POPULATIONS

How Populations Grow

- A **population** consists of individuals of a species that live together in one place at one time.
- The statistical study of populations is called **demography.**
- A population can be widely distributed or confined to a small area.

POPULATION DYNAMICS

- three key features of populations

POPULATION SIZE

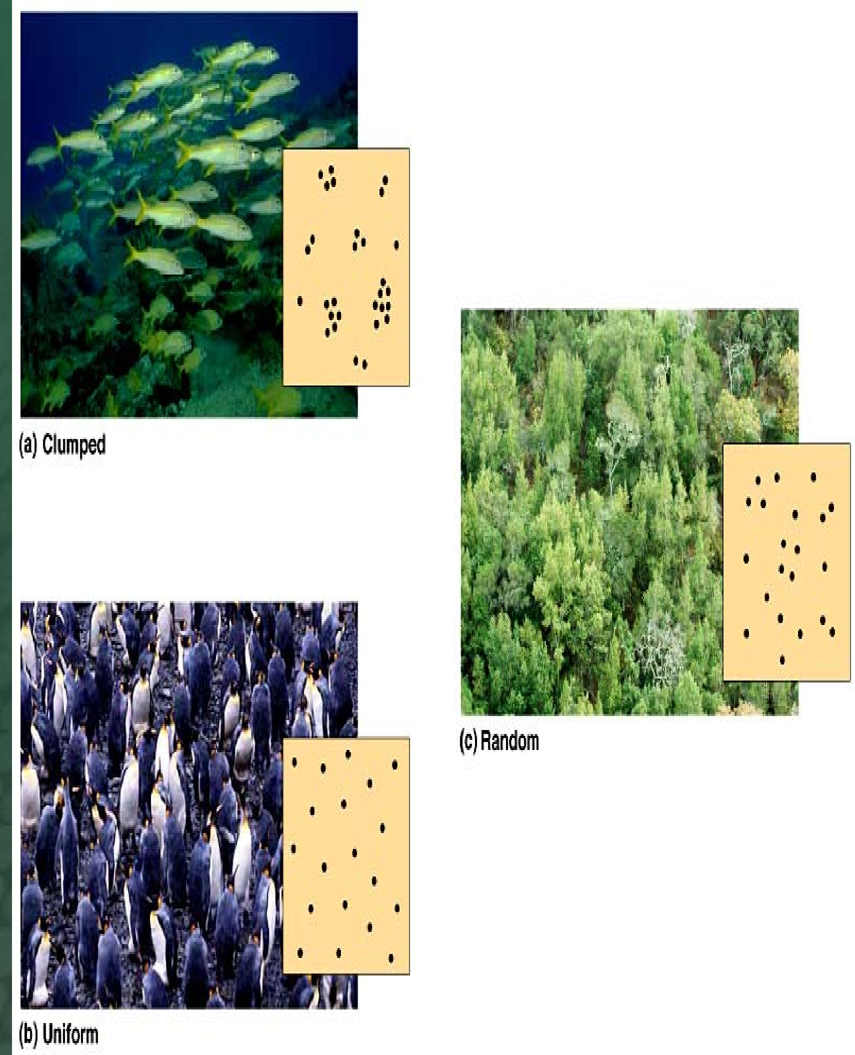
- defined as the number of individuals
- has an important effect on population survival
- very small populations - more likely become extinct
  - random events may threaten the survival
  - inbreeding may become common as possible mates become scarce
  - inbreeding leads to genetic uniformity and population less likely to survive changes in environment

POPULATION DENSITY

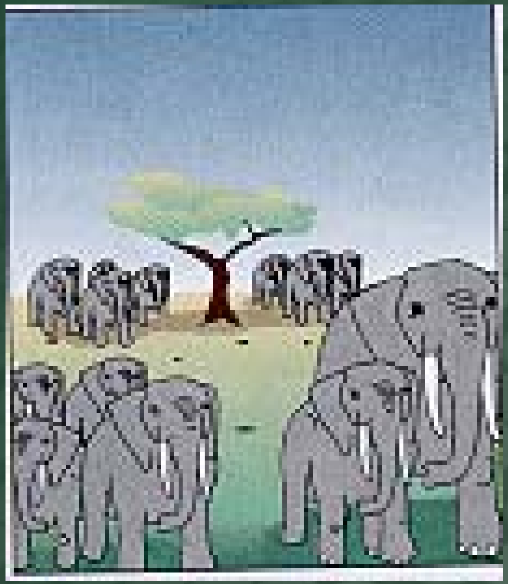
- refers to number of individuals per unit area
- determined by
  - social or population structure
  - mating relationships
  - time of year
- examples: high density - fleas on a dog
  low density - hawks in the woodland

POPULATION DISPERSION

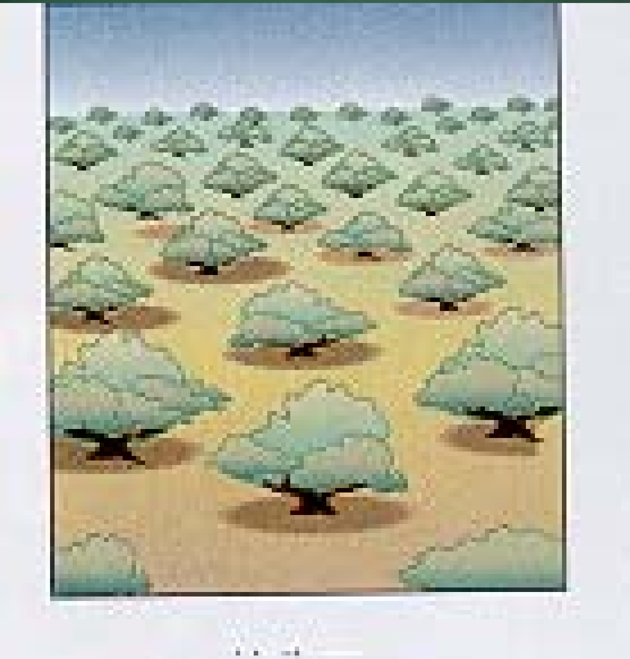
- the way individuals of a population are arranged
- Three main classifications -
  - clumped
  - uniform
  - random



- CLUMPED: individuals are lumped into groups
    - ex. Flocking birds or herbivore herds
    - due to resources that are clumped or social interactions
    - most common



- UNIFORM - Individuals are regularly spaced in the environment
  - ex. Creosote bush
  - due to antagonism between individuals, or due to regular spacing of resources
  - rare because resources are rarely evenly spaced

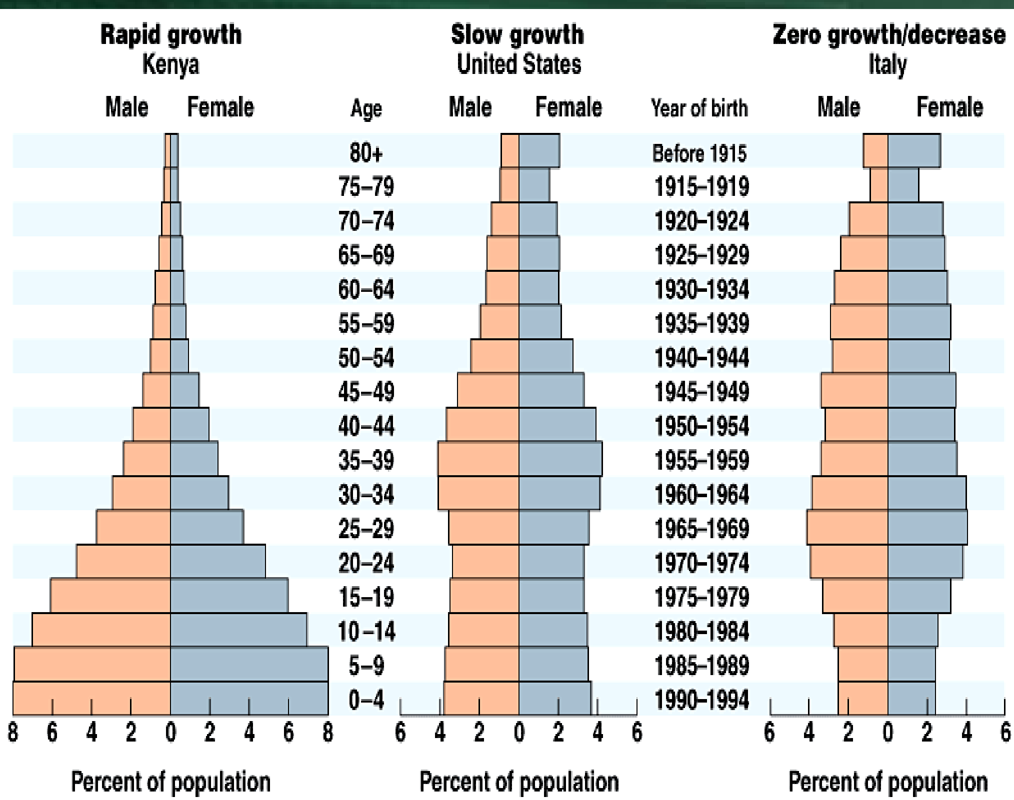


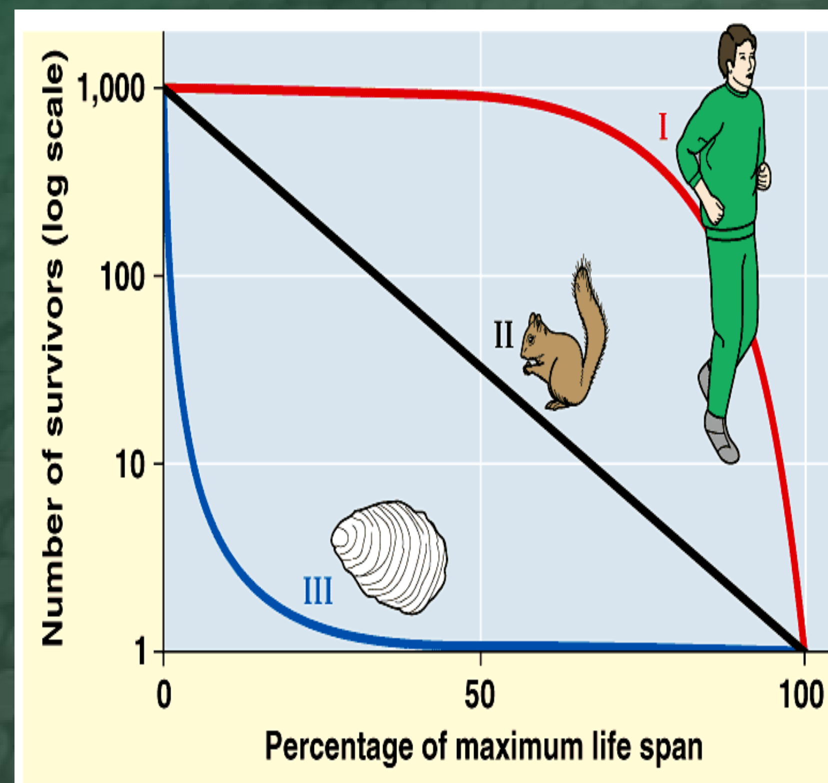
- **RANDOM**: Individuals are randomly dispersed in the environment
  - ex. Dandelions
  - due to random distribution of resources in the environment, and neither positive nor negative interaction between individuals
  - rare because these conditions are rarely met

- All populations are dynamic - they change in size and composition.
- When trying to predict how a population will grow, demographers construct a model of the population.
- A **model** of a population consists of computer programs and/or equations written to simulate what happens in a population and the environment.

- One important measure is **birth rate**, the number of births in a period of time.
- A second important measure is **death rate**, the number of deaths in a period of time.
- **Growth rate**= per capita birth rate - per capita death rate, or the amount by which a population's size changes in a given time.

- If growth rate is a positive number, the population is increasing; if it is a negative number the population is shrinking.





Immigration

- Coming into the population
- Increases # in the population

Emigration

- Leaving the population
- Decreases # in the population

Aliens would immigrate

Space Colonies would emigrate

Four fundamental processes determine the change in population size (births, deaths, immigrations and emigrations).

Knowing this, we can write the fundamental equation of population change as:

N= births - deaths + immigration - emigration.

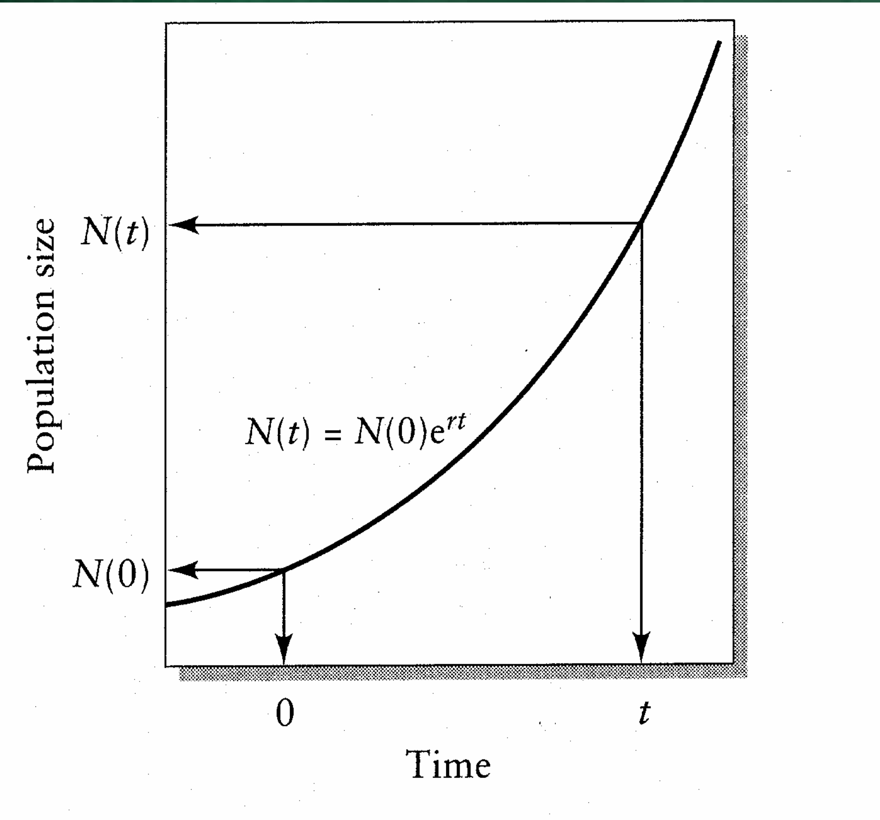
POPULATION GROWTH

Populations show two types of growth

- Exponential
- Logistic

- The **exponential model** of population growth describes a population that increases rapidly after only a few generations.
- The larger the population gets, the faster it grows.

Exponential growth



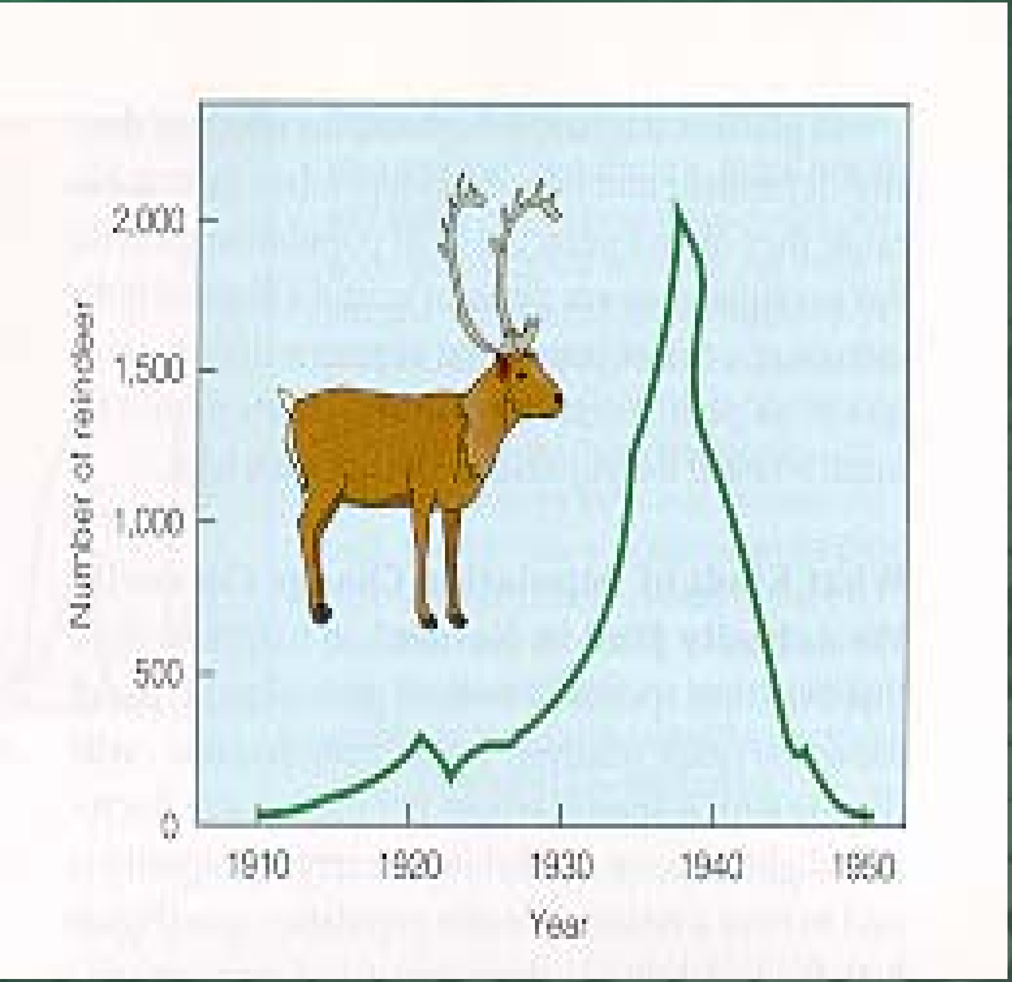
- As early as Darwin, scientists have realized that populations have the ability to grow exponentially
- All populations have this ability, although not all populations realize this type of growth
- J-shaped curve

- Theoretically, in an exponentially growing population :
  - one bacterium dividing every thirty minutes could produce over 1M cells in 10 hours
  - a single pair of house flies could produce >6T offspring in one summer IF all eggs hatched and survived

- Exponential growth is growth that is independent of population density
- No population exhibits exponential growth for very long, usually because they run out of resources and accumulate wastes.

Possible Outcome of Exp. Growth

- Populations increase so rapidly that they over-shoot the pop size that the environment can support, and the population crashes
  - ex. reindeer



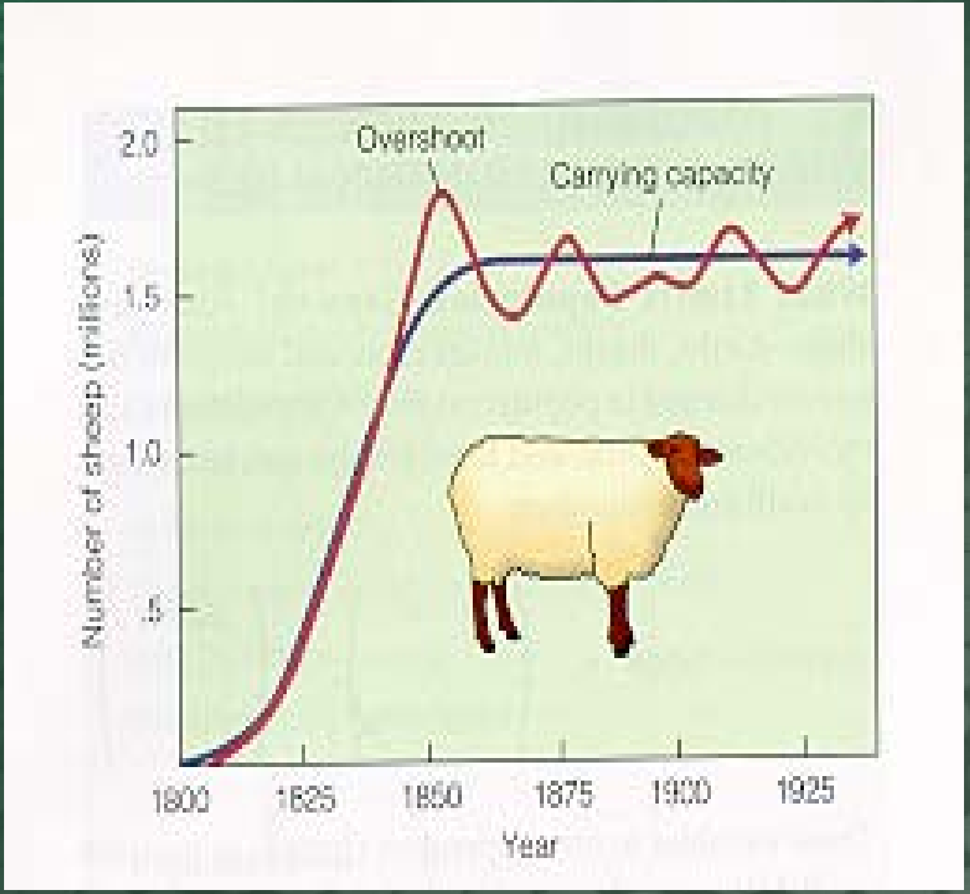
Logistic Growth

- In the **logistic model** of population growth, the growth rate declines as the population size rises. The population stabilizes at the carrying capacity.

- Population size that an environment can sustain is called **carrying capacity**.

Logistic Growth

- Populations increase to some level, and then maintain that stable level
  - ex. sheep



- **Logistics** refers to procuring, maintaining and transporting materials.
- It assumes that the birth rate and death rate are not constant but that birth rates → as the population grows and death rates ⬇
- Consists of lag phase, exponential phase, stable phase

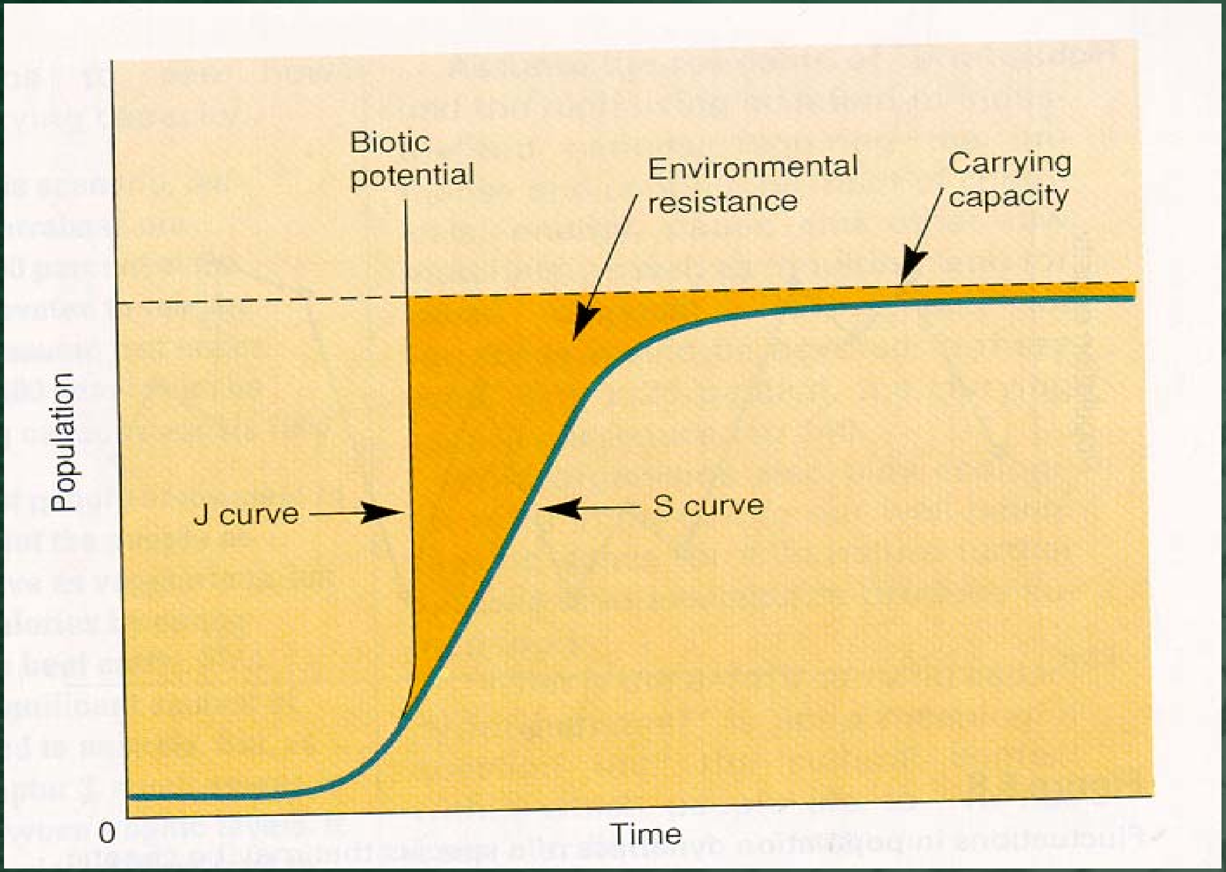
What limits population growth?

- **<u>Density-independent factors:</u>**
  - affect populations randomly (without respect to density)
  - ex. hurricanes, tornadoes, fire, drought, floods
  - poor regulators of populations (don't maintain populations at a stable level

- **Density-dependent factors:**
  - affect populations when densities are high
  - ex. disease, competition, predation, parasitism
  - good regulators of populations
    - cause logistic growth
    - maintain populations at carrying capacity

Population Regulation/Logistic Growth

- Most populations grow exponentially until the effect of **density- dependent factors** increases and limits population growth



- S-shaped growth curve

Life History Strategies

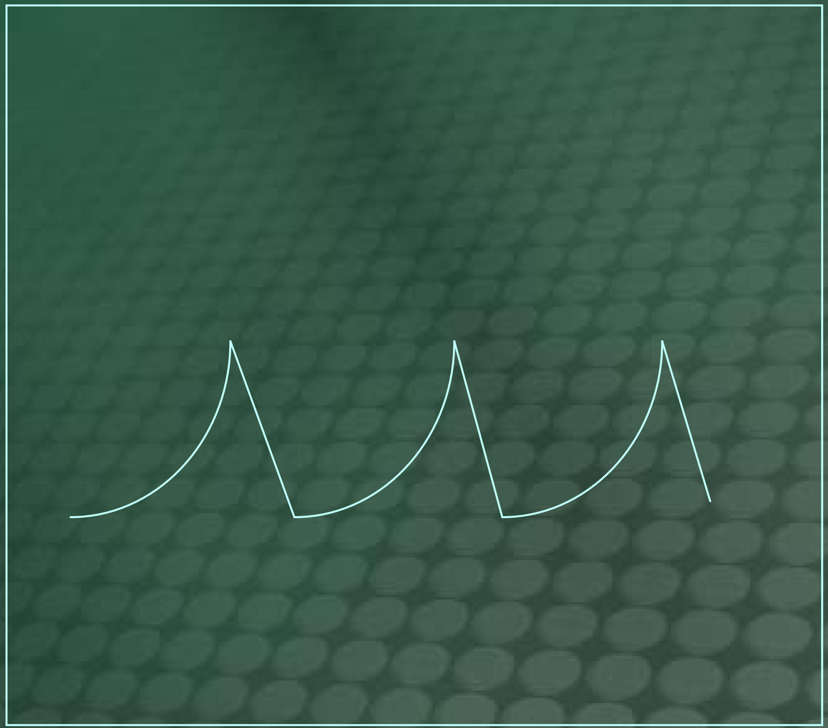
- Individuals have limited energy to put toward maintaining their own bodies and reproducing.
  - they can devote it to long life and low reproductive rate **OR**
  - short life and high reproductive rate

Life History Strategies

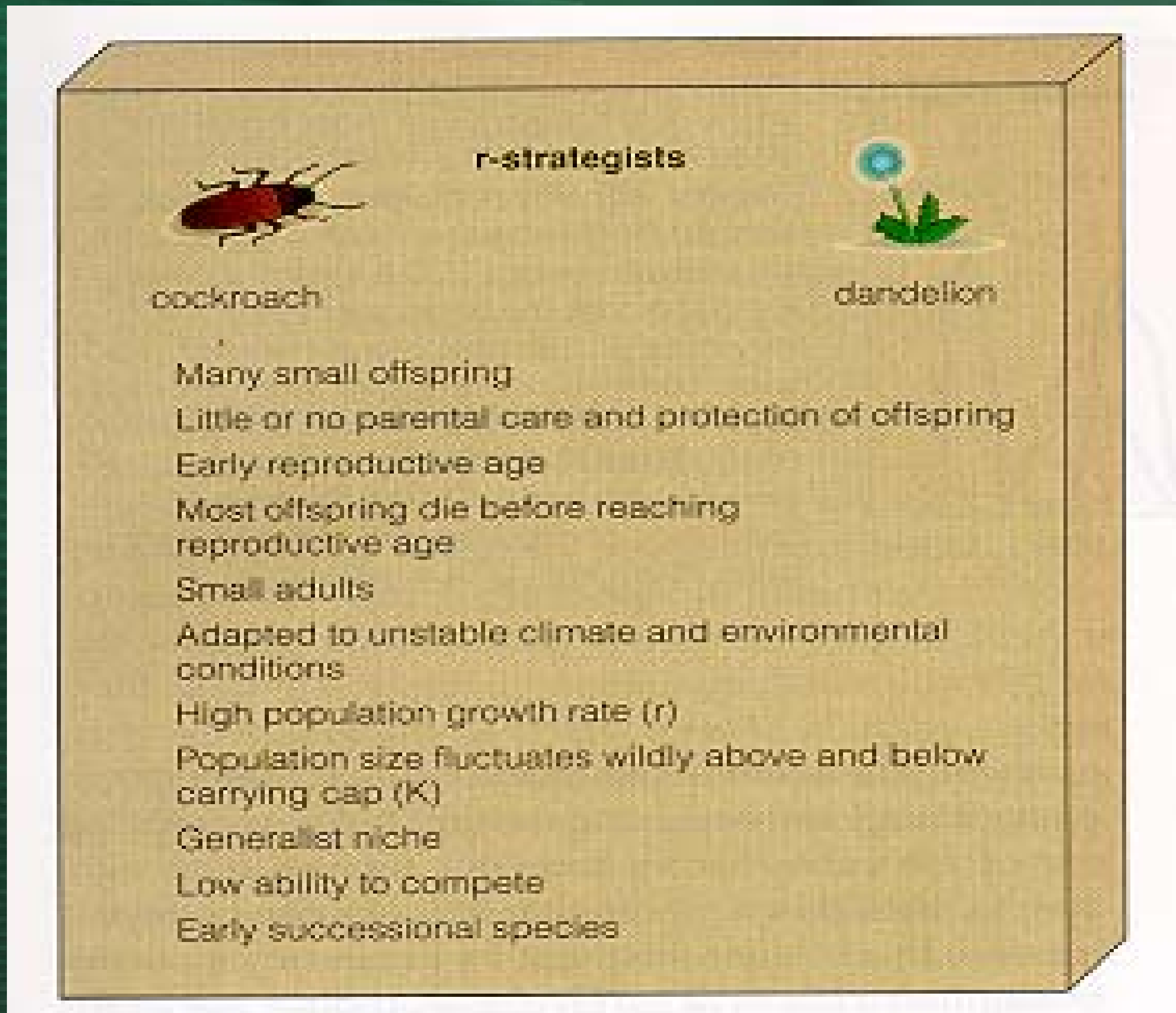
- Populations of species that are **r-strategists** are characterized by exponential growth.
  - short life spans, mature and reproduce early
  - many, small offspring; little parental care
  - changing habitats - exploit, grow, move on
  - generalists

r - strategists

- r-strategists are so-called, because they spend most of their time in exponential growth
- they maximize the reproductive rate



r - strategists



r-strategists

cockroach

dandelion

Many small offspring

Little or no parental care and protection of offspring

Early reproductive age

Most offspring die before reaching reproductive age

Small adults

Adapted to unstable climate and environmental conditions

High population growth rate (r)

Population size fluctuates wildly above and below carrying cap (K)

Generalist niche

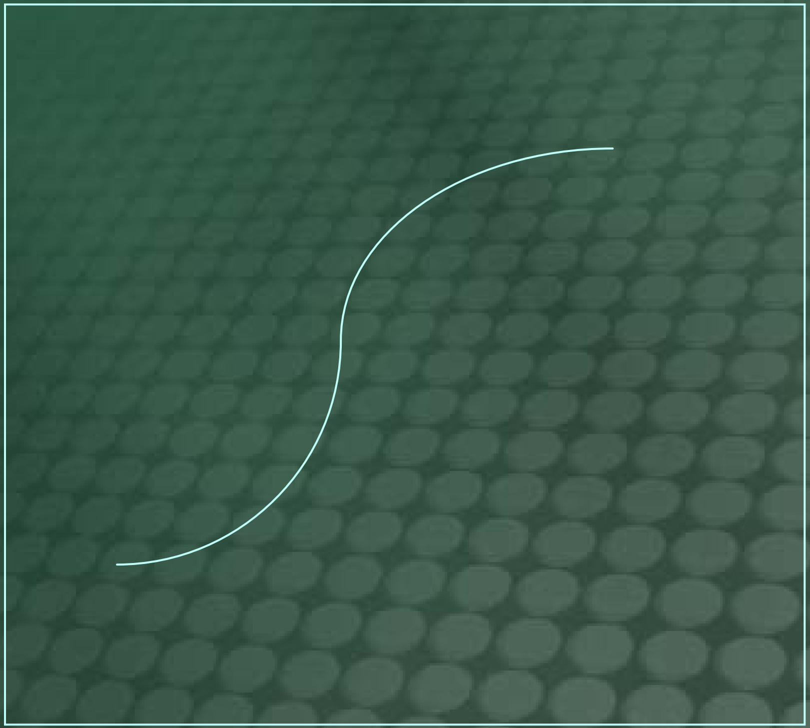
Low ability to compete

Early successional species

- Populations that are **k-strategists** are characterized by logistic growth.
  - longer life spans, mature & reproduce later
  - few, large offspring; high parental care
  - stable environments; maximize carrying capacity
  - specialists
  - many are endangered

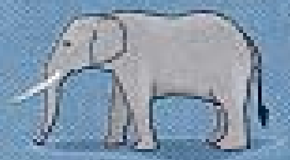
K - strategists

- Those species that maintain their population levels at K
- these populations spend most of their time at K



K - strategists

K-strategists


elephant


saguaro

Fewer, larger offspring
High parental care and protection of offspring
Later reproductive age
Most offspring survive to reproductive age
Larger adults
Adapted to stable climate and environmental conditions
Lower population growth rate (r)
Population size fairly stable and usually close to carrying capacity (K)
Specialist niche
High ability to compete
Late successional species

- Human Population Growth:
  - humans are K strategists
  - historically the population has remained stable
  - agricultural and industrial revolution have increased carrying capacity of the earth
  - at this rate
    - human population is doubling every 35 years
    - 6 B currently; 94 million every year; 230,000/day
  - damage to planet will eventually reduce carrying capacity and slow human growth rate

Human Population