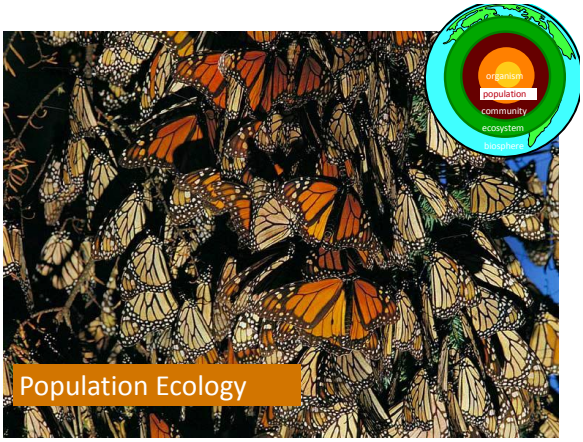
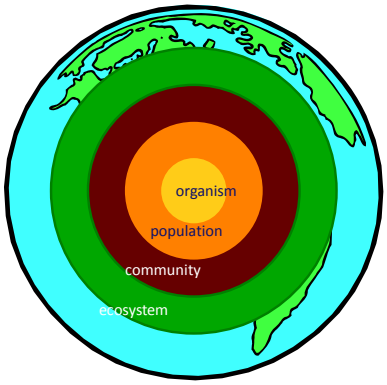


Studying organisms in their environment



Life takes place in populations

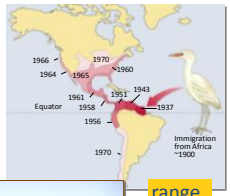
- Population
  - group of individuals of same species in same area at same time

- rely on same resources
- interact
- interbreed

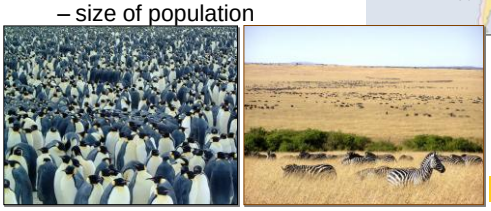
Population Ecology: What factors affect a population?

Characterizing a Population

- Describing a population
  - population range
  - pattern of spacing
    - density
  - size of population



range



density

Population Range

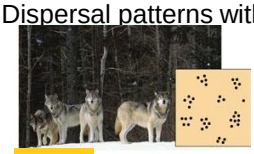
- Geographical limitations
  - abiotic & biotic factors
    - temperature, rainfall, food, predators, etc.
  - habitat

adaptations to polar biome

adaptations to rainforest biome

Population Spacing

- Dispersal patterns within a population



clumped

Provides insight into the environmental associations & social interactions of individuals in population

random

uniform

Which pattern is most common? Why?

Clumped Pattern (most common)

Uniform

- May result from direct interactions between individuals in the population
- → territoriality

Demography

- Factors that affect growth & decline of populations
  - vital statistics & how they change over time

Life table

Table 52.1 Life Table for Belding Ground Squirrels (*Spermophilus beldingi*) at Tioga Pass, in the Sierra Nevada Mountains of California*

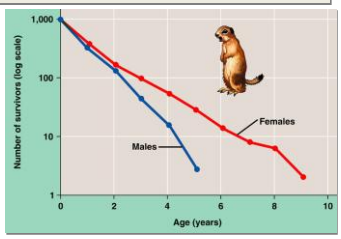
	females					males				
Age (years)	Number Alive at Start of Year	Proportion Alive at Start of Year	Number of Deaths During Year	Death Rate†	Average Life Expectancy (years)	Number Alive at Start of Year	Proportion Alive at Start of Year	Number of Deaths During Year	Death Rate†	Average Life Expectancy (years)
0–1	337	1.000	207	0.61	1.33	369	1.000	227	0.65	1.07
1–2	252‡‡	0.386	125	0.50	1.56	248‡‡	0.350	140	0.56	1.12
2–3	127	0.197	60	0.47	1.60	108	0.152	74	0.69	0.93
3–4	67	0.106	32	0.48	1.59	34	0.048	23	0.68	0.89
4–5	35	0.054	16	0.46	1.59	11	0.015	9	0.82	0.68
5–6	19	0.029	10	0.53	1.50	2	0.003	0	1.00	0.50
6–7	9	0.014	4	0.44	1.61	0				
7–8	5	0.008	1	0.20	1.50					
8–9	4	0.006	3	0.75	0.75					
9–10	1	0.002	1	1.00	0.50					

*Males and females have different mortality schedules, so they are separated.
†The death rate is the proportion of individuals dying during a specific time interval.
‡‡Includes 122 females and 126 males first captured as 1-year-olds; therefore, not included in the count of squirrels age 0–1.
SOURCE: Data from P. W. Sherman and M. L. Morton, "Demography of Belding's Ground Squirrel," *Ecology* 65(1984): 1617–1628.

Survivorship curves

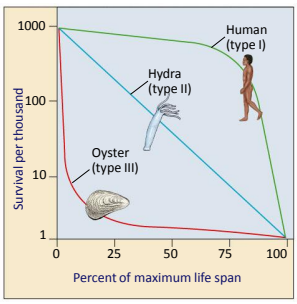
- Graphic representation of life table

The relatively straight lines of the plots indicate relatively constant rates of death; however, males have a lower survival rate overall than females.



Survivorship curves

- Generalized strategies



What do these graphs tell about survival & strategy of a species?

I. High death rate in post-reproductive years

II. Constant mortality rate throughout life span

III. Very high early mortality but the few survivors then live long

Trade-offs: survival vs. reproduction

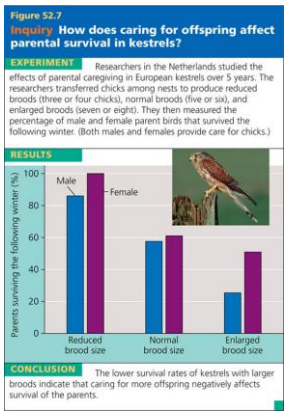
- The cost of reproduction
  - increase reproduction may decrease survival
    - investment per offspring
    - number of reproductive cycles per lifetime

Natural selection favors a life history that maximizes lifetime reproductive success

Parental survival

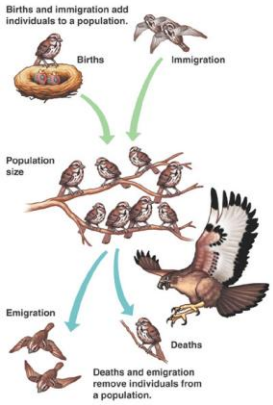
Kestrel Falcons:

The cost of larger broods to both male & female parents



Population Size

- Changes to population size
  - adding & removing individuals from a population
    - birth
    - death
    - immigration
    - emigration



Population growth

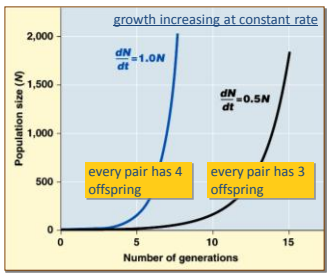
change in population = births – deaths

Exponential model (ideal conditions)

$\frac{dN}{dt} = r_i N$

N = # of individuals
r = rate of growth
r_i = intrinsic rate
t = time
d = rate of change

intrinsic rate = maximum rate of growth



Population growth

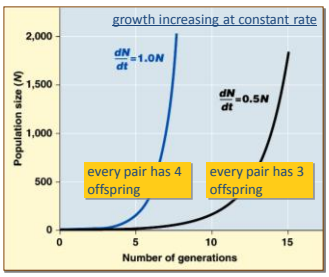
change in population = births – deaths

Exponential model (ideal conditions)

$G = r_i N$

G = rate of growth
r_i = intrinsic rate
N = # of individuals

intrinsic rate = maximum rate of growth

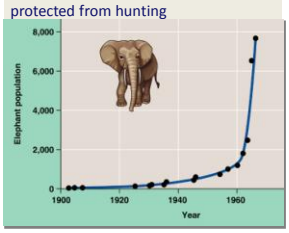


Exponential growth rate

- Characteristic of populations without limiting factors
  - introduced to a new environment or rebounding from a catastrophe

Whooping crane coming back from near extinction

African elephant protected from hunting

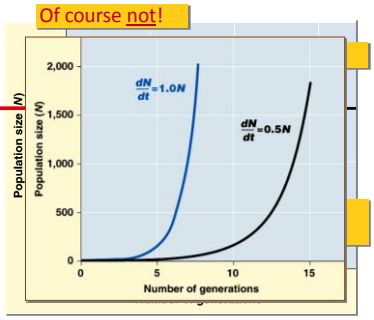


Logistic rate of growth

- Can populations continue to grow exponentially?

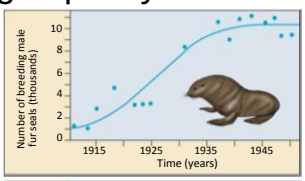
Of course not!

K = carrying capacity

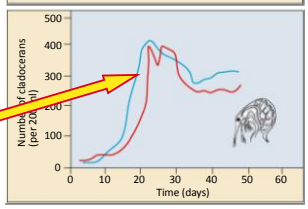


Carrying capacity

- Maximum population size that environment can support with no degradation of habitat
  - varies with changes in resources

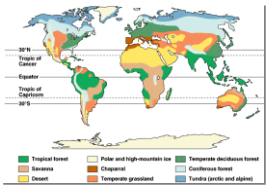


?



Factors that affect Population Size

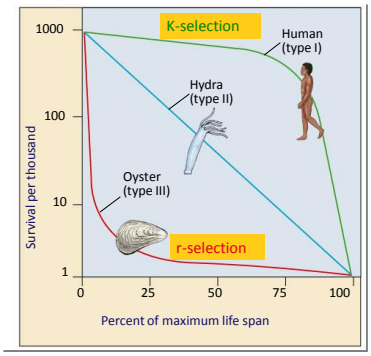
- Abiotic factors (density independent)
  - sunlight & temperature
  - precipitation / water
  - soil / nutrients
- Biotic factors (density dependent)
  - other living organisms
    - prey (food)
    - competitors
    - predators, parasites, disease



Reproductive strategies

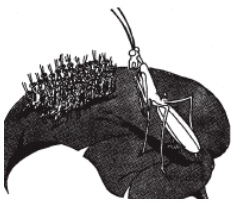
- K-selected
  - late reproduction
  - few offspring
  - invest a lot in raising offspring
    - primates
    - coconut
- r-selected
  - early reproduction
  - many offspring
  - little parental care
    - insects
    - many plants

Life strategies & survivorship curves



Trade offs

Number & size of offspring
vs.
Survival of offspring or parent



"Of course, long before you mature, most of you will be eaten."

(a) Most weedy plants, such as this dandelion, grow quickly and produce a large number of seeds, ensuring that at least some will grow into plants and eventually produce seeds themselves.

(b) Some plants, such as this coconut palm, produce a moderate number of very large seeds. The large endosperm provides nutrients for the embryo, an adaptation that helps ensure the success of a relatively large fraction of offspring.

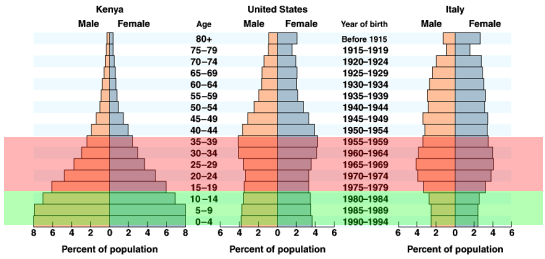
Population growth rates

- Factors affecting population growth rate
  - sex ratio
    - how many females vs. males?
  - generation time
    - at what age do females reproduce?
  - age structure
    - how many females at reproductive age in cohort?

Age structure

- Relative number of individuals of each age

What do these data imply about population growth in these countries?

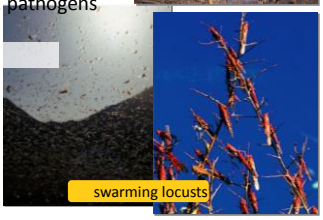


Regulation of population size

- Limiting factors
  - density dependent
    - competition: food, mates, nesting sites
    - predators, parasites, pathogens
  - density independent
    - abiotic factors

marking territory = competition

competition for nesting sites

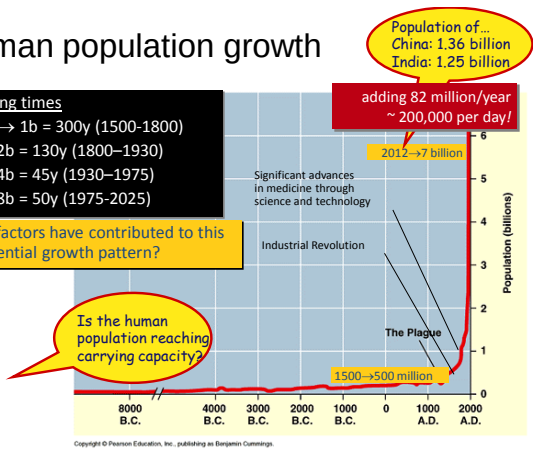


swarming locusts

Human population growth

Doubling times
500m → 1b = 300y (1500-1800)
1b → 2b = 130y (1800–1930)
2b → 4b = 45y (1930–1975)
4b → 8b = 50y (1975-2025)

What factors have contributed to this exponential growth pattern?



Estimating Population Size

- Two Methods
  - Quadrat Sampling
    - How many Maple Trees in a State Park?
  - Mark and Recapture
    - How many Bass in a pond?

Quadrat Sampling

- Estimates the population density based upon a few sample plots
  - Ex: to determine how many dandelions are in a field (100m x 100m= 10,000m^2), one could count the dandelions in a few smaller plots (10m by 10m= 100m^2), and apply the averages to the whole area