, Overshoot, and Population Crash of a Reindeer



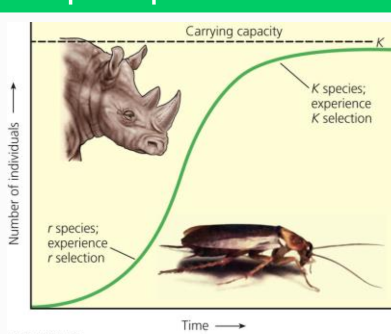
Species Have Different Reproductive Patterns

- r-Selected species, opportunists
- K-selected species, competitors





Positions of r- and K-Selected Species on the S-Shaped Population Growth Curve



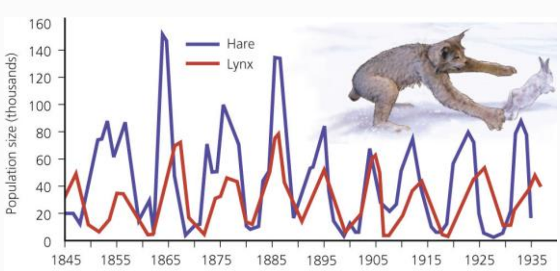
Under Some Circumstances Population Density Affects Population Size

- **Density-dependent population controls**
  - Predation
  - Parasitism
  - Infectious disease
  - Competition for resources

Several Different Types of Population Change Occur in Nature

- **Stable**
- **Irruptive**
- **Cyclic fluctuations, boom-and-bust cycles**
  - Top-down population regulation
  - Bottom-up population regulation
- **Irregular**

Population Cycles for the Snowshoe Hare and Canada Lynx



Humans Are Not Exempt from Nature's Population Controls

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

5-4 How Do Communities and Ecosystems Respond to Changing Environmental Conditions?

- ***Concept 5-4*** *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

- **Natural ecological restoration**
  - **Primary succession**
  - **Secondary succession**

Some Ecosystems Start from Scratch: Primary Succession

- No soil in a terrestrial system
- No bottom sediment in an aquatic system
- *Early successional (or pioneering spp)*
  - Lichens and mosses
  - Grow close to the ground
- *Midsuccessional*
  - Herbs, grass and low shrubs
  - Soil is deep and fertile
  - Sun tolerant trees replace
- *Late succesional*
  - Shade tolerant tree, forest community

Primary Ecological Succession

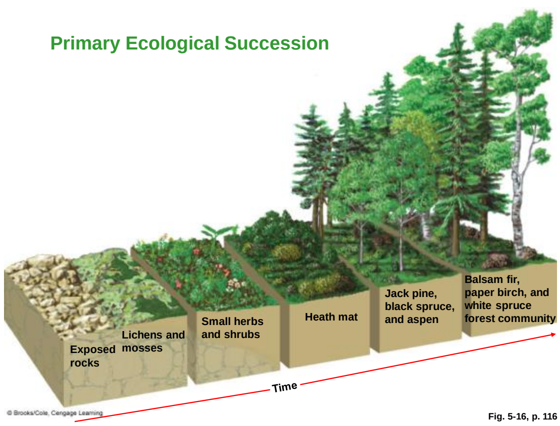
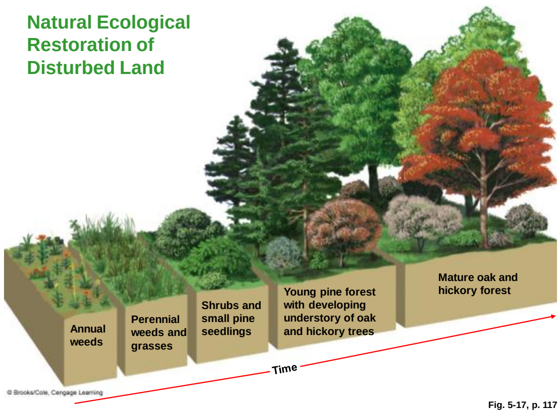


Fig. 5-16, p. 116

Some Ecosystems Do Not Have to Start from Scratch: Secondary Succession (1)

- Some soil remains in a terrestrial system
- Some bottom sediment remains in an aquatic system
- Ecosystem has been
  - Disturbed
  - Removed
  - Destroyed



Some Ecosystems Do Not Have to Start from Scratch: Secondary Succession (2)

- Primary and secondary succession can be interrupted by
  - Fires
  - Hurricanes
  - Clear-cutting of forests
  - Plowing of grasslands
  - Invasion by nonnative species

Succession Doesn't Follow a Predictable Path

- Traditional view
  - Balance of nature and a climax community
- Current view
  - Ever-changing mosaic of patches of vegetation
  - Mature late-successional ecosystems
    - State of continual disturbance and change

Living Systems Are Sustained through Constant Change

- **Inertia, persistence**
  - 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
- **Tipping point – irreversible stress to a system**