Chapter 53

Population Ecology

- **Population ecology** is the study of populations in relation to environment, including environmental influences on density and distribution, age structure, and population size

processes influence population density, dispersion, and demographics

- A **population** is a group of individuals of a single species living in the same general area

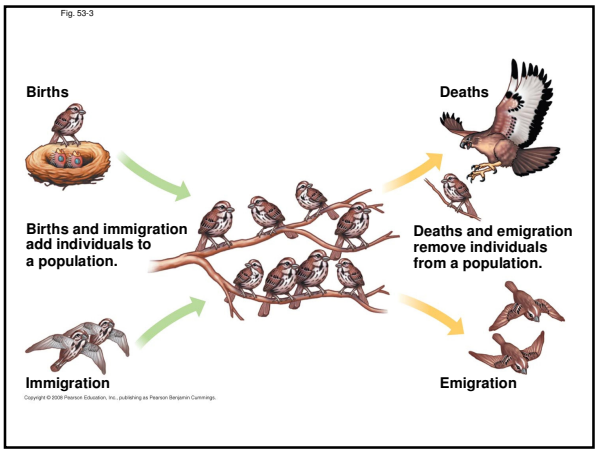
Density and Dispersion

- **Density** is the number of individuals per unit area or volume
- **Dispersion** is the pattern of spacing among individuals within the boundaries of the population

Density: A Dynamic Perspective

- In most cases, it is impractical or impossible to count all individuals in a population
- Sampling techniques can be used to estimate densities and total population sizes
- Population size can be estimated by either extrapolation from small samples, an index of population size, or the **mark-recapture method**

- Density is the result of an interplay between processes that add individuals to a population and those that remove individuals
- **Immigration** is the influx of new individuals from other areas
- **Emigration** is the movement of individuals out of a population

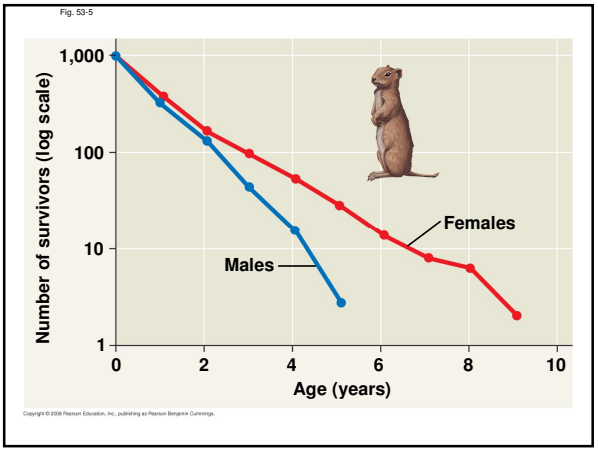


Demographics

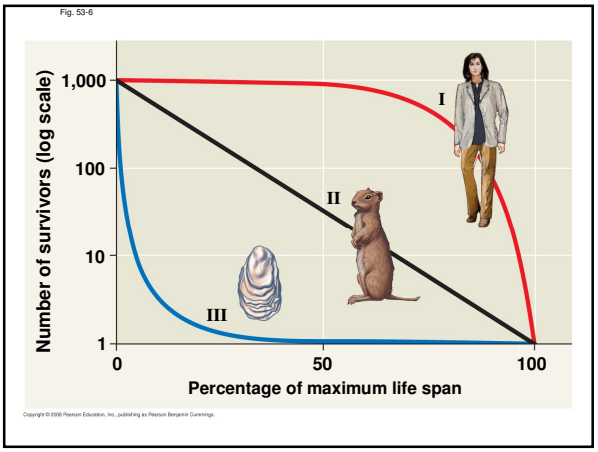
- **Demography** is the study of the vital statistics of a population and how they change over time
- Death rates and birth rates are of particular interest to demographers

Survivorship Curves

- A **survivorship curve** is a graphic way of representing the data in a life table
- The survivorship curve for Belding's ground squirrels shows a relatively constant death rate



- Survivorship curves can be classified into three general types:
  - Type I: low death rates during early and middle life, then an increase among older age groups
  - Type II: the death rate is constant over the organism's life span
  - Type III: high death rates for the young, then a slower death rate for survivors



Reproductive Rates

- For species with sexual reproduction, demographers often concentrate on females in a population
- A **reproductive table**, or fertility schedule, is an age-specific summary of the reproductive rates in a population
- It describes reproductive patterns of a population

- Some plants produce a large number of small seeds, ensuring that at least some of them will grow and eventually reproduce

- In animals, parental care of smaller broods may facilitate survival of offspring

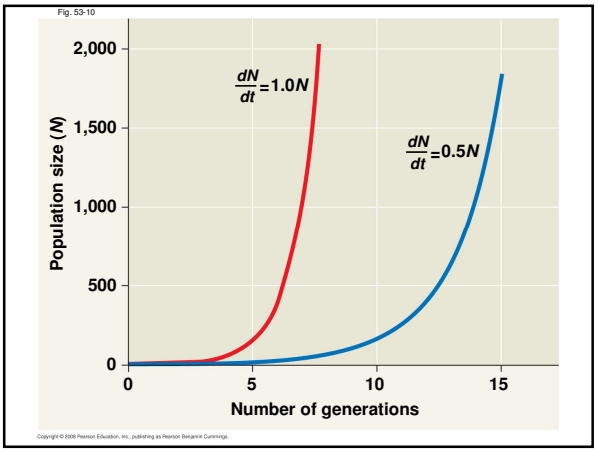
- **Zero population growth** occurs when the birth rate equals the death rate
- Most ecologists use differential calculus to express population growth as growth rate at a particular instant in time:

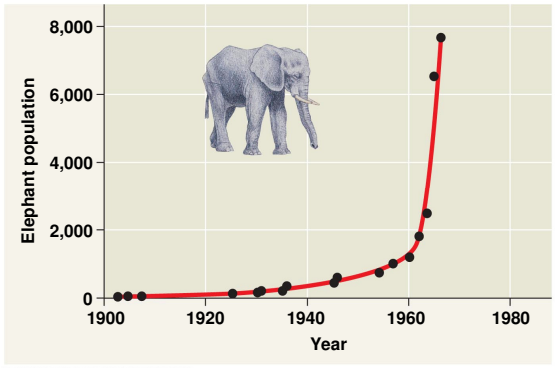
$$\frac{\Delta N}{\Delta t} = rN$$

where N = population size, t = time, and r = per capita rate of increase = birth – death

Exponential Growth

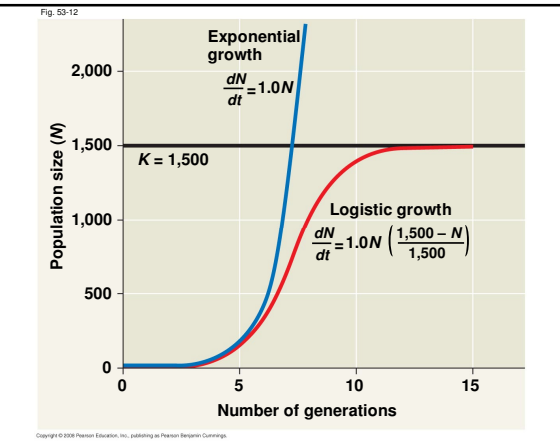
- **Exponential population growth** is population increase under idealized conditions
- Under these conditions, the rate of reproduction is at its maximum, called the intrinsic rate of increase





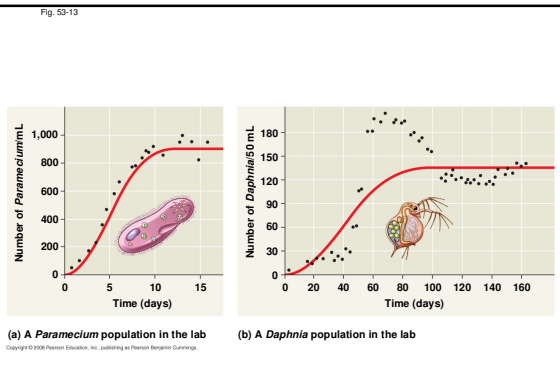
Concept 53.4: The logistic model describes how a population grows more slowly as it nears its carrying capacity

- Exponential growth cannot be sustained for long in any population
- A more realistic population model limits growth by incorporating carrying capacity
- **Carrying capacity** (*K*) is the maximum population size the environment can support



The Logistic Model and Real Populations

- The growth of laboratory populations of paramecia fits an S-shaped curve
- These organisms are grown in a constant environment lacking predators and competitors



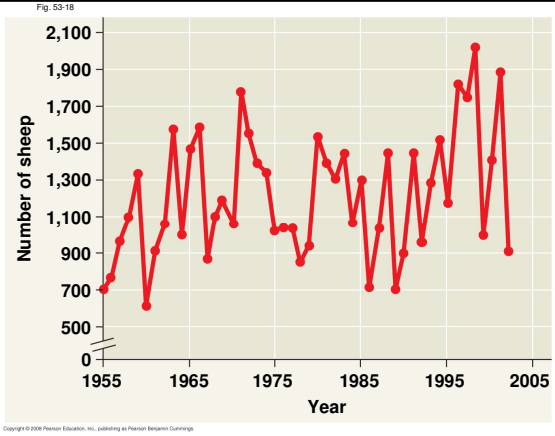
Population Dynamics

- The study of **population dynamics** focuses on the complex interactions between biotic and abiotic factors that cause variation in population size

Stability and Fluctuation

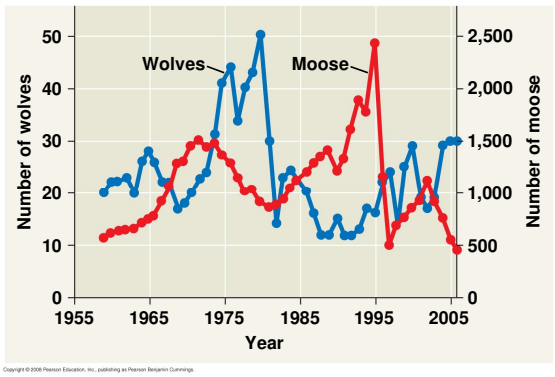
- Long-term population studies have challenged the hypothesis that populations of large mammals are relatively stable over time
- Weather can affect population size over time

Fig. 53-18



- Changes in predation pressure can drive population fluctuations

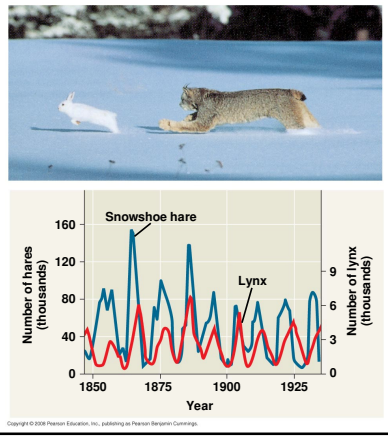
Fig. 53-19



Population Cycles: Scientific Inquiry

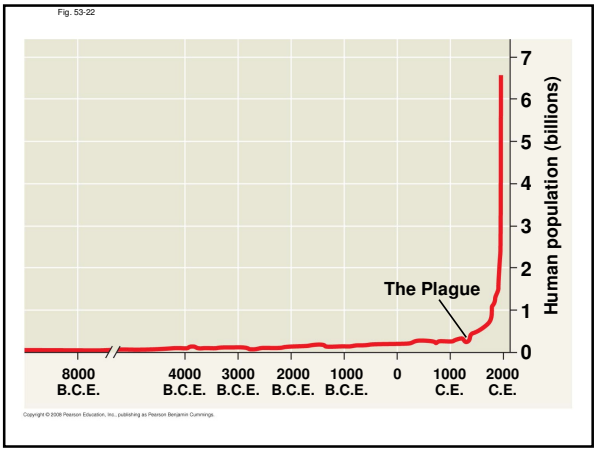
- Some populations undergo regular boom-and-bust cycles
- Lynx populations follow the 10 year boom-and-bust cycle of hare populations
- Three hypotheses have been proposed to explain the hare's 10-year interval

Fig. 53-20

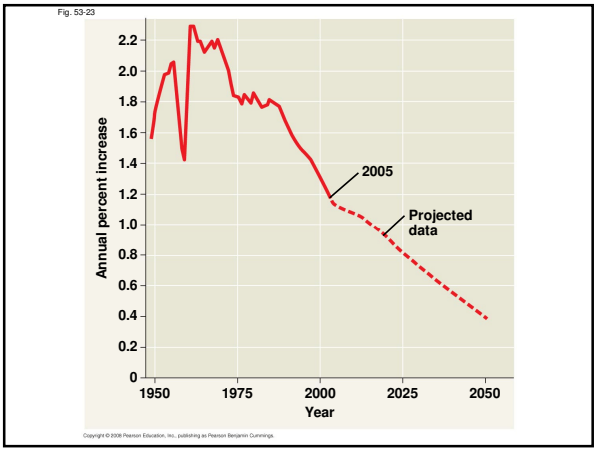


The Global Human Population

- The human population increased relatively slowly until about 1650 and then began to grow exponentially



- Though the global population is still growing, the rate of growth began to slow during the 1960s



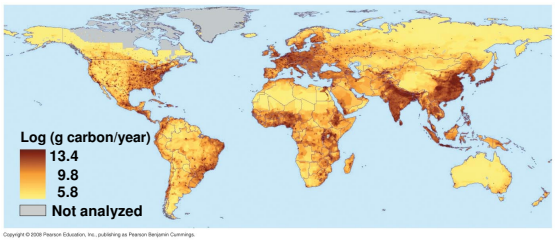
Regional Patterns of Population Change

- To maintain population stability, a regional human population can exist in one of two configurations:
  - Zero population growth = High birth rate – High death rate
  - Zero population growth = Low birth rate – Low death rate
- The **demographic transition** is the move from the first state toward the second state

Limits on Human Population Size

- The **ecological footprint** concept summarizes the aggregate land and water area needed to sustain the people of a nation
- It is one measure of how close we are to the carrying capacity of Earth
- Countries vary greatly in footprint size and available ecological capacity

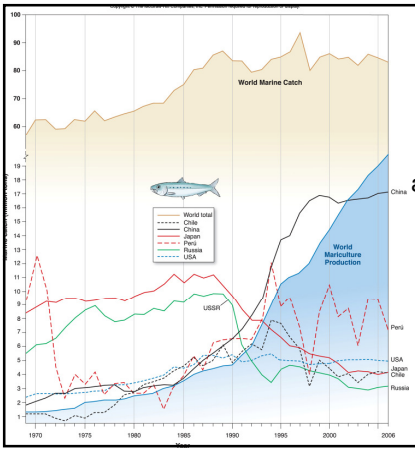
Fig. 53-27



- Our carrying capacity could potentially be limited by food, space, nonrenewable resources, or buildup of wastes

Food From the Sea

- What types of organisms are harvested?
  - Finfish (about 90% of worldwide harvest)
  - Shellfish
  - Other species such as jellyfish, sea cucumbers, polychaetes and seaweed
  - While seafood represents only about 1% of the food consumed each year, it represents about 30% of total animal protein consumed



Worldwide Marine Catch and Mariculture

Atlantic bluefin tuna *Thunnus thynnus*

- Can grow >300 cm; 680 kg
- Extremely streamlined, one of the ocean's fastest swimmers, endothermic

Bluefin as food

- 2001 440 pound tuna sold for $220,000 ($500/pound)
- Farm in oceanic pens
- Spotter planes and electric harpoons

Optimal Yield and Overfishing

- Sea-life species are renewable resources
- However, for a fishery to last long-term, it must be fished in a sustainable way
- The sustainable yield is the amount that can be caught and just maintain a constant population size

Collapse of a Fishery

- A fishery is regarded as collapsed if numbers fall to 10% of historic highs
- It is estimated that one-third of fisheries are already collapsed
- A 2006 study indicates that all major fisheries will collapse by 2050 if protective measure are not taken to better manage and protect these resources

Managing the Resources

- Management can be difficult for many reasons:
  - Maximum sustainable yield is difficult to calculate
  - Harvested species may compete with other species and fishing pressure may affect competitive balance
  - Real fisheries are more complex than models
  - High seas are “common property”

- Bluefin tuna harpoon
- http://www.youtube.com/watch?v=tL-1te9SbLs&feature=related
- crab pot
- http://www.youtube.com/watch?v=Zd_OPFfpRdk
- tuna farming
- http://www.youtube.com/watch?v=XIbGTwLGZNU&feature=related