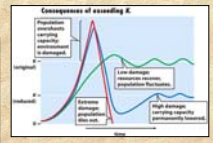
Population Ecology

Text Readings

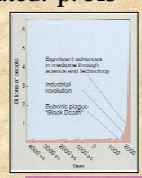
Chapter Reading:

Chapter #26 in Audesirk, Audesirk and Byers:
"*Population Growth and Regulation*"
Pg. #513-534.

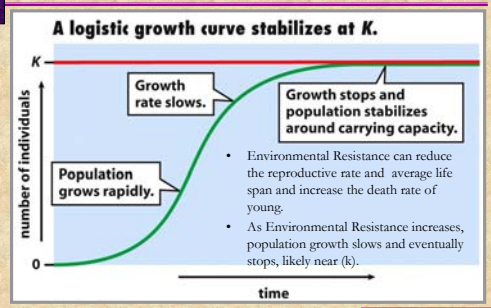


Questions to Answer in the Chapter

- How Does Population Size Change? p. 514
- **How Is Population Growth Regulated? p. 515**
- **How Are Populations Distributed in Space and Time? p. 524**
- How Is the Human Population Changing? p. 526

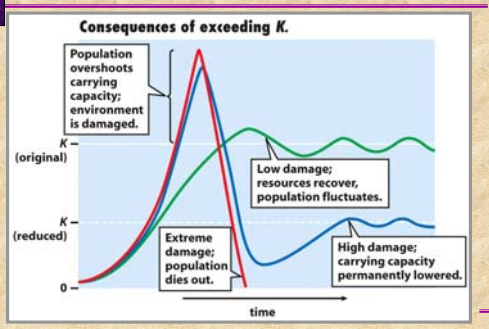


Population Dynamics
Logistic Growth



- Environmental Resistance can reduce the reproductive rate and average life span and increase the death rate of young.
- As Environmental Resistance increases, population growth slows and eventually stops, likely near (k).

Population Dynamics
Logistic Growth



Population Dynamics
Logistic Growth

- Question:
  - »At Carrying Capacity (k), what is the association between birth rates and death rates?

Population Dynamics Logistic Growth

- As population density increases, individuals compete for space, energy, and nutrients.
- At carrying capacity, each individual's share of resources is just enough to allow it to replace itself in the next generation.
- At carrying capacity the birth rate (*b*) = death rate (*d*).
- Carrying capacity (k) is determined by the continuous availability of resources.

Environmental Resistance (ER)

- Environmental Resistance can be classified into two broad categories
  - **Density-dependent factors**
  - **Density-independent factors**

Population Ecology

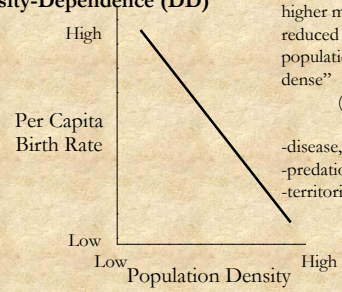
A factor that causes higher mortality or reduced birth rates as a population becomes more dense is referred to as a **density-dependent** factor.

Density-Dependence

- **Density-dependent factors** become more effective as population density increases.
- Exert negative feedback effect on population size.

Density-Dependence

Density-Dependence (DD)



"A factor that causes higher mortality or reduced birth rates as a population becomes more dense"
(*Bolen & Robinson*)

-disease, food supply,
-predation, and
-territorial behavior

Population Dynamics
Population Cycles

- **Predation**

  - involves a **predator** killing a **prey** organism to consume.

- Predators exert density-dependent controls on a population.
  - Increased prey availability can increase birth rates and/or decrease death rates of predators.
    - Prey population losses will increase.

Population Dynamics
Population Cycles

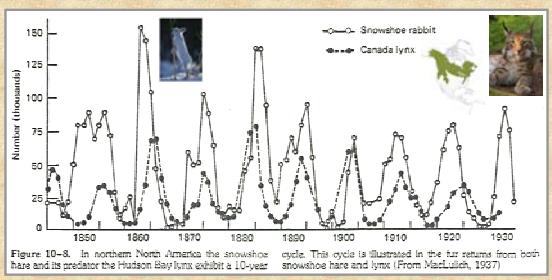
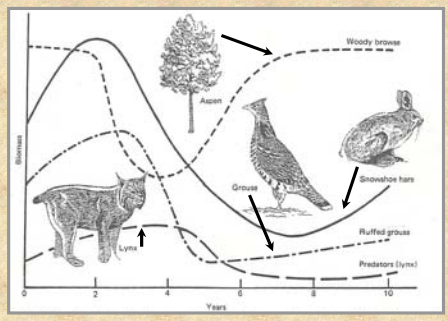


Figure 10–8. In northern North America, the snowshoe hare and its predator the Hudson Bay lynx exhibit a 10-year cycle. This cycle is illustrated in the fur returns from both snowshoe hare and lynx (From MacLulich, 1937)

Prey Switching and Availability - Interactions



Population Dynamics
Logistic Growth

- Question:
  - »Define and discuss "competition".

Competition for Resources

- **Competition**
  - Describes the interaction among individuals who attempt to utilize a resource that is limited relative to the demand for it.
- Competition intensifies as populations grow and near carrying capacity.
- For two organisms to compete, they must share the same resource(s).

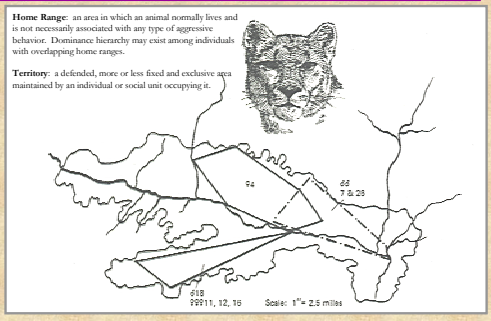
Competition for Resources

- Competition may be divided into two groups based on the species identity of the competitors:
  - **Interspecific competition** is between individuals of different species.
  - **Intraspecific competition** is between individuals of the same species.

Competition for Resources

- Competition may also be divided into two types based on the nature of the interaction
  - **Scramble (exploitative) competition** is a free-for-all scramble as individuals try to beat others to a limited pool of resources.
  - **Contest (interference) competition** involves social or chemical interactions that limit a competitor's access to resources

Social Behavior Limits Access to Resources



Density-Independence

- **Density-independent factors** limit populations regardless of their density
  - Examples: climate, weather, floods, fires, pesticide use, pollutants, and overhunting.

Population Dynamics Logistic Growth

- Question:

»Draw the density-independent graph and explain its meaning.

Density-Independence

Density-Independence (DI)

Per Capita Birth Rate

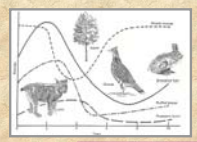
Population Density

No association with population density – they act on a population independent of density

- e.g., weather (floods, hurricanes) fires, earthquakes, volcanoes

Ultimately . . . .

- The abundance of a population at any given time is the result of complex interactions between density-independent and density-dependent forms of environmental resistance.



Basic Ecological (Resources) for Populations

Dr. Aldo Leopold

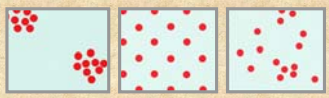
Food - Herbivores, Carnivores, Omnivores
Water - Marshes, Bogs, Lakes, Streams
Cover – Protection from predators & weather
Space – Territoriality, Breeding and Nesting

Population Dynamics

Quantity and Quality

Spatial Distributions

- The spatial pattern in which individuals are dispersed within a given area is that population's *distribution,* which may vary with time and available resources.
- There are three major types of spatial distributions:
  - **Clumped**
  - **Uniform**
  - **Random**



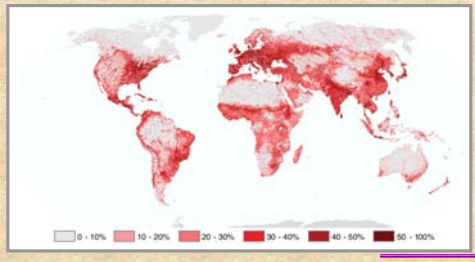
Spatial Distributions

- **Clumped distribution –** includes family and social groups
- **Examples**: elephant herds, wolf packs, prides of lions, flocks of birds, and schools of fish.

- **Advantages:**
  - Provides many eyes to can search for local food sources.
  - Confuses predators with sheer numbers.
  - Cooperation for hunting more effectively.

Spatial Distributions

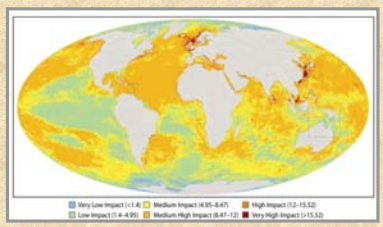
Human Global Footprint on Land



Source: Kareiva, P.; Watts, S.; McDonald, R.; Boucher, T. (2007). Domesticated nature: shaping landscapes and ecosystems for human welfare. *Science (Wash.) 316(5833)*: 1866-1869.

Spatial Distributions

Human Global Footprint In the Oceans



Source: Benjamin Halpern, et al. 2008. A Global Map of Human Impact on Marine Ecosystems. *Science* 15 February 2008(319) no. 5865:948 – 952.

Spatial Distributions

- **Uniform distribution** – constant distance maintained between individuals; common among territorial animals defending scarce resources or defending breeding territories.

- **Examples**: iguanas, shorebirds, tawny owls
- **Advantage**: a uniform distribution helps ensure adequate resources for each individual.

Spatial Distributions

- **Random distribution - rare**, exhibited by individuals that do not form social groups; occurs when resources are not scarce enough to require territorial spacing or cooperative behavior.
- **Examples**: Trees and other plants in rain forests.

In Summary . . . . . .

- Environmental Resistance/Carrying Capacity (k)
- Density-Dependence/Density-Independence
- Predation
- Competition
- Spatial Distributions