POPULATIONS

Population

Members of the same species living in a specific geographic area

Key Features of Populations

1. **Size** - number of individuals in a population

   - determines ability of population to survive

   small populations: most likely to become extinct
   - more inbreeding increases bad alleles and reduces fitness

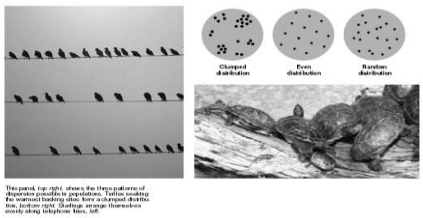
2. **Density** - number of individuals in a given area

   small populations: individuals rarely meet and reproduce due to low density

3. **Dispersion** - how individuals are arranged in a given area

   regular (uniform): evenly spaced intervals
   random: location in not orderly
   clumped: bunched in clusters

Three Patterns of Population Dispersion



This panel, top right, shows the three patterns of dispersion possible in populations. Turtles seeking the warmest basking sites form a clumped distribution, bottom right. Starlings arrange themselves evenly along telephone lines, left.

Populations are affected by:

- growth rate
- available resources
- predators and disease

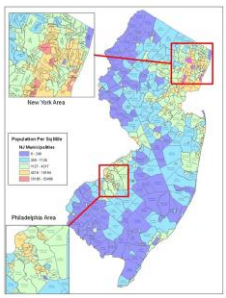
Population Density

- Number of individuals of a particular species per unit area or volume

  ex: number of alligators/km_2 of swamp
  number of bacteria/cm_2 of agar plate
  number of earthworms/cc of soil

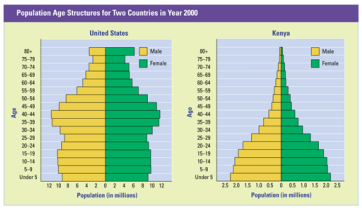
- If there are 1000 beech trees in a 50 km2 forest, what is the population density of the beech trees?

  population density = $\frac{\text{individuals}}{\text{unit area}}$



Tracking Population Growth

Population Age Structure Pyramid



X-axis : population
Y axis: age

males on left
females on right

- shows the distribution of various age groups in a human population
- forms the shape of a pyramid when the region is healthy
- indication of the reproductive capabilities and likelihood of the continuation of a species

Limits to Population Growth

Carrying capacity

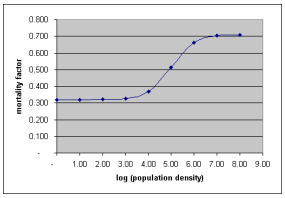
maximum number of organisms in a population that an environment can maintain or "carry" without a net increase or decrease

Factors That Affect Population Growth

Limiting Factor: a condition that restricts population growth

- **Density Dependant Factor**
  factor that limits a population more as population density increases

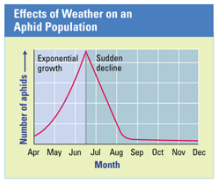
  ex: food, water, space, disease



Factors That Affect Population Growth

- **Density Independent Factor**
  factors that limit population growth that are unrelated to population density

  ex: weather events, fires, floods, major changes in a habitat



A population of aphids typically grows exponentially in the wet springs months. The population nearly dies off in the hot, dry summer. Weather is a density-independent factor that limits the aphid populations

MODELS IN POPULATION GROWTH

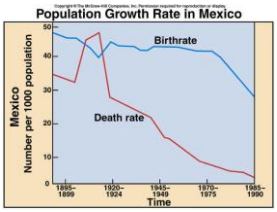
Population Model: hypothetical population which exhibits key characteristics of a real population

- allows demographers to predict outcomes that might occur in a real population

MODELS IN POPULATION GROWTH

1. **Stage I model**
   - growth rate
   - birth rate vs death rate
   - expressed as:

     # births and deaths/ 1000 people/ year



2. Stage II model (exponential)

- population size vs time
- J shaped curve
  - rate stays same and population size increases steadily
  - growth affected by predators, disease, and availability of resources
  - carrying capacity (k) – pop. size an environment can sustain

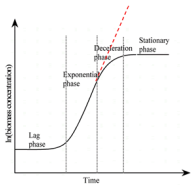
3. Stage III model (logistical)

- S shaped
- exponential growth limited by a density dependant factor (food and water)
- refers to ability of population to solve day to day problems of living

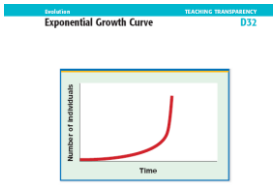
Size below K: rapid growth rate

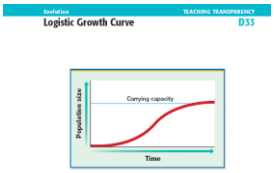
Size near K: death rates rise, births decline growth of population slows

At K: birth = death population stops growing



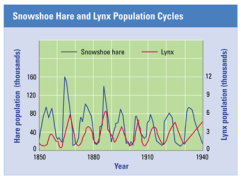
- most realistic model in nature





Population Growth Cycles

- **Boom and Bust Cycle**



- direct relationship between predator and prey
- causes fluctuations in populations in stable ecosystems

ex: increases in hare population are followed closely by increases in lynx population

Population Growth Patterns

1. r strategists

- rapidly growing populations
- large population size
- affected by density independent factors (weather, climate)

- in good conditions, grow exponentially
- in poor conditions, population size drops quickly
- short life span, reproduce early, many offspring

Ex: insects, plants, bacteria

2. k strategists

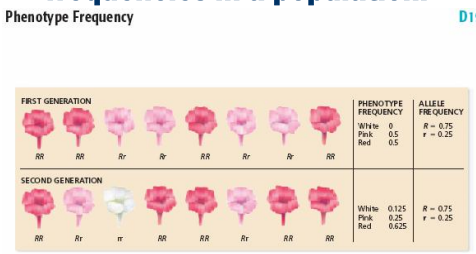
- grow slowly
- affected by density dependant factors (food, water)
- small population size
- population density near K (carrying capacity)
- long life span, few young, slow maturation, repro. late in life, take care of young

ex: whales , redwood trees

Genetics and Evolution

- Populations evolve
  - each individual in population has own assortment of alleles
  - as they reproduce and die, genetic makeup of population changes from generation to generation

Modern evolution studies the gradual change in allele frequencies in a population.



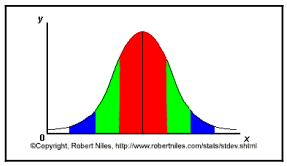
Sources of Genetic Variation in Populations

1. **Mutation**

DeVries (dutch botanist) 1900 introduced concept of mutation
- evening primroses
- occasionally plant appeared with totally new form
- plants bred true in future generations
- he considered sudden changes to be **mutations**
- major source in genetic variation
- most recessive

2. **Gene flow** through migration
   - new individuals (immigrants) add alleles to population
   - emigrants take away alleles from population
3. **Genetic drift** - random change in allele frequency (chance)
4. **Natural selection**
   - most powerful agent of genetic change
   - alleles most favorable to allow survival, reproduce and increase in population
   - reduces harmful genes in a population

Natural Selection Distribution Curves



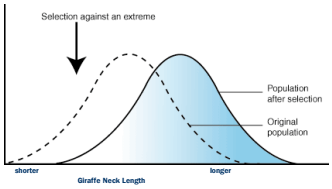
NORMAL BELL CURVE

- normal distribution of data: most of the examples in a set of data are close to the "average," while relatively few examples tend to one extreme or the other
  - »**x**-axis: the value in question
  - »**y**-axis: number of datapoints for each X value

Ex: number people who eat X calories per day

Natural Selection Distribution Curves

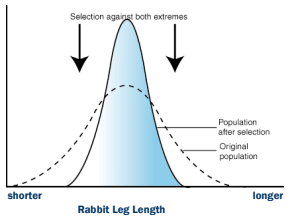
1. **Directional selection**
   - eliminates one extreme of the phenotypes so it becomes less common
   - causes frequency of particular trait to move in one direction
   - characterizes evolution of single gene traits



ex: pesticide resistance
antibiotic resistance
peppered moth

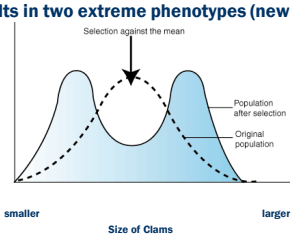
2. Stabilizing selection

- eliminates extremes at both ends of phenotype
- intermediate phenotypes increase
- results in fewer extreme phenotypes



3. Disruptive selection

- individuals with either extreme variation of a trait have greater fitness than individuals with average form of trait
- eliminates average phenotype
- results in two extreme phenotypes (new species)



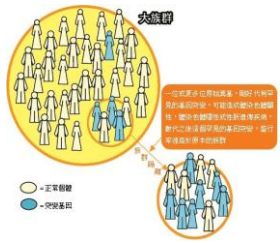
Other Causes of Population Genotype Changes

1. Founder effect (Ernst Mayr)

- The establishment of a new population by a few original founders carry only a small fraction of the total genetic variation of the parental population

- reason:
  a small number of individuals may colonize a place previously uninhabited by their species

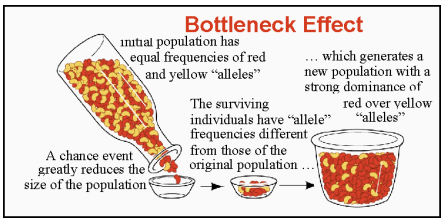
- result:
  the frequencies of the genes may differ from the parental population



2. Bottleneck effect:

- an evolutionary event in which a significant percentage of a population or species is killed or prevented fro reproducing

- effect:
  reduction of a population's gene pool and the accompanying changes in gene frequency produced when a few members survive the widespread elimination of a species



Study for the test !