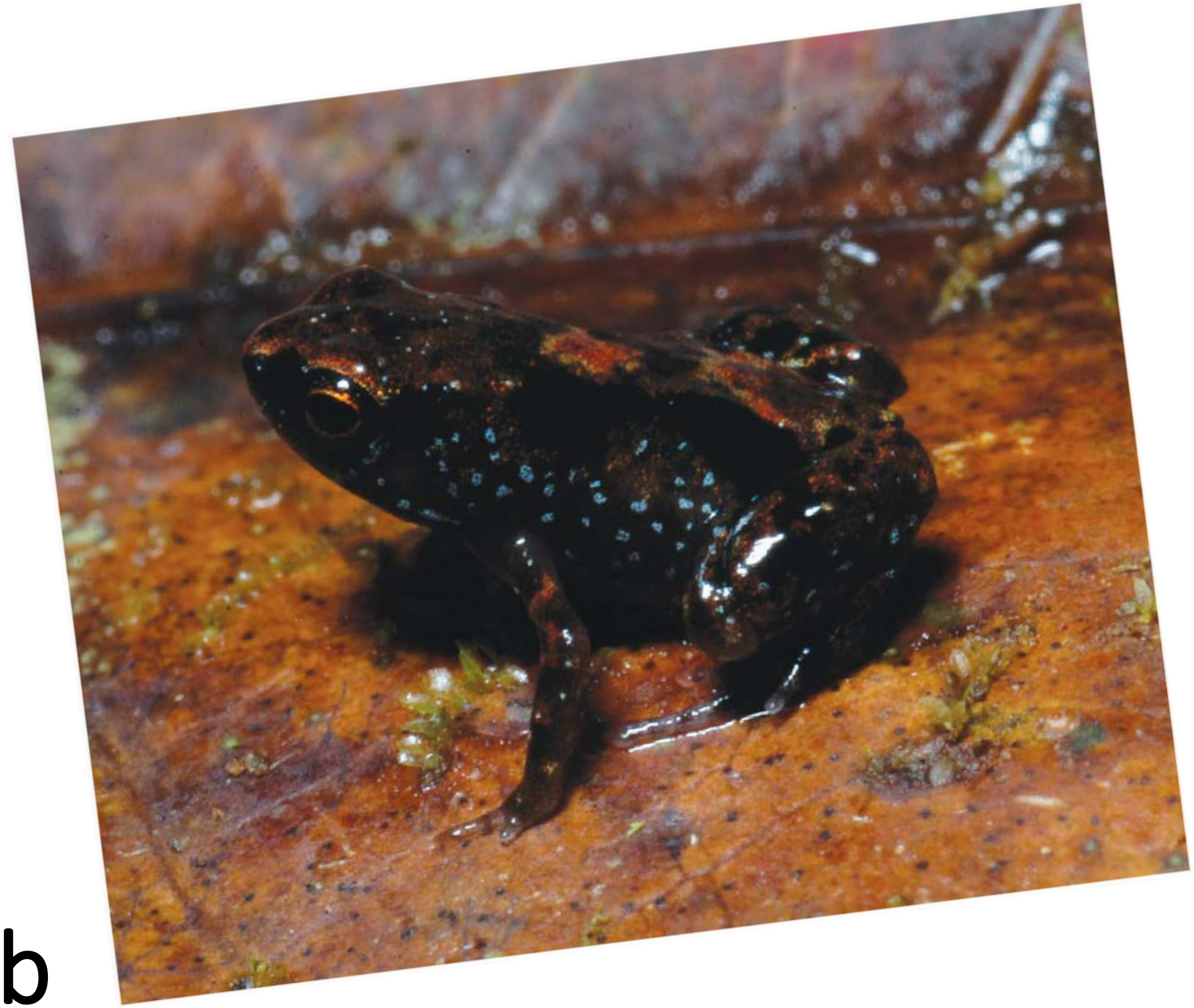
Ch. 40b Warm-Up

Define the following terms:

- Demography
- Semelparity
- Iteroparity
- Carrying capacity
- Exponential growth curve
- Logistic growth curve
- K-selection
- r-selection
- Ecological footprint



Chapter 40b

POPULATION ECOLOGY

Introduction

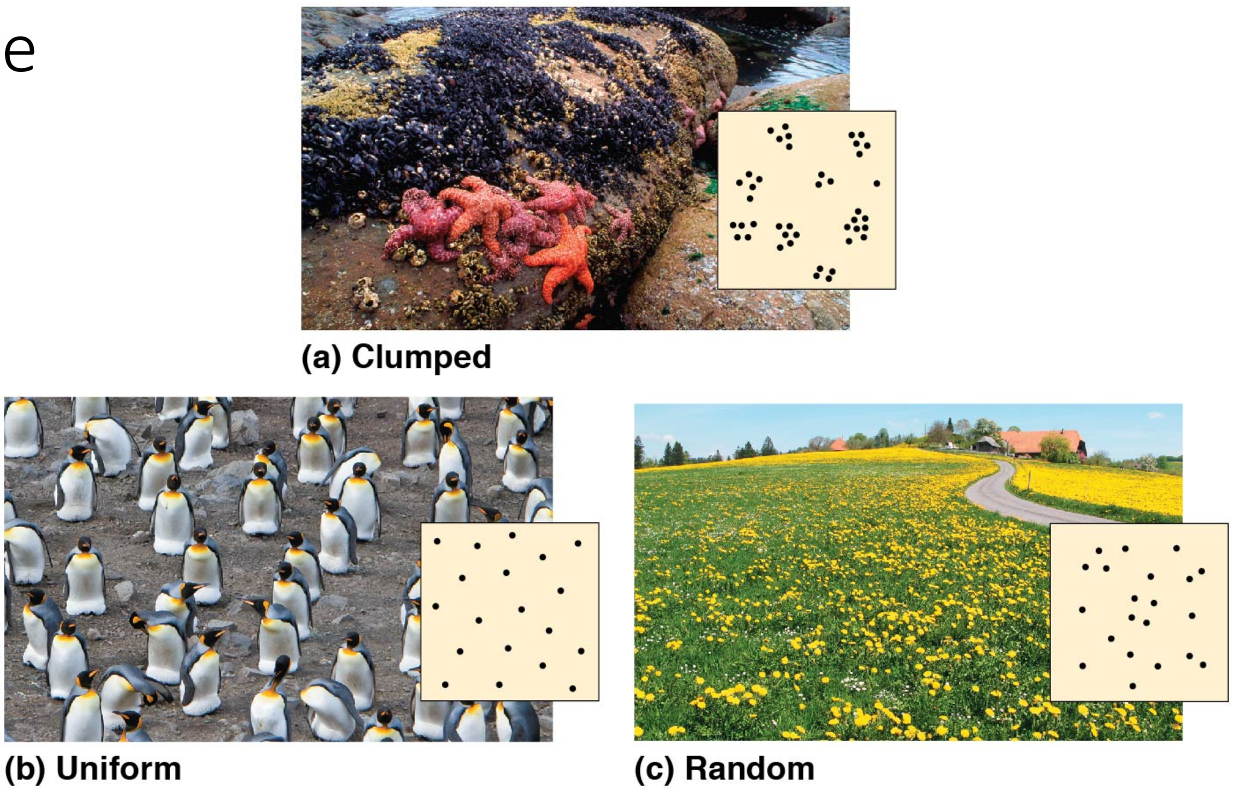
- **Population** = group of individuals of a **single species** living in same general area
  - Density: # individuals / area
  - Dispersion: pattern of spacing between individuals

Determining population size and density:

- Count every individual
- Random sampling
- Mark-recapture method

Patterns of Dispersal:

1. **Clumped** – most common; near required resource
2. **Uniform** – usually antagonistic interactions
3. **Random** – unpredictable spacing, not common in nature



Demography: the study of vital statistics of populations and how they change over time

- Additions occur through **birth**, and subtractions occur through **death**.
- **Life table**: age-specific summary of the survival pattern of a population

Table 40.1 Life Table for Female Belding's Ground Squirrels (Tioga Pass, in the Sierra Nevada of California)

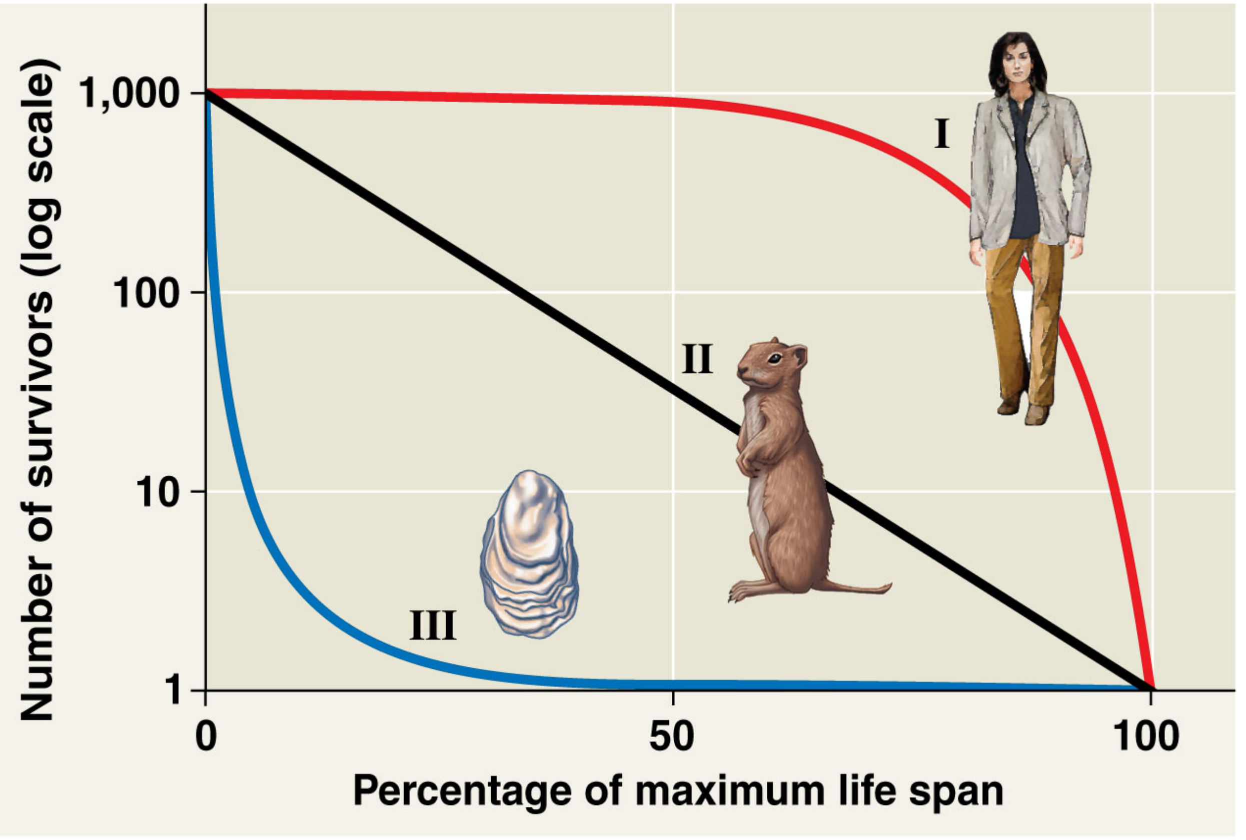
Age (years)	Number Alive at Start of Year	Proportion Alive at Start of Year†	Death Rate‡	Average Number of Female Offspring
0–1	653	1.000	0.614	0.00
1–2	252	0.386	0.496	1.07
2–3	127	0.197	0.472	1.87
3–4	67	0.106	0.478	2.21
4–5	35	0.054	0.457	2.59
5–6	19	0.029	0.526	2.08
6–7	9	0.014	0.444	1.70
7–8	5	0.008	0.200	1.93
8–9	4	0.006	0.750	1.93
9–10	1	0.002	1.00	1.58

Data from P. W. Sherman and M. L. Morton, Demography of Belding's ground squirrel, *Ecology* 65:1617–1628 (1984).

†Indicates the proportion of the original cohort of 653 individuals that are still alive at the start of a time interval.

‡The death rate is the proportion of individuals alive at the start of a time interval that die during that time interval.

Survivorship Curve: represent # individuals alive at each age



- **Type I:** low death rate early in life (humans)
- **Type II:** constant death rate over lifespan (squirrels)
- **Type III:** high death rate early in life (oysters)

Change in Population Size

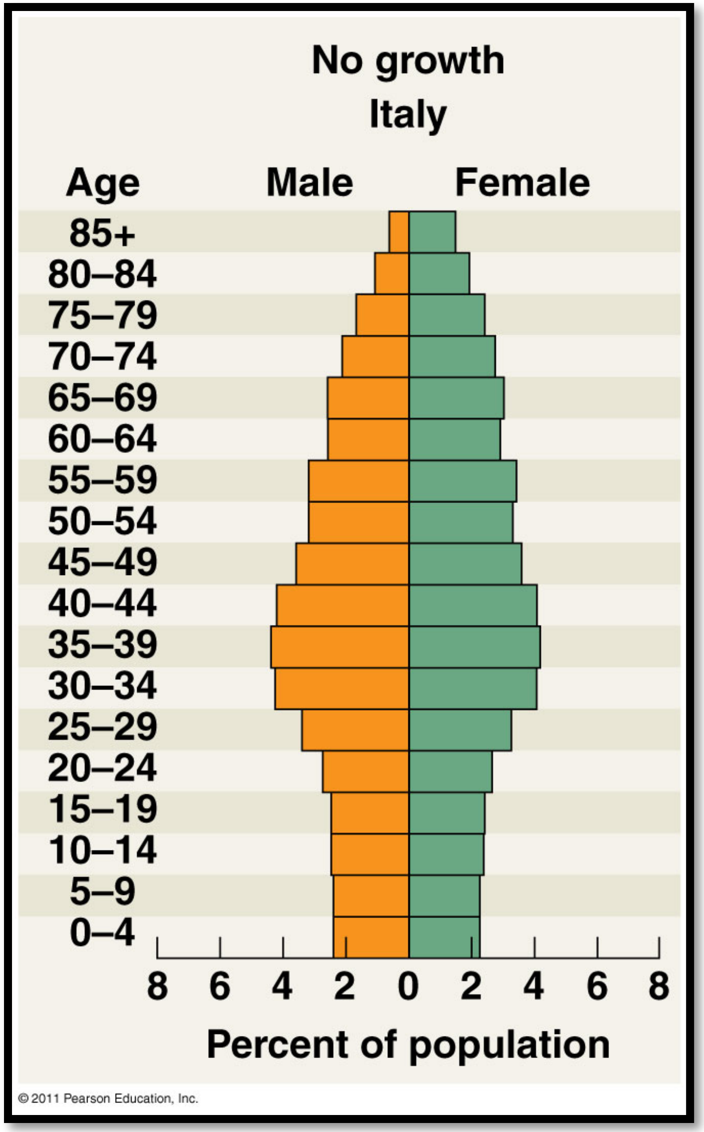
Change in population size during time interval = Births during time interval - Deaths during time interval

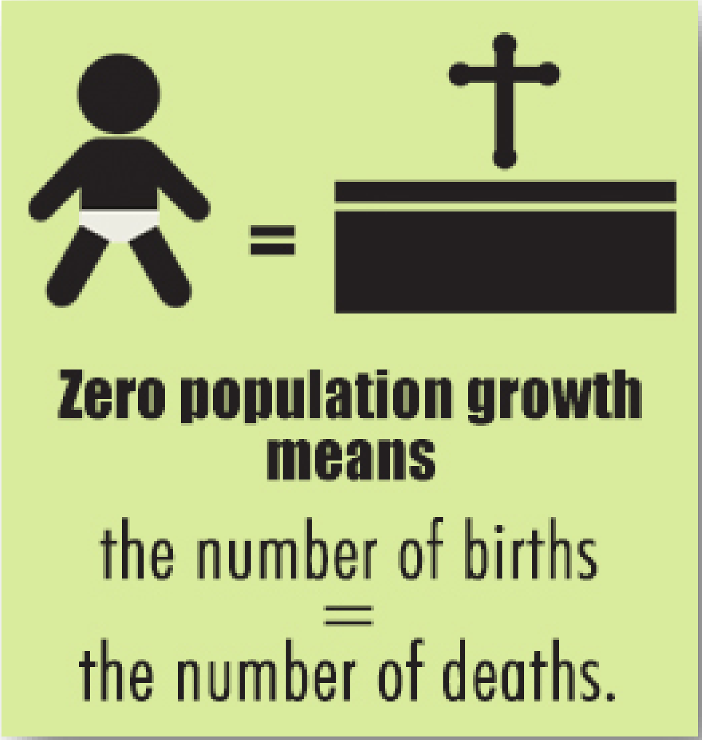
$$dN/dt = B - D$$

N = population size

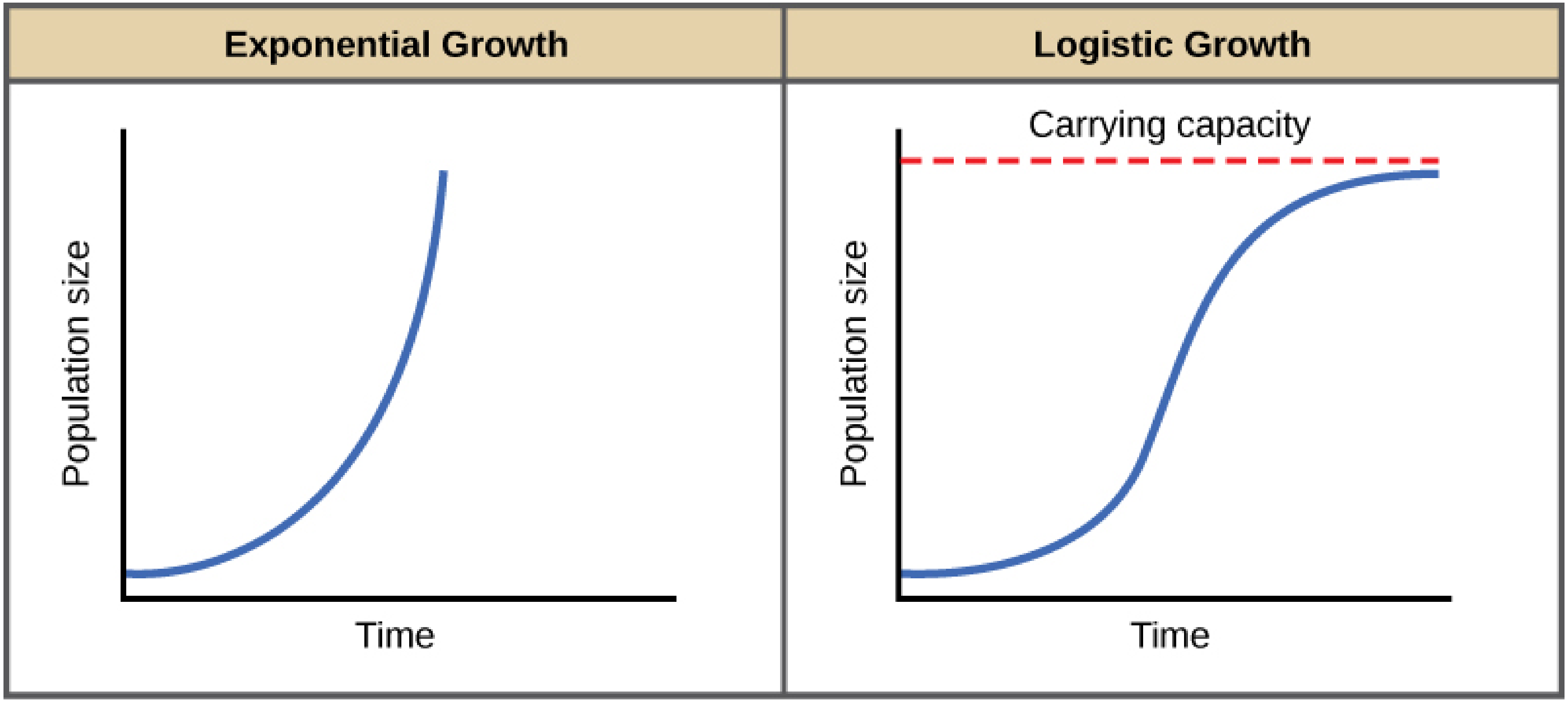
t = time

Zero Population Growth

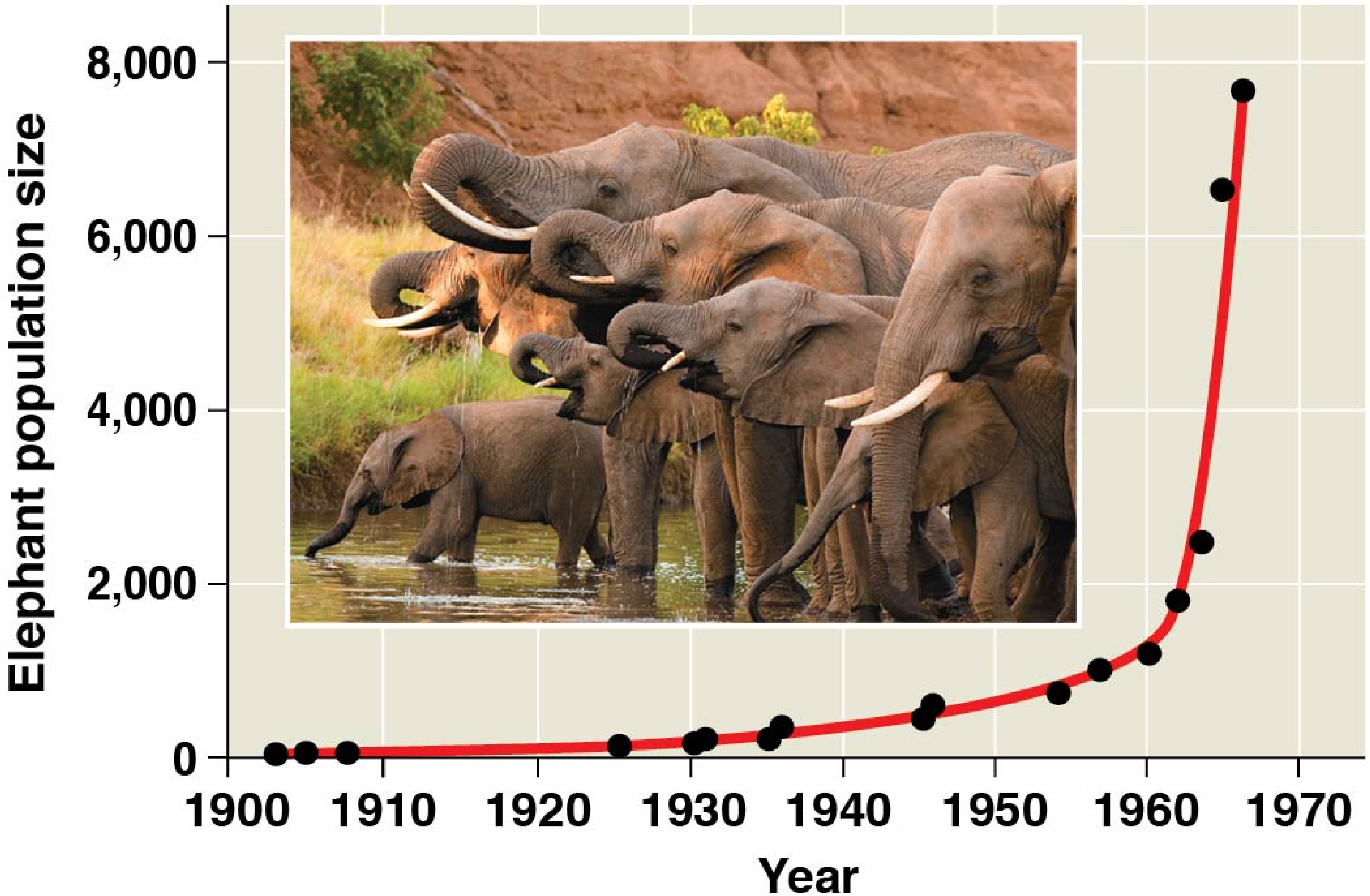




Population Growth Models



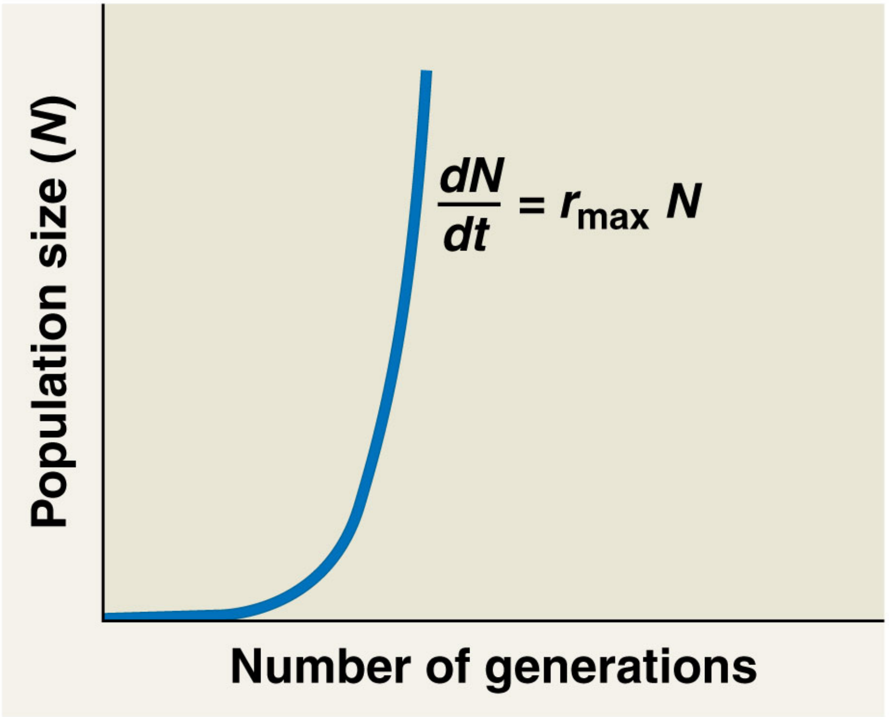
Exponential population growth: ideal conditions, population grows rapidly



Exponential Growth Equation

$$\frac{dN}{dt} = rN$$

dN/dt = change in population
r = growth rate of pop.
N = population size



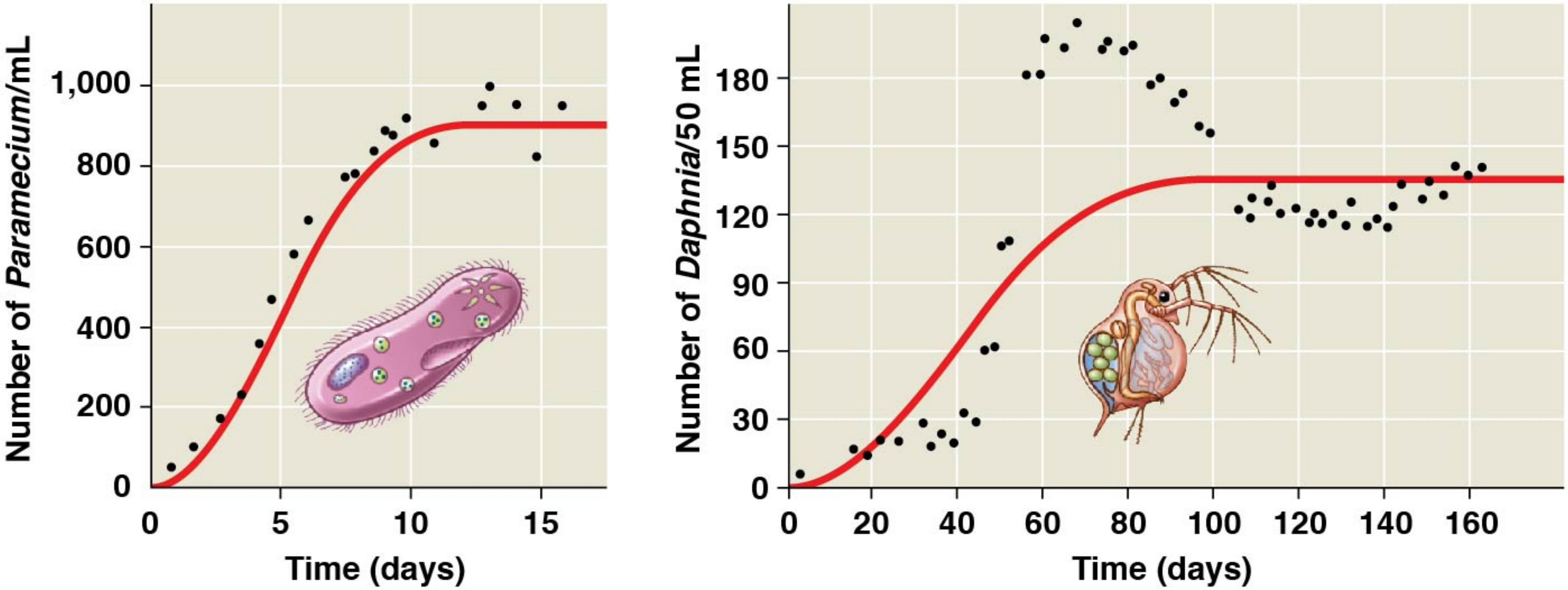
Exponential Growth Problem

$$\frac{dN}{dt} = rN$$

Sample Problem:

A certain population of mice is growing exponentially. The growth rate of the population (r) is 1.3 and the current population size (N) is 2,500 individuals. How many mice are added to the population each year?

- Unlimited resources are rare!
- **Logistic model**: incorporates **carrying capacity (K)**
  - **K** = maximum stable population which can be sustained by environment

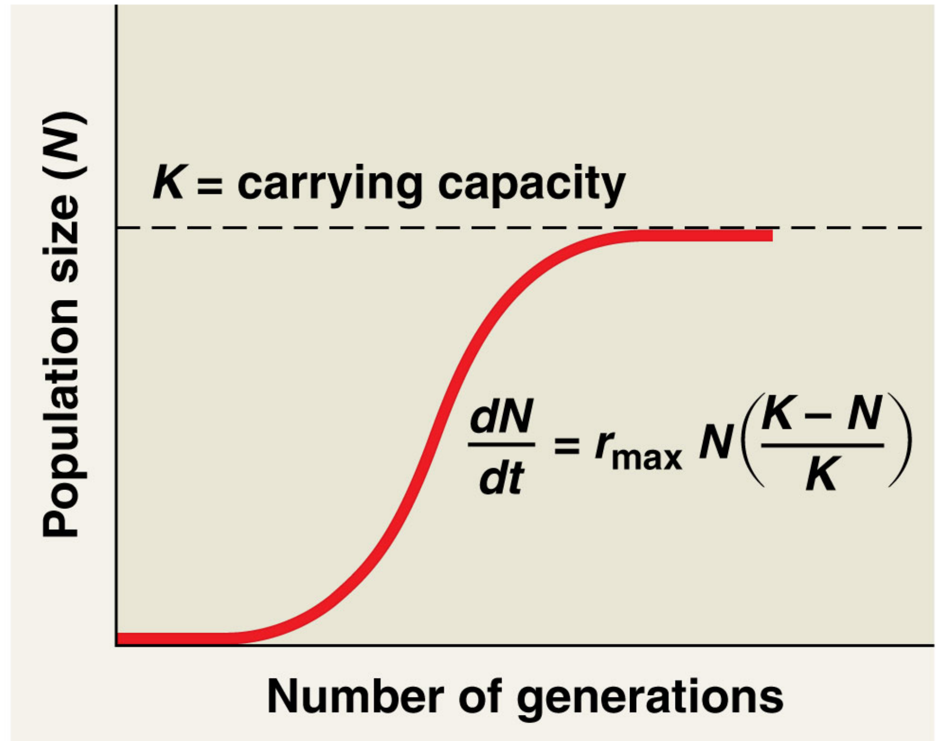


(a) A *Paramecium* population in the lab (b) A *Daphnia* (water flea) population in the lab

Logistic Growth Equation

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

dN/dt = change in population
r = growth rate of pop.
N = population size
K = carrying capacity



Logistic Growth Problem

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

Sample Problem:

If a population has a carrying capacity (K) of 900, and the growth rate (r) is 1.1, what is the population growth when the population (N) is 425?

Life History: traits that affect an organism’s schedule of reproduction and survival

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3 Variables:

1. Age of sexual maturation
2. How often organism reproduces
3. # offspring produced per reproductive episode

Note: These traits are evolutionary outcomes, *not* conscious decisions by organisms

Semelparity

- Big-bang reproduction
- Many offspring produced at once
- Individual often dies afterwards
- Less stable environments

Agave Plant

(a) Dandelions release a large number of tiny fruits.

(b) The Brazil nut tree (above), produces a moderate number of large seeds in pods (left).

Iteroparity

- Repeated reproduction
- Few, but large offspring
- More stable environments

Lizard

Critical factors: survival rate of offspring and repeated reproduction when resources are limited

- **K-selection**: pop. close to carrying capacity
- **r-selection**: maximize reproductive success

K-selection	r-selection
Live around K	Exponential growth
High prenatal care	Little or no care
Low birth numbers	High birth numbers
Good survival of young	Poor survival of young
Density-dependent	Density independent
ie. Humans	ie. cockroaches

Factors that limit population growth:

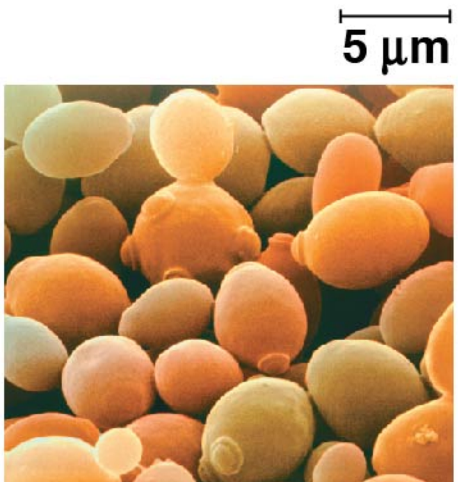
- Density-Dependent factors: population matters
  - i.e. Predation, disease, competition, territoriality, toxic wastes, physiological factors
- Density-Independent factors: population not a factor
  - i.e. Natural disasters: fire, flood, weather

Density-Dependent Regulation

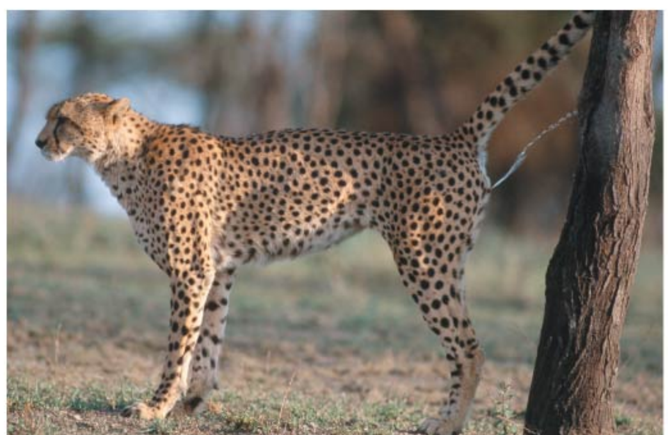
Competition for resources

Predation

Disease



Toxic wastes

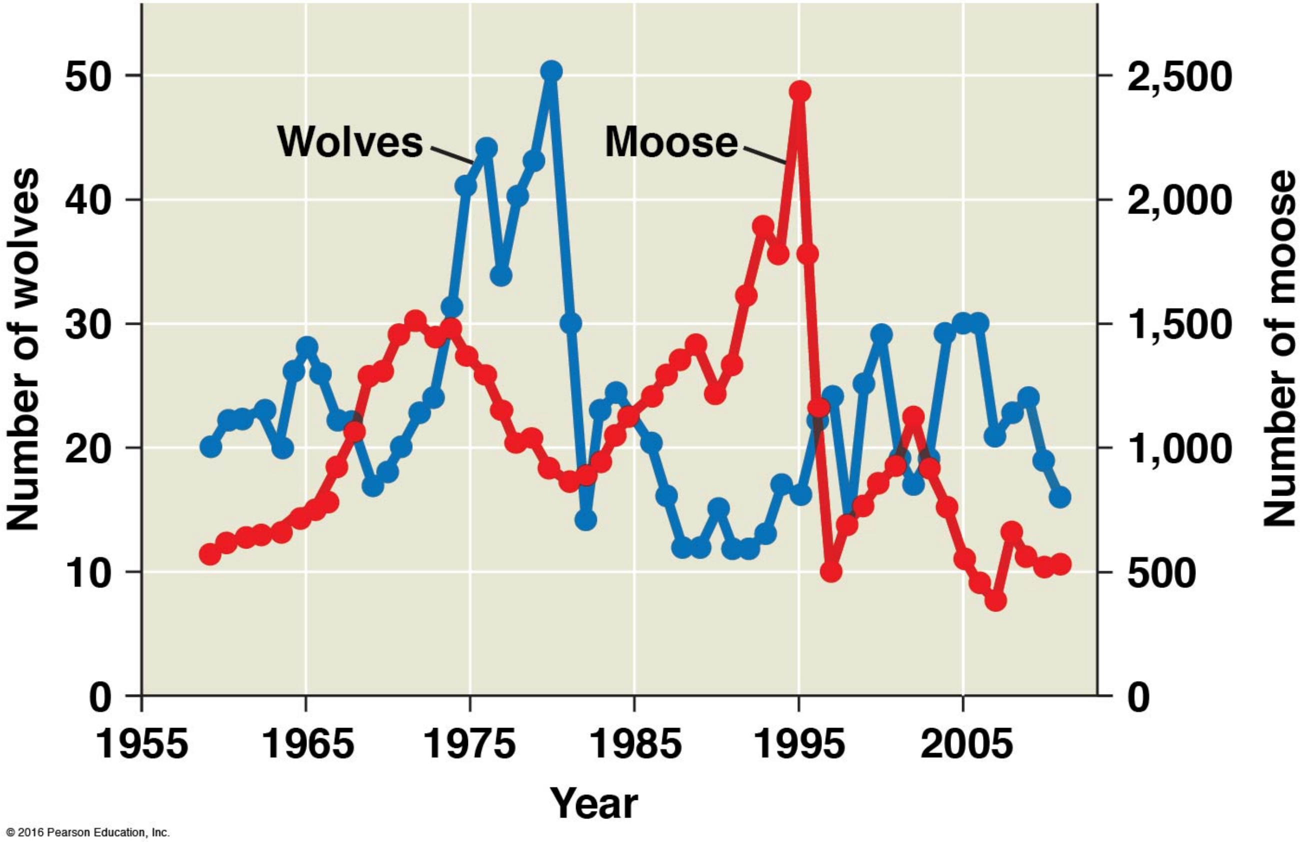


Territoriality

Intrinsic factors

Population Dynamics

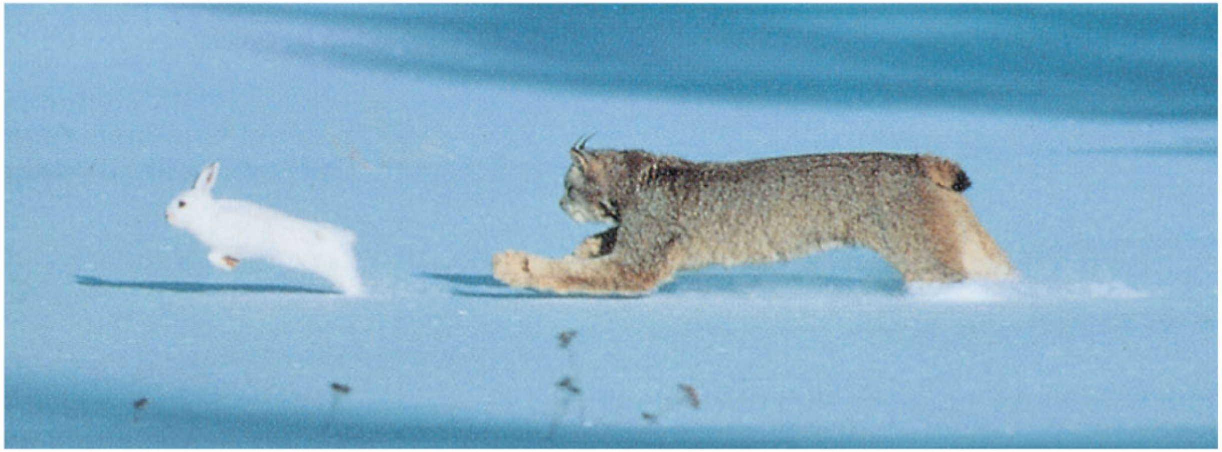
- Population fluctuations due to biotic & abiotic factors

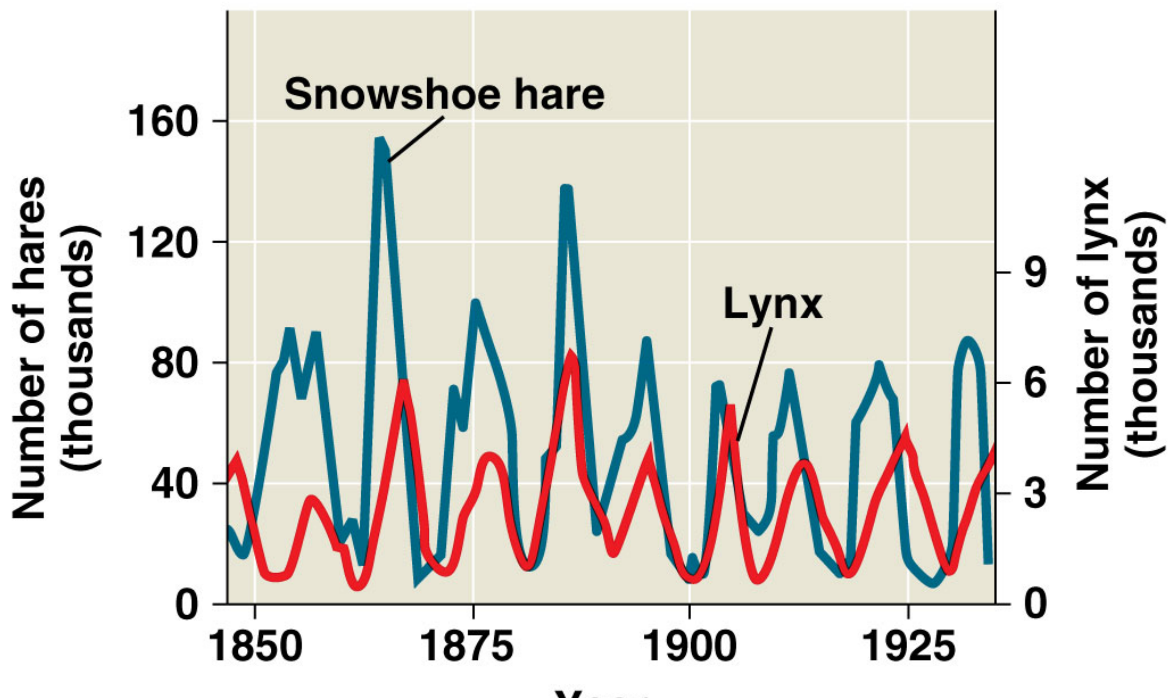


1975-1980: peak in wolf numbers

1995: harsh winter weather (deep snow)

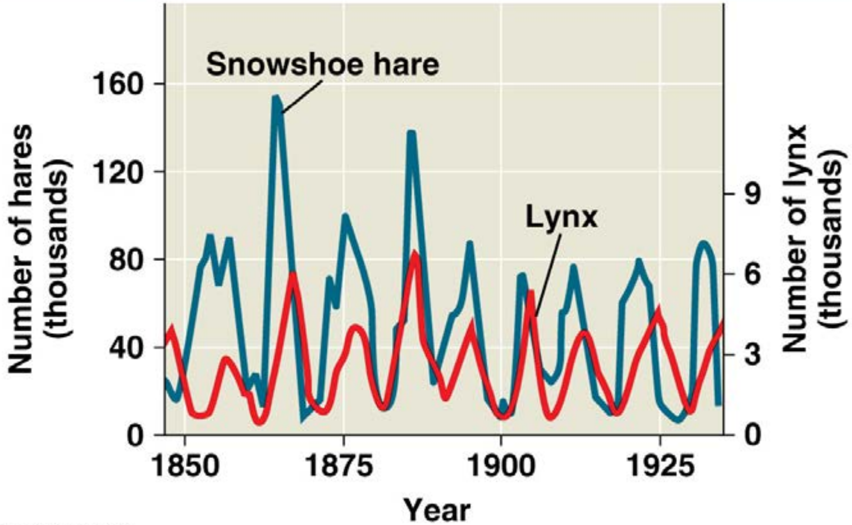
What do you notice about the population cycles of the snowshoe hare and lynx?



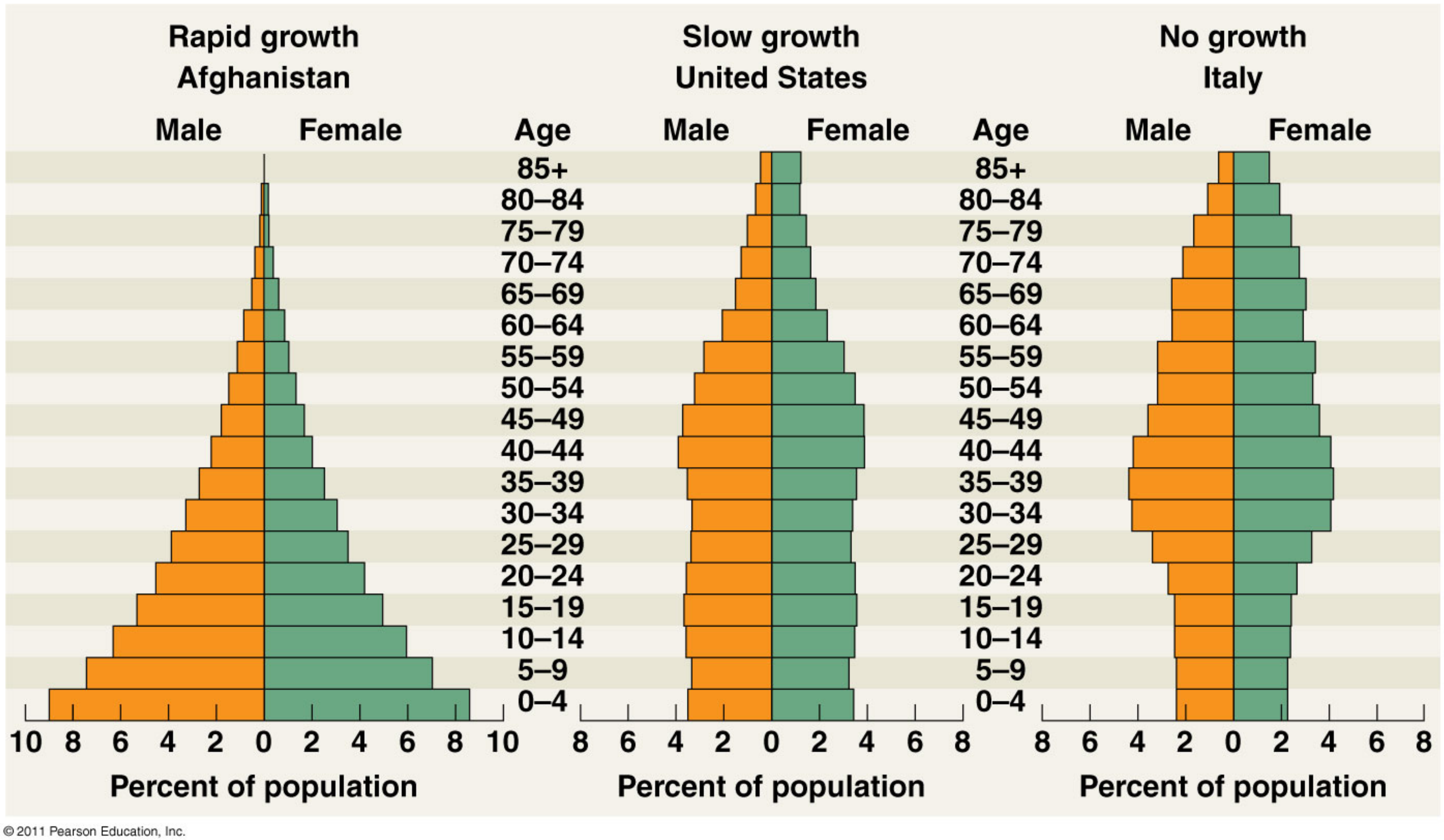


Boom-and-bust cycles

- Predator-prey interactions
- Eg. lynx and snowshoe hare on 10-year cycle



Age-Structure Diagrams



Human Population Growth

- 2 configurations for a stable human population (zero population growth):
    A. High birth / high death
    B. Low birth / low death

- <u>**Demographic transition**</u>: occurs when population goes from A → B

Sample Problem:

To estimate the size of an animal population, researchers often use a method known as mark-recapture, which involves marking individuals from a large population for easy identification upon recapture. The mark-recapture method assumes that the proportion of marked individuals in the recapture group is equal to the proportion of marked individuals in the entire population.

Researchers used the mark-recapture method to estimate the number of individuals in a population. Using the results presented in the table below, estimate the total number of individuals in the population. Give your answer to the nearest whole number.

	Number of Marked Individuals	Total Number of Individuals
Recapture Group	27	210
Entire Population	100	?