Biodiversity, Species Interactions, and Population Control

Chapter 5
Three big ideas

• Interactions among species affect their use of resources and their population sizes.

• There are always limits to population size.

• Changes in environmental conditions cause communities and ecosystems to gradually alter their species composition and population sizes (ecological succession).
Form groups of 3-4 and come up with as many categories of interactions that occur between species as you can… AND provide an example for each category.

Be prepared to share with the class
Most species compete with one another for certain resources

- There are five basic types of interaction between species when they share limited resources:
  - **Interspecific competition** occurs when two or more species interact to gain access to the same limited resources.
  - **Predation** occurs when a member of one species (predator) feeds directly on all or part of a member of another species (prey).
  - **Parasitism** occurs when one organism (the parasite) feeds on another organism (the host), usually by living on or in the host.
  - **Mutualism** is an interaction that benefits both species by providing each with food, shelter, or some other resource.
  - **Commensalism** is an interaction that benefits one species but has little, if any, effect on the other.
Most species compete with one another for certain resources

- Interspecific competition is the most common interaction between species.

- When two species use the same resource, their **niches** overlap.
How do you suppose the diets of these different species of warblers compare?

- Blackburnian Warbler
- Black-throated Green Warbler
- Cape May Warbler
- Bay-breasted Warbler
- Yellow-rumped Warbler
Most species compete with one another for certain resources

• **Resource partitioning** occurs when species competing for similar scarce resources evolve specialized traits that allow them to use shared resources at different times, in different ways, or in different places.
  
  – e.g. warblers who live in the same trees but have such specialized feeding niches that they do not compete.

• How about hawks and owls?
Most consumer species feed on live organisms of other species

- **Predation** occurs when a member of one species (predator) feeds directly on all or part of a living organism of another plant or animal species (prey), forming a predator-prey relationship.

  – Herbivores… how do they capture prey?

  – Carnivores… how do they capture prey?
Most consumer species feed on live organisms of other species

- Prey have evolved ways to avoid predators.
Most consumer species feed on live organisms of other species

– Behavioral strategies such as…
Interactions between predator and prey species can drive each other’s evolution

- **Coevolution** occurs when two different species interact over a long period of time and changes in the gene pool of one species can lead to changes in the gene pool of the other.

- Some bats and moths have coevolved with their plant mutualists.
Some species feed off other species by living on or in them

- **Parasitism** occurs when one species (parasite) feeds on the body of, or the energy used by, another organism (host), usually by living on or in the host.

- A parasite usually is much smaller than its host and rarely kills it.

- Parasites can live the inside of the host, (e.g. tapeworms) or on the outside of the host (e.g. mistletoe, sea lampreys).
In some interactions, both species benefit

- **Mutualism** occurs when two species behave in ways that benefit both by providing each with food, shelter, or some other resource.

- Examples of mutualism include birds that ride on the backs of large animals, like African buffalo, and remove pests, and the bacteria that live in our intestines and help digest our food.
In some interactions, one species benefits and the other is not harmed

- **Commensalism** is an interaction that benefits one species but has little, if any, beneficial or harmful effect on the other.
- Epiphytes are plants that attach themselves to the trunks or branches of large trees for access to sunlight; these represent commensalism.
(a) Oxpeckers and black rhinoceros

(b) Clownfish and sea anemone
Section 5-2

WHAT LIMITS THE GROWTH OF POPULATIONS?
Populations can grow, shrink, or remain stable

- A **population** is a group of individuals of the same species living in a particular place.

- Population size may vary in cycles based on births, deaths, immigration, and emigration.

- **Population change** = (births + immigration) - (deaths + emigration).
The graph illustrates the population changes of reindeer over several decades. The x-axis represents the year from 1910 to 1950, while the y-axis shows the number of reindeer. The carrying capacity is indicated by the orange line, which remains relatively stable throughout the years. The green line, representing the population, shows an initial increase following a long period below the carrying capacity. Around 1930, the population spikes dramatically, exceeding the carrying capacity, before crashing down sharply to reach zero by 1950.
Populations can grow, shrink, or remain stable

- Physical or chemical **limiting factors**, such as light, water, and nutrients, can affect the number of individuals in a population.

- Population density can affect population size.
  - In a dense population, parasites and diseases can spread more easily, and sexually reproducing individuals can find mates more easily.
Species have different reproductive patterns

• Some species have many, usually small, offspring and give them little or no parental care or protection.
Examples?

• Some species have few, usually fairly large, offspring and invest parental care and protection.
Examples?
No population can grow indefinitely

- **Environmental resistance** is the combination of all factors that act to limit the growth of a population.

- Environmental resistance largely determines an area’s **carrying capacity**, the maximum population of a given species that a particular habitat can sustain indefinitely.

- **Exponential growth** starts slowly but then accelerates as the population increases.
  - Occurs when a population has unlimited resources to support its growth. A graph of population size over time of an exponential growth has a **J-shaped curve**.
No population can grow indefinitely

- **Logistic growth** occurs when the growth rate decreases as the population becomes larger and nears the carrying capacity of its environment because resources such as food, water, and space begin to dwindle.

- Population size may stabilize at or near the carrying capacity of its environment. The result is a sigmoid (S-shaped) population growth curve.
No population can continue to grow indefinitely.
When a population exceeds its carrying capacity its population can crash

- A **population crash**, or sharp decline in size, can occur when a population uses up its resources and exceeds the carrying capacity of their environment.
- Population crashes occur because of a reproductive time lag, the period needed for the birth rate to fall and the death rate to rise in response to resource overconsumption.
- Population crashes are more likely when the organisms cannot switch to new resources or move to other locations.
Humans are not exempt from nature’s population controls

- Ireland recorded about 1 million human deaths and 3 million emigrants associated with the 1845 potato crop destruction.
- During the 14th century, the bubonic plague killed at least 25 million people.
- Between 1981 and 2007, AIDS killed more than 27 million people and continues to claim 2 million lives each year.
HOW DO COMMUNITIES AND ECOSYSTEMS RESPOND TO CHANGING ENVIRONMENTAL CONDITIONS?
Communities and ecosystems change over time: Ecological succession

- Ecological succession is the gradual change in species composition in a given area.
- **Primary ecological succession** involves the gradual establishment of biotic communities in lifeless areas where there is no soil in a terrestrial ecosystem or no bottom sediment in an aquatic ecosystem.
Primary ecological succession
Communities and ecosystems change over time: Ecological succession

- **Secondary succession** occurs with a series of communities or ecosystems with different species develop in places containing soil or bottom sediment. Such areas include:
  - Abandoned farmland.
  - Burned or cut forests.
  - Heavily polluted streams.
  - Flooded land.
Natural ecological restoration of disturbed land
Succession does not follow a predictable path

- The traditional view holds that succession proceeds in an orderly sequence along an expected path until a certain stable type of climax community occupies an area.
- The current view is that succession reflects an ongoing struggle by different species for resources such as light, water, nutrients, food, and space, and that mature, late-successional ecosystems in a state of continual disturbance and change, not a state of permanent equilibrium.
Living systems are sustained through constant change

- Living systems contain complex processes that interact to provide some degree of stability. This capacity to withstand external stress and disturbance is maintained by change in response to changing environmental conditions.

- One aspect of stability is inertia, or persistence, which is the ability of a living system, such as a grassland or forest, to survive moderate disturbances.

- A second aspect of stability is resilience, which is the ability of a living system to be restored through secondary succession after a more severe disturbance.
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