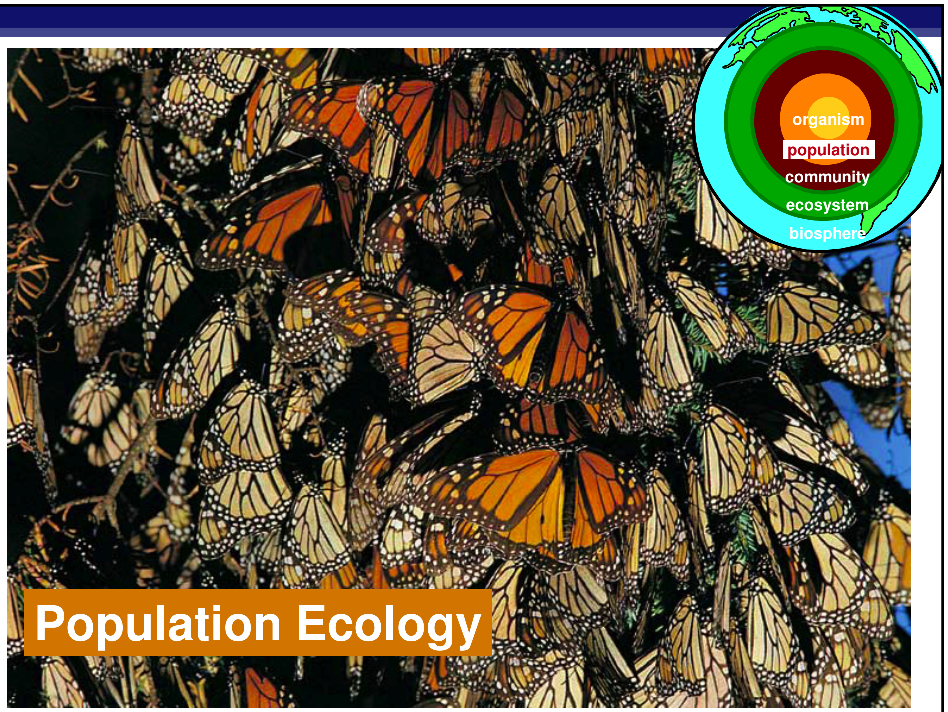


Population Ecology

Life takes place in populations

- **Population**
  - group of individuals of <u>same</u> species in <u>same</u> area at <u>same</u> time

- rely on same resources
- interact
- interbreed

Population Ecology: What factors affect a population?

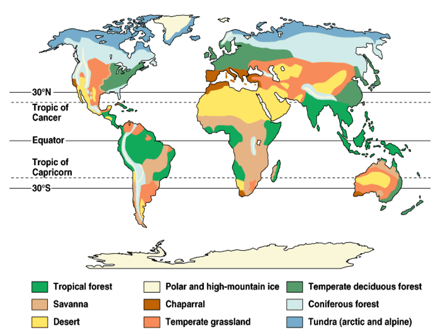
Why Population Ecology?

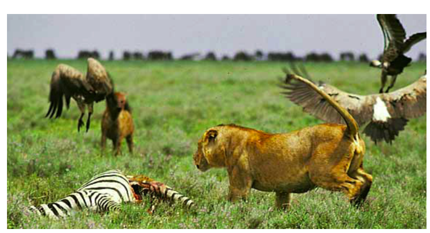
- Scientific goal
  - understanding the factors that influence the size of populations
    - general principles
    - specific cases
- Practical goal
  - management of populations
    - increase population size
      - endangered species
    - decrease population size
      - pests
    - maintain population size
      - fisheries management
        - maintain & maximize sustained yield

AP Biology

Factors that affect Population Size

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

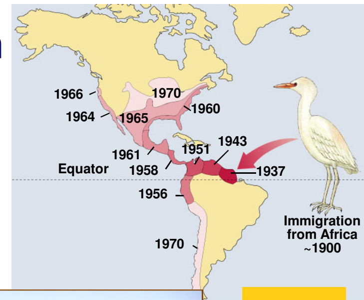


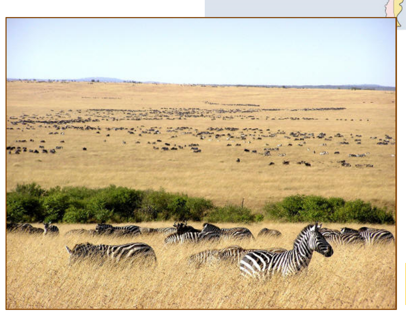


AP Biology

Characterizing a Population

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





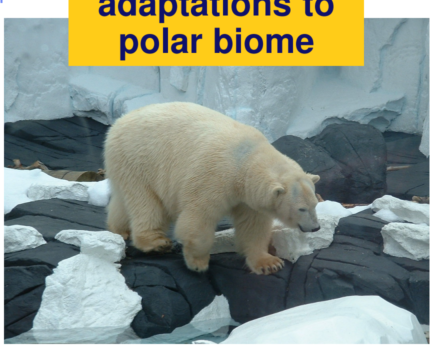
range

density

Population Range

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

adaptations to polar biome

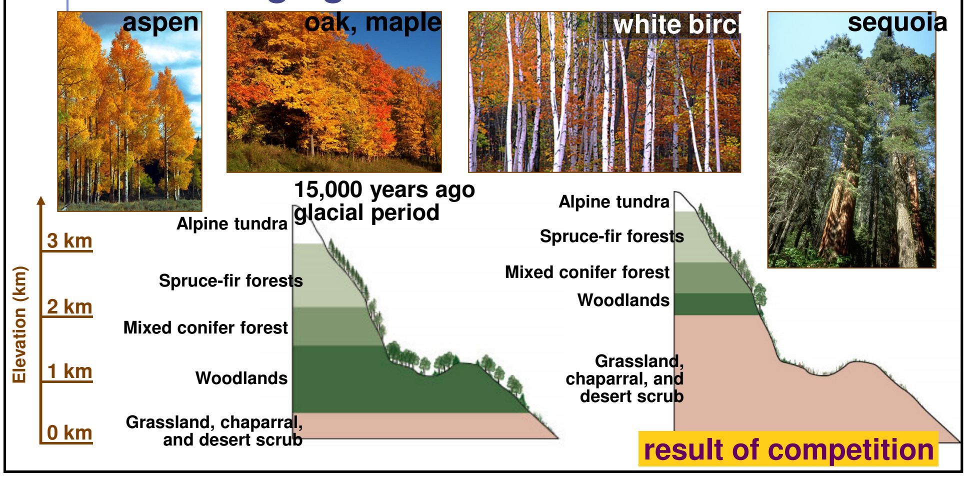


adaptations to rainforest biome

AP

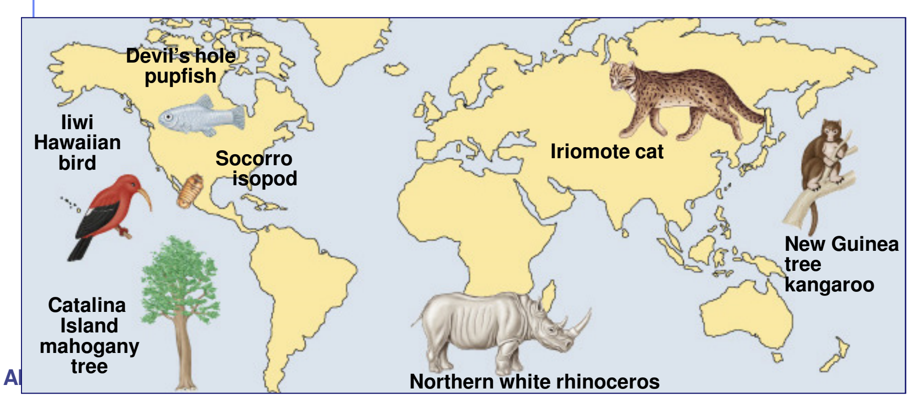
Changes in range

- Range expansions & contractions
  - changing environment



At risk populations

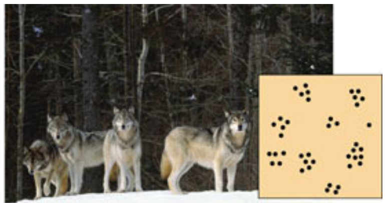
- Endangered species
  - limitations to range / habitat
    - places species at risk



Population Spacing

- Dispersal patterns within a population

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



clumped

random

(b) Uniform

uniform

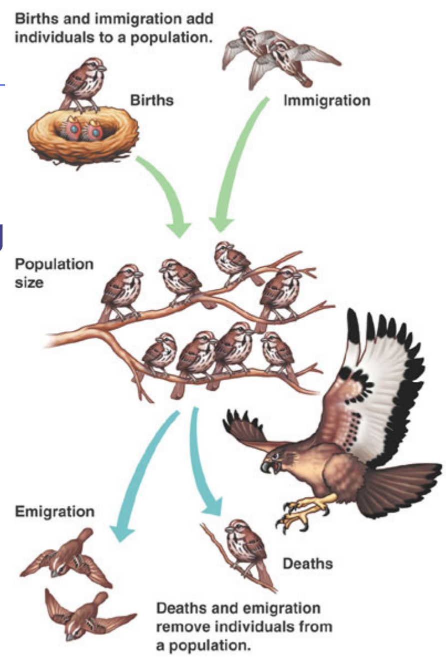
Clumped Pattern (most common)

Uniform

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

Population Size

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



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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 females at reproductive age in cohort?

AP Biology

Why do teenage boys pay high car insurance rates?

Demography

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

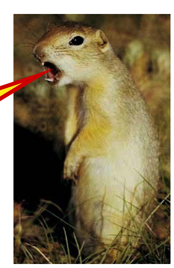
Life table

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	349	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, ey are tal separately.
†The death rate is the proportion of individuals dying i e specific t e interval.
††Includes 122 females and 126 males first captured as o -year-olds therefore t included in the
SOURCE: Data from P. W. Sherman and M. L. Morton, " mography Belding's G und Squirrel," *Ecology* 65(
1617–1628.

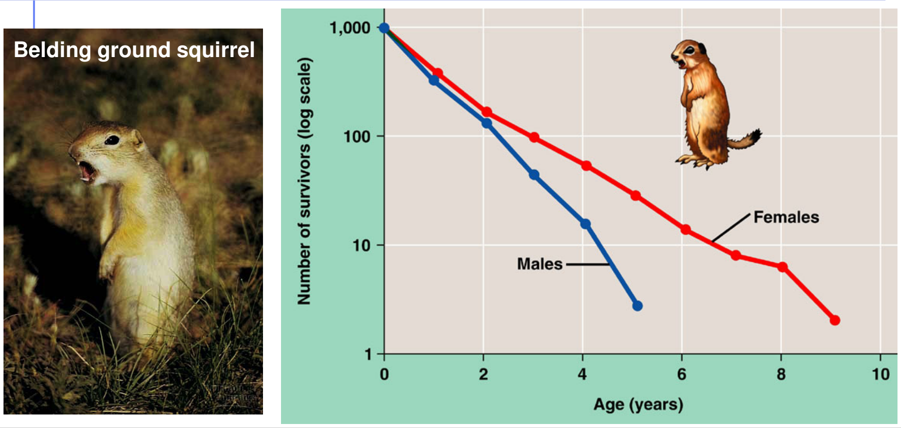
What adaptations have led to this difference in male vs. female mortality?



Survivorship curves

- Graphic representation of life table

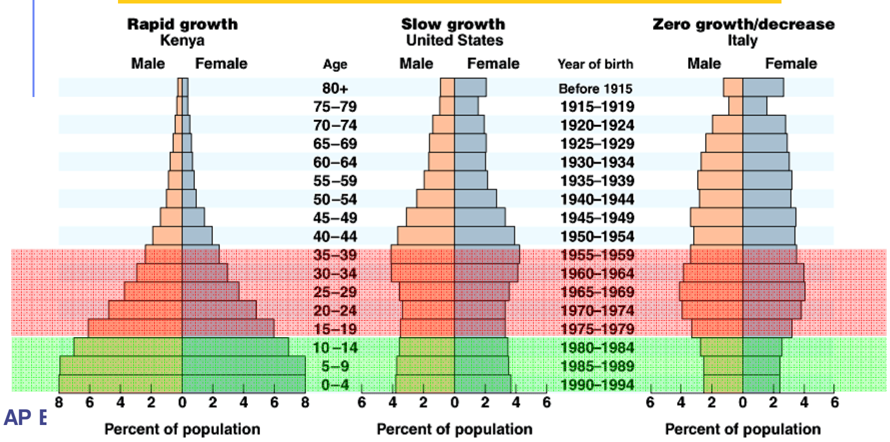
The relatively straight lines of the plots indicate relatively constant rates of death; however, males have a lower survival rate overall than females.



Age structure

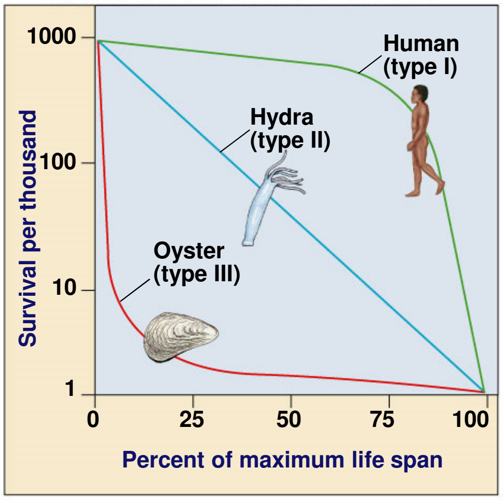
- Relative number of individuals of each age

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



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 (stay reproductive)

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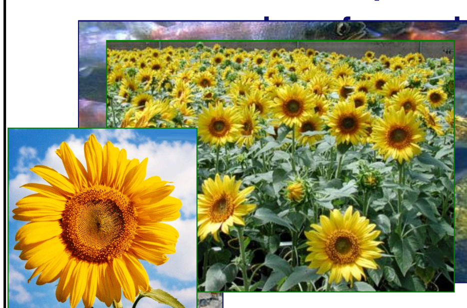
Trade-offs: survival vs. reproduction

- The cost of reproduction
  - increase reproduction may decrease survival
    - age at first reproduction
    - investment per offspring
    - ...uctive cycles per lifetime

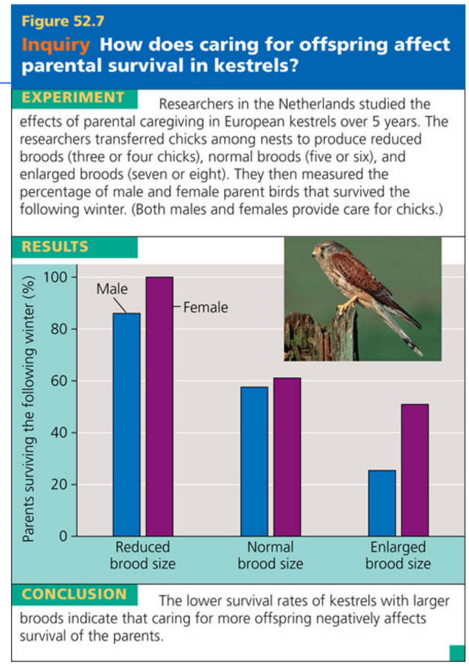


Natural selection favors a life history that maximizes lifetime reproductive success

Parental survival

Kestrel Falcons:

The cost of larger broods to both male & female parents



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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

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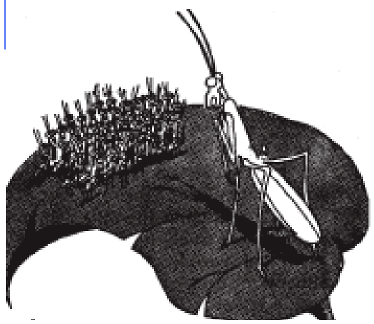
Trade offs

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

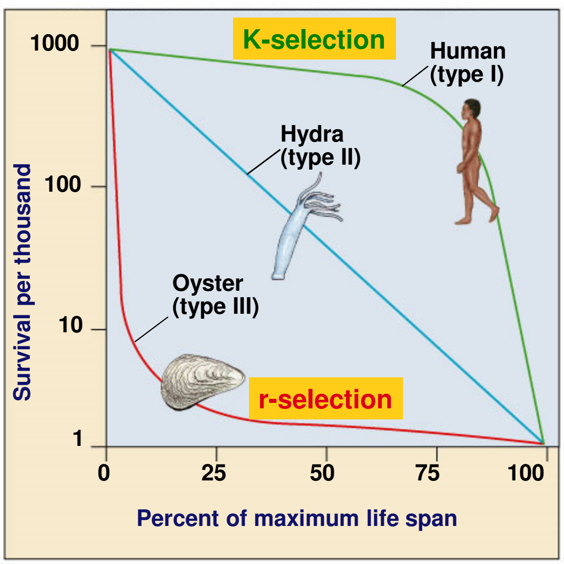


"Of course, long before you mature, most of you will be eaten."

(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.

Life strategies & survivorship curves



Population growth

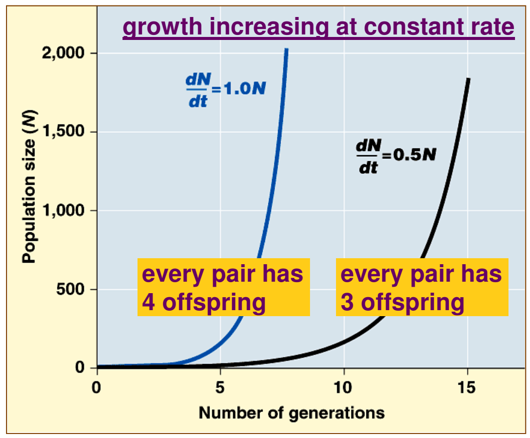
change in population = births – deaths

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

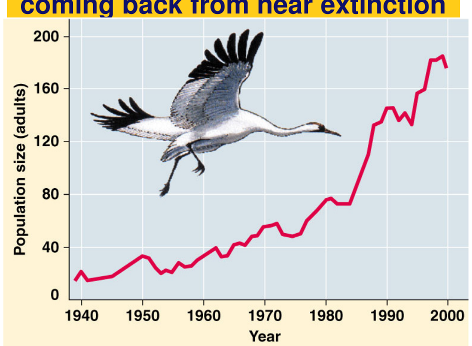
intrinsic rate = maximum rate of growth



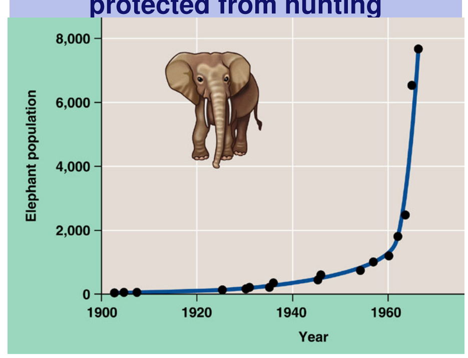
Exponential growth rate

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

Whooping crane
coming back from near extinction



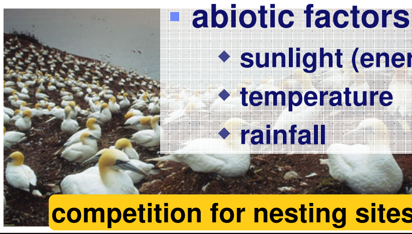
African elephant
protected from hunting



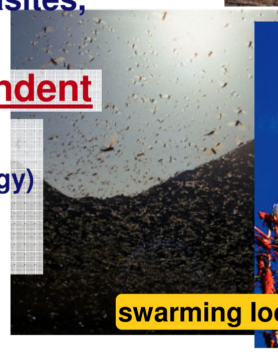
Regulation of population size

- Limiting factors
  - **density dependent**
    - competition: food, mates, nesting sites
    - predators, parasites, pathogens
  - **density independent**
    - abiotic factors
      - sunlight (energy)
      - temperature
      - rainfall

marking territory = competition



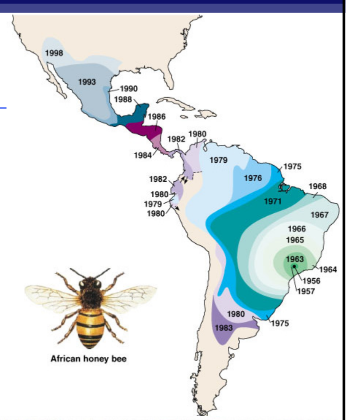
competition for nesting sites



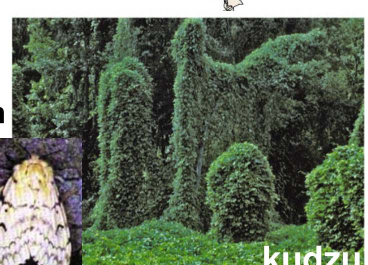
swarming locusts

Introduced species

- Non-native species
  - transplanted populations grow exponentially in new area
  - out-compete native species
    - loss of natural controls
    - lack of predators, parasites, competitors
  - reduce diversity
  - examples
    - African honeybee
    - gypsy moth
    - zebra mussel
    - purple loosestrife



gypsy moth



kudzu

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Zebra Mussel Shell
Zebra mussel
~2 months
June 1988
February 1992
April 1994
ecological & economic damage
reduces diversity
loss of food & nesting sites for animals
economic damage
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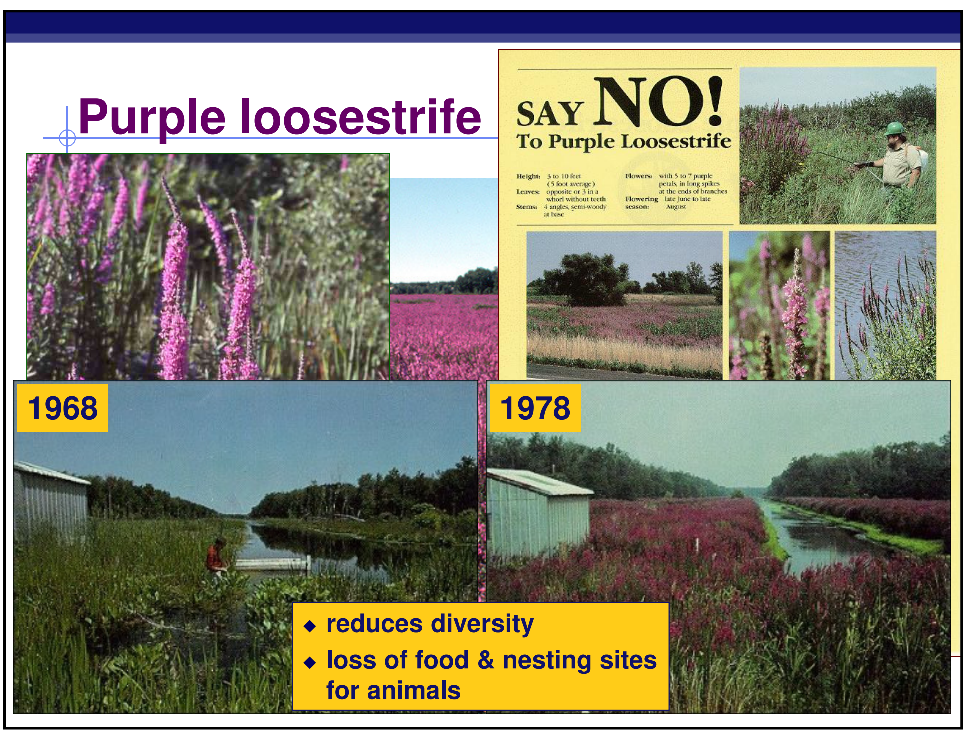
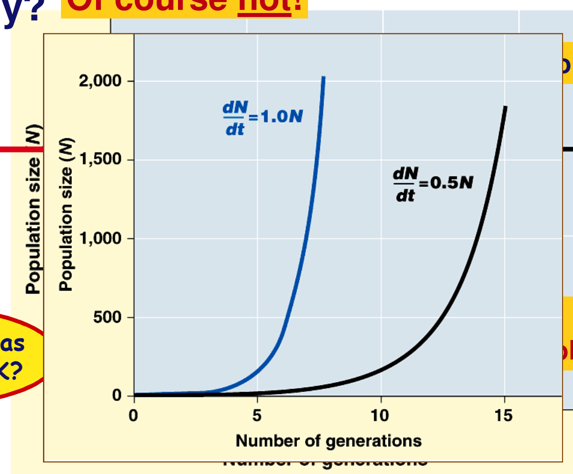

Purple loosestrife
SAY NO!
To Purple Loosestrife
1968
1978
reduces diversity
loss of food & nesting sites for animals

Logistic rate of growth

- Can populations continue to grow exponentially? Of course not!

K = carrying capacity

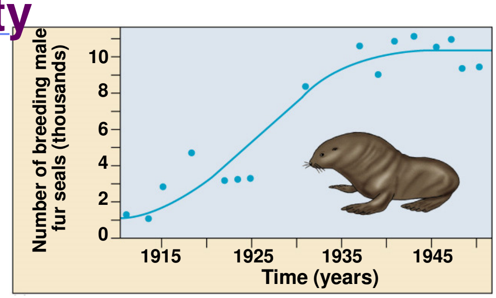
What happens as N approaches K?

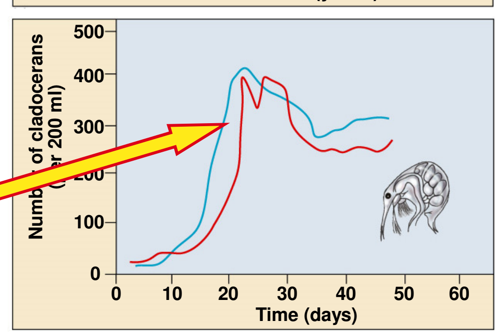


Carrying capacity

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

What's going on with the plankton?

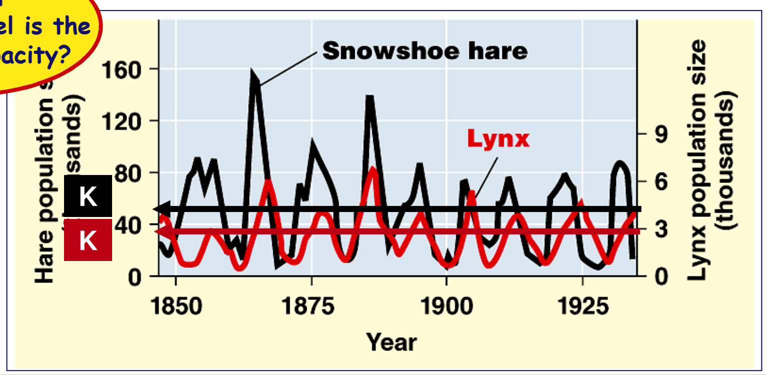




Changes in Carrying Capacity

- Population cycles
  - predator – prey interactions

At what population level is the carrying capacity?



Human population growth

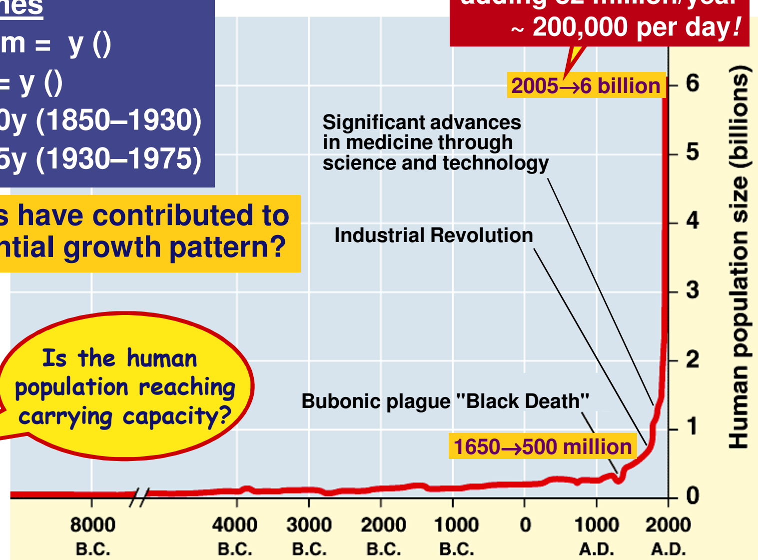
Population of…
China: 1.3 billion
India: 1.1 billion

Doubling times

250m → 500m = y ()
500m → 1b = y ()
1b → 2b = 80y (1850–1930)
2b → 4b = 75y (1930–1975)

What factors have contributed to this exponential growth pattern?

adding 82 million/year
~ 200,000 per day!



Is the human population reaching carrying capacity?

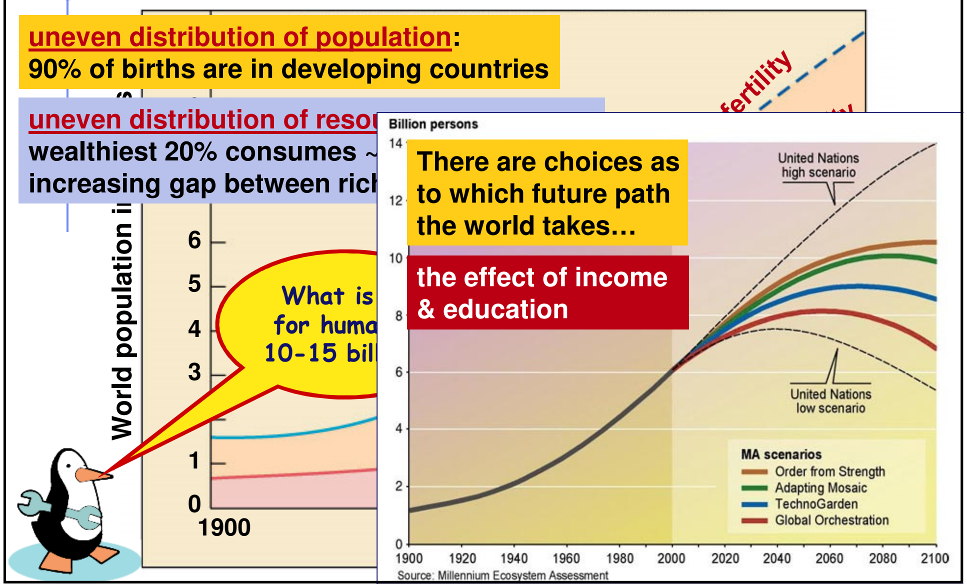
Distribution of population growth

uneven distribution of population:
90% of births are in developing countries

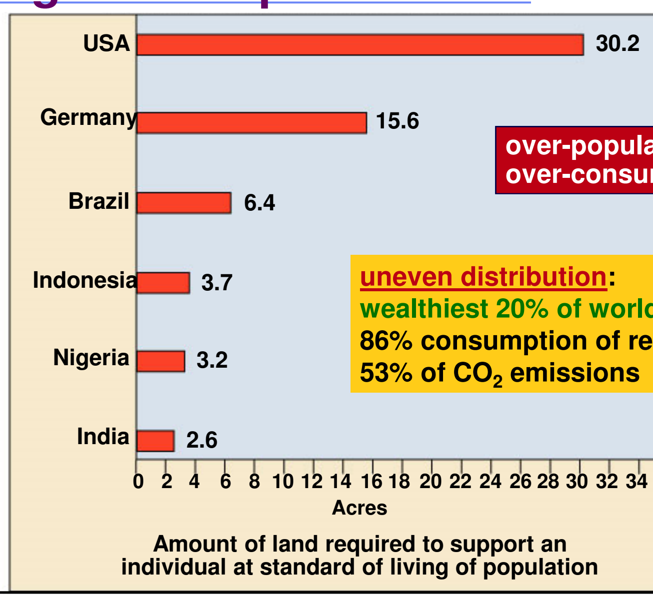
uneven distribution of reso
wealthiest 20% consumes ~
increasing gap between rich

There are choices as to which future path the world takes…

the effect of income & education



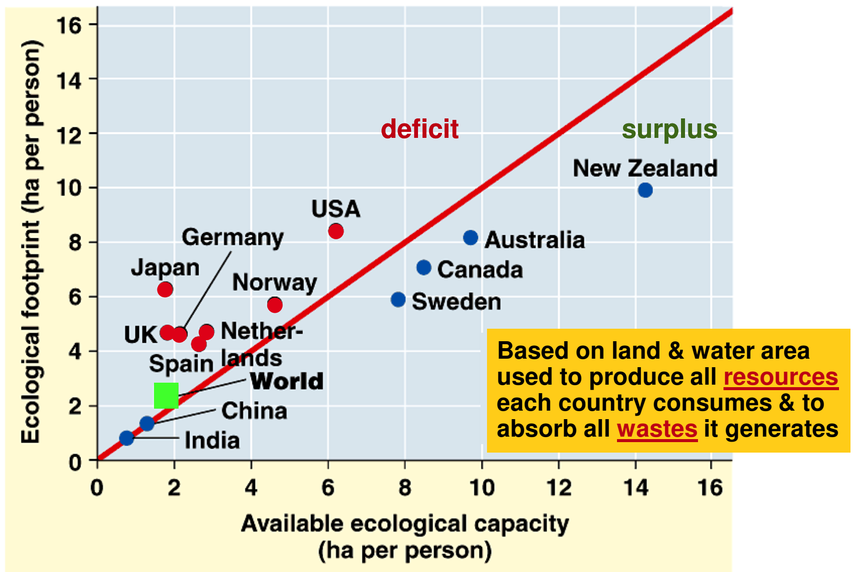
Ecological Footprint



over-population or over-consumption?

uneven distribution:
wealthiest 20% of world:
86% consumption of resources
53% of CO_2 emissions

Ecological Footprint



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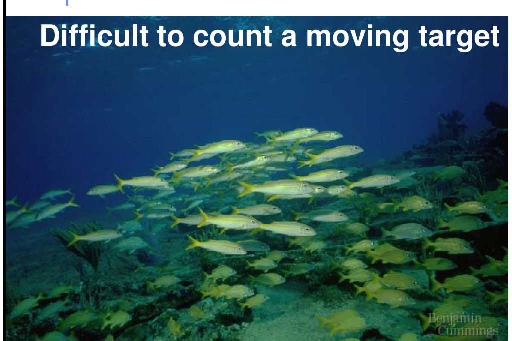
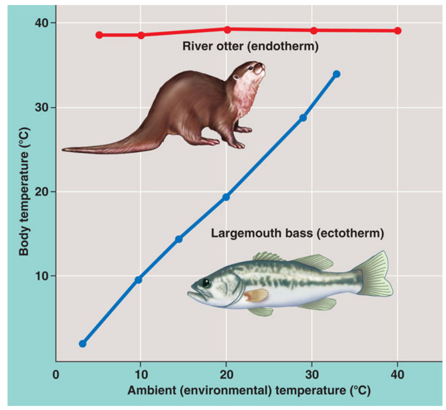
Measuring population density

- How do we measure how many individuals in a population?
  - number of individuals in an area
  - mark & recapture methods



Evolutionary adaptations

- Coping with environmental variation
  - regulators
    - endotherms
    - homeostasis
    - ("warm-blooded")
  - conformers
    - ectotherms
    - ("cold-blooded")



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Bright blue marble spinning in space

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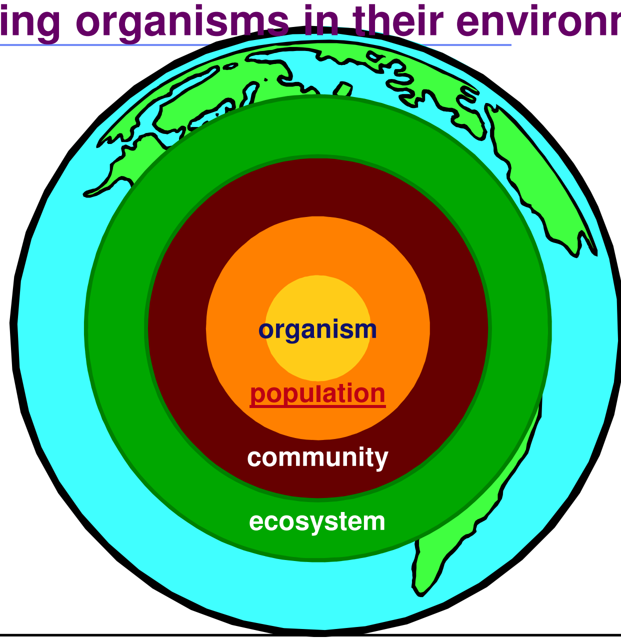
Studying organisms in their environment



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Any Questions?

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