POPULATION ECOLOGY

Population ecology: overview

- *Population*
  - Group of individuals of same species in same area at same time
- *Population ecology*
  - Study of how and why a population changes over time
  - Utilizes mathematics as predictive tool

Demography

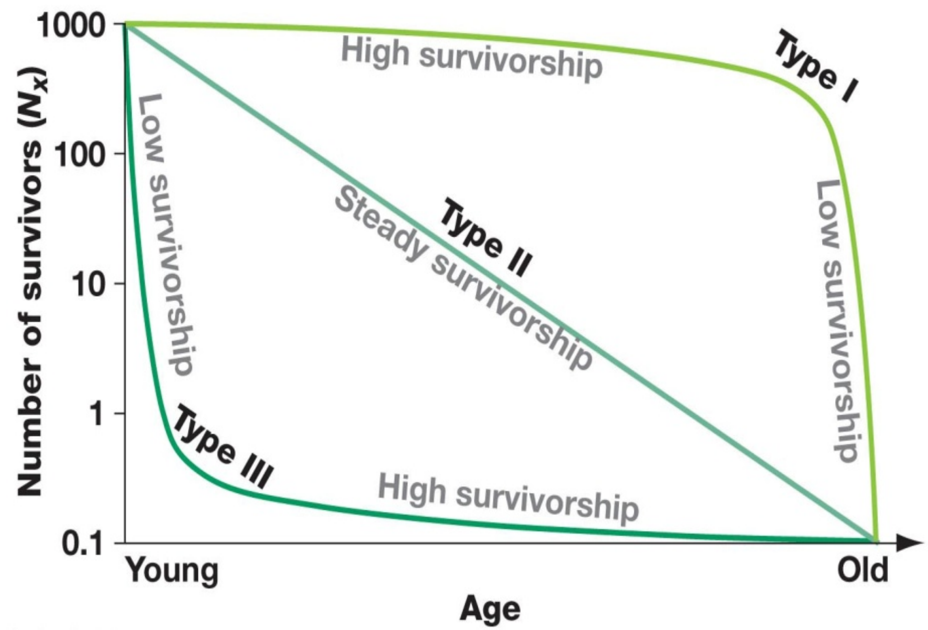
- *Demography*
  - Study of factors that determine size and structure of populations through time
- Populations grow
  - Birth
  - Immigration

$$P_2 = P_1 + (B + I - D - E)$$

- Populations decline
  - Death
  - Emigration

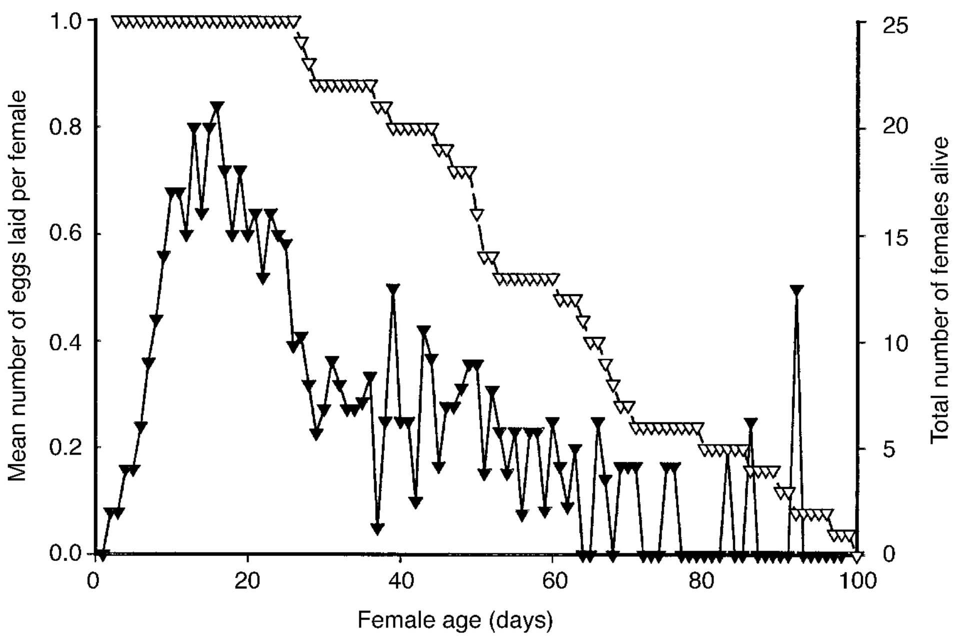
Survivorship curve

- Proportion of offspring that survive at specific age
  - Logarithm of number of survivors vs. age
- Type
  - Type I curve
    - Survivorship high throughout life
    - Humans
  - Type II curve
    - Survivorship constant over life
    - Songbirds
  - Type III curve
    - High death rates early
    - High survivorship after maturity
    - Trees



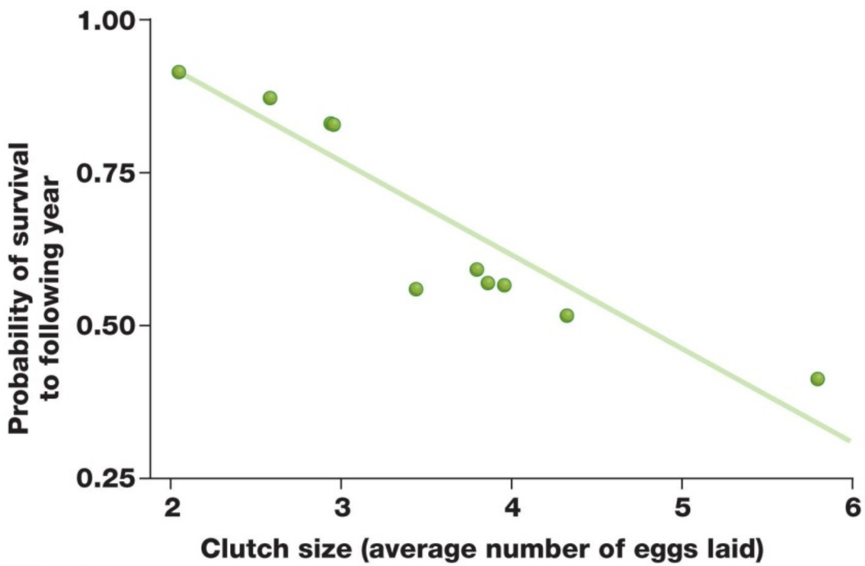
Fecundity

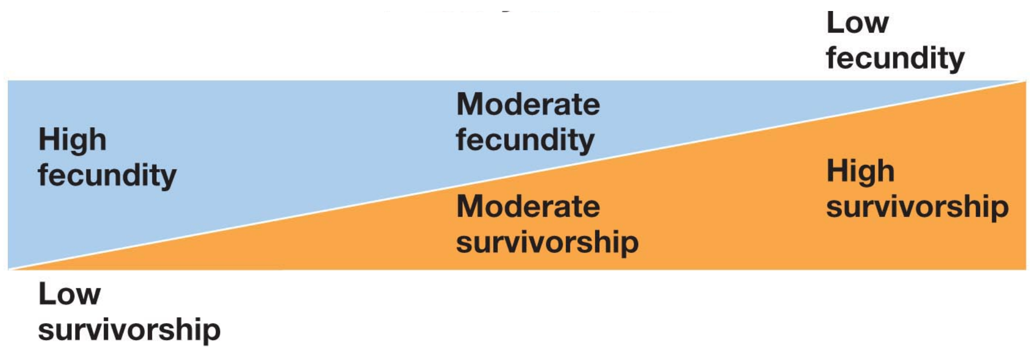
- The number of offspring produced by each female a population
- Survivorship curve and fecundity useful in calculating growth rate of population



Fitness trade-offs

- Resources are limited
  - Limited E
  - Female can:
    - Maximize fecundity
    - Maximize survivorship
    - Balance the two
  - Resource allocation





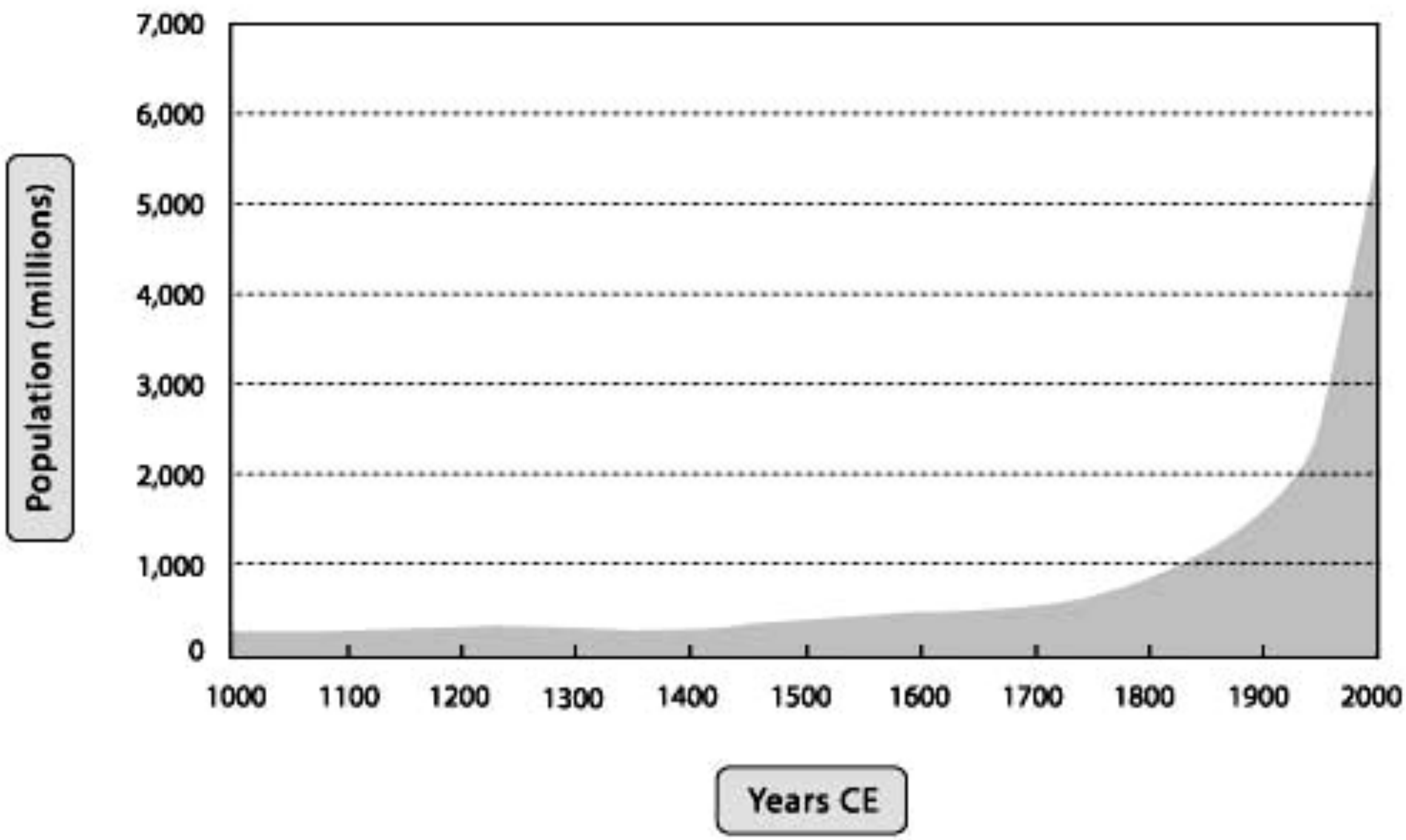
Population growth

- Growth rate (*r*) is function of
  - Change individuals of population (ΔN) per unit time (Δt)

$$r = \Delta N / \Delta t = (b - d)$$

  - *r* varies through time
    - Positive: growing
    - Negative: declining
    - Neutral: no growth

Exponential growth

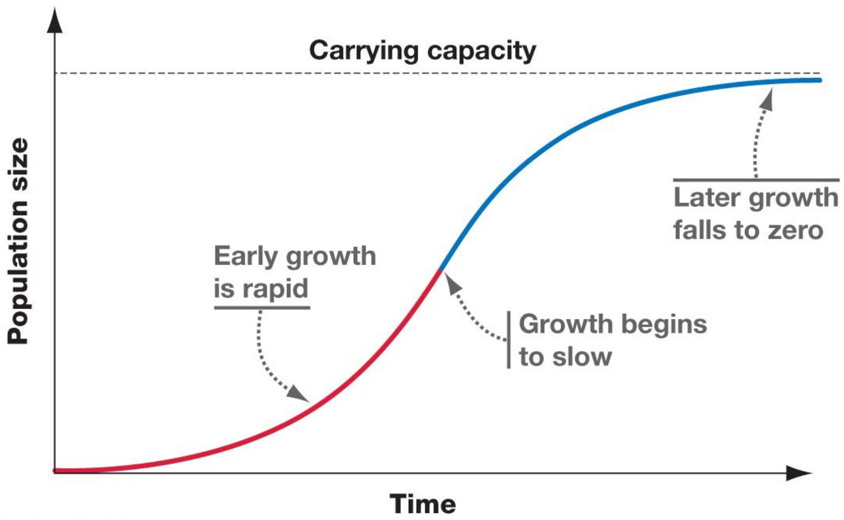


Exponential growth

- Occurs when *r* doesn't change over time
  - *Density independent*
    - Doesn't depend on number of individuals in population
- Observed in:
  1. Founding of new habitat
  2. Population devastated (e.g. hurricance) & recovers from few individuals
- Can't continue forever
  - Population density gets too high (*r* declines)
    - *Density dependent*

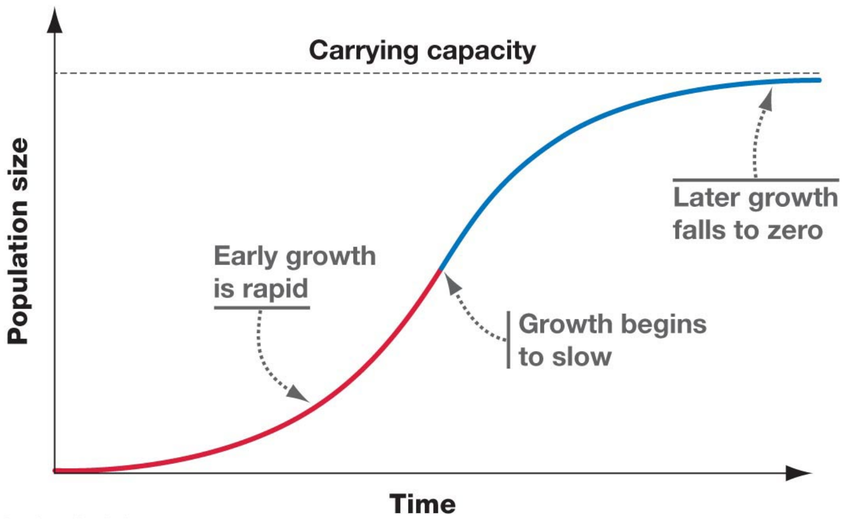
Logistic growth

- *Carrying capacity* (K)
  - Maximum individuals that are sustainable over time
  - If population < K
    - Population grows
  - If population > K
    - Population decreases
- Logistic growth equation
  - Density dependent



Logistic growth

- *r* phase
  - Growth is exponential
  - *r* is constant
- Density-dependency
  - *r* declines when *N* increases
- *K* phase
  - *r* reaches zero at *K*



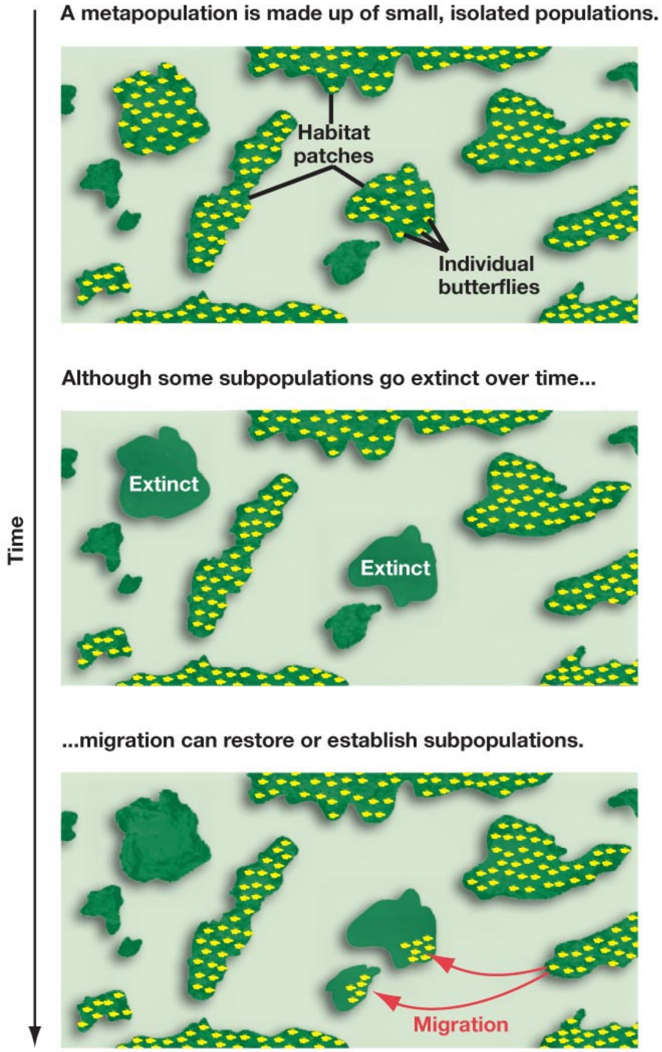
Density dependence

- Key factor of *K*
- Factors of density dependence
  - Over-exploitation of resources (food, space, light)
  - Predation

Carrying capacity varies

- *K* is not fixed in type
  - Varies among spp. & populations
- *K* is not fixed in space
  - Varies among habitats
  - Food availability, space, etc
- *K* is not fixed time
  - Some years are better

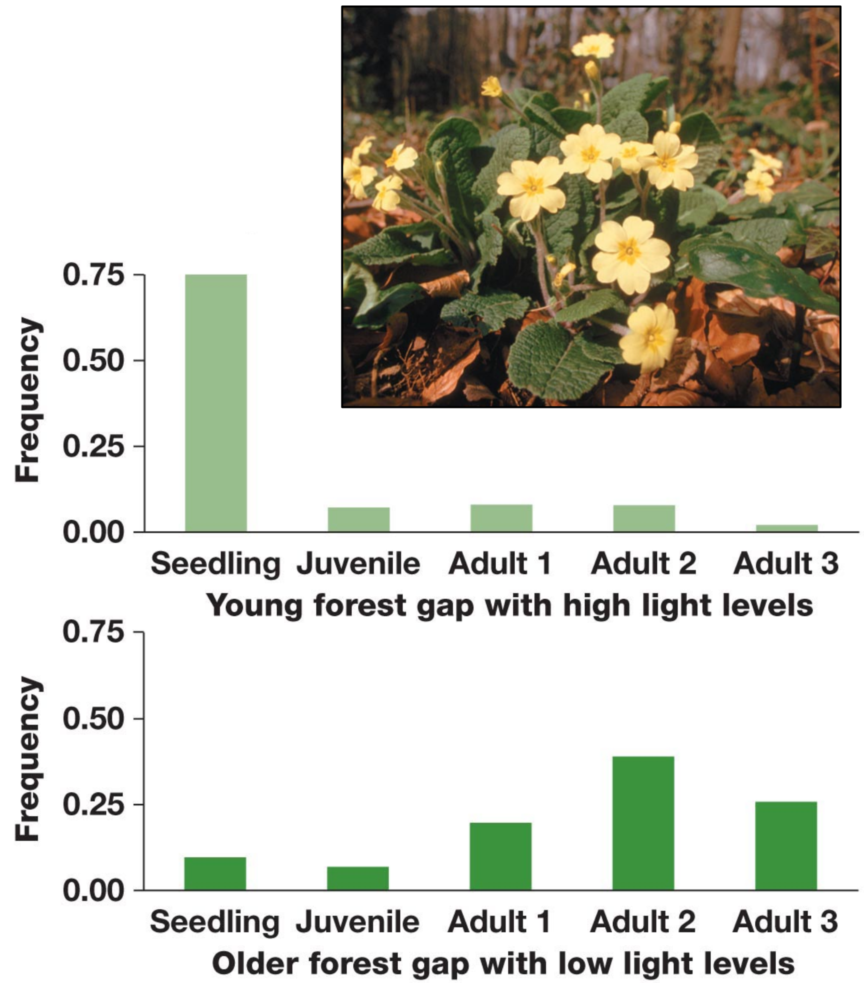
Metapopulations



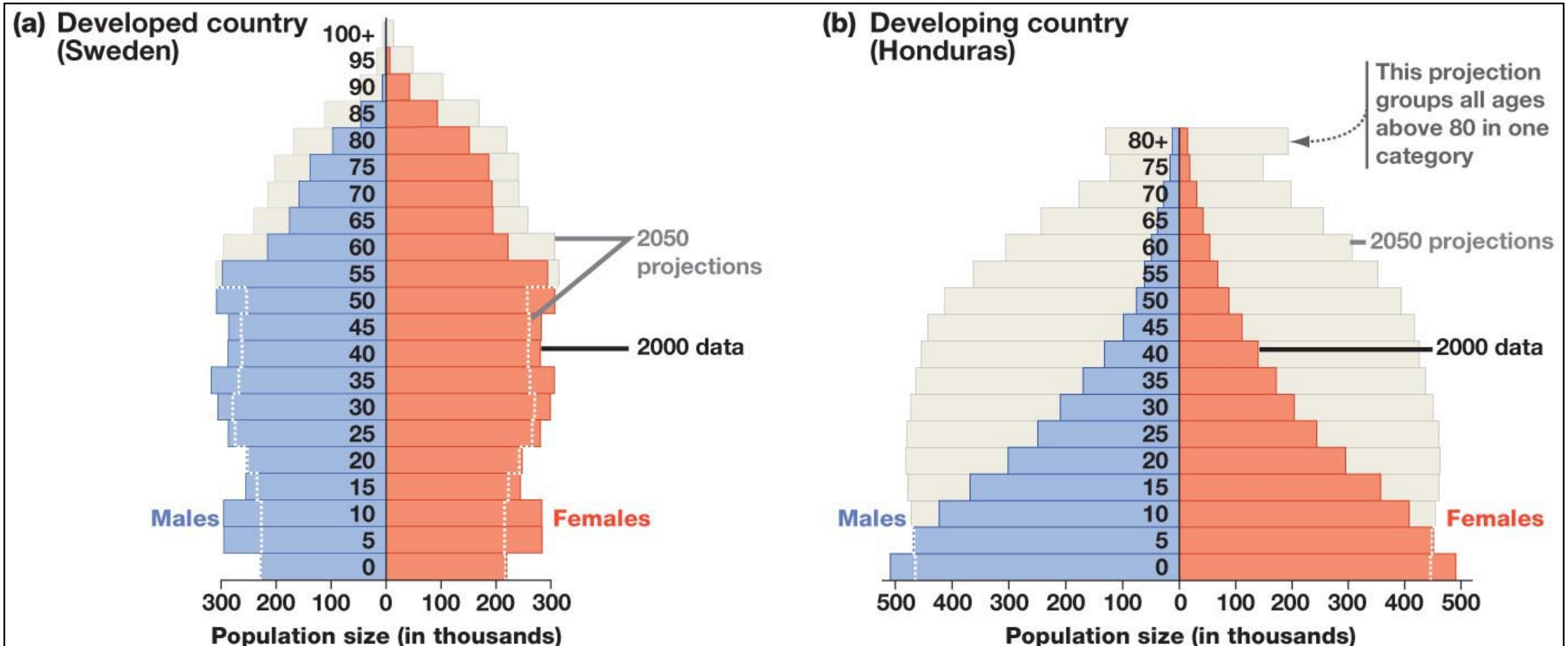
- Population of populations
- Patches go extinct, redevelop, and are reestablished over time

Age structure

- Proportion of individuals at each age group
- Affects population's growth over time
- Varies over time
  - Common primrose
    - New tree gaps have rapidly growing juveniles
    - As tree grows, population declines leaving mostly adults

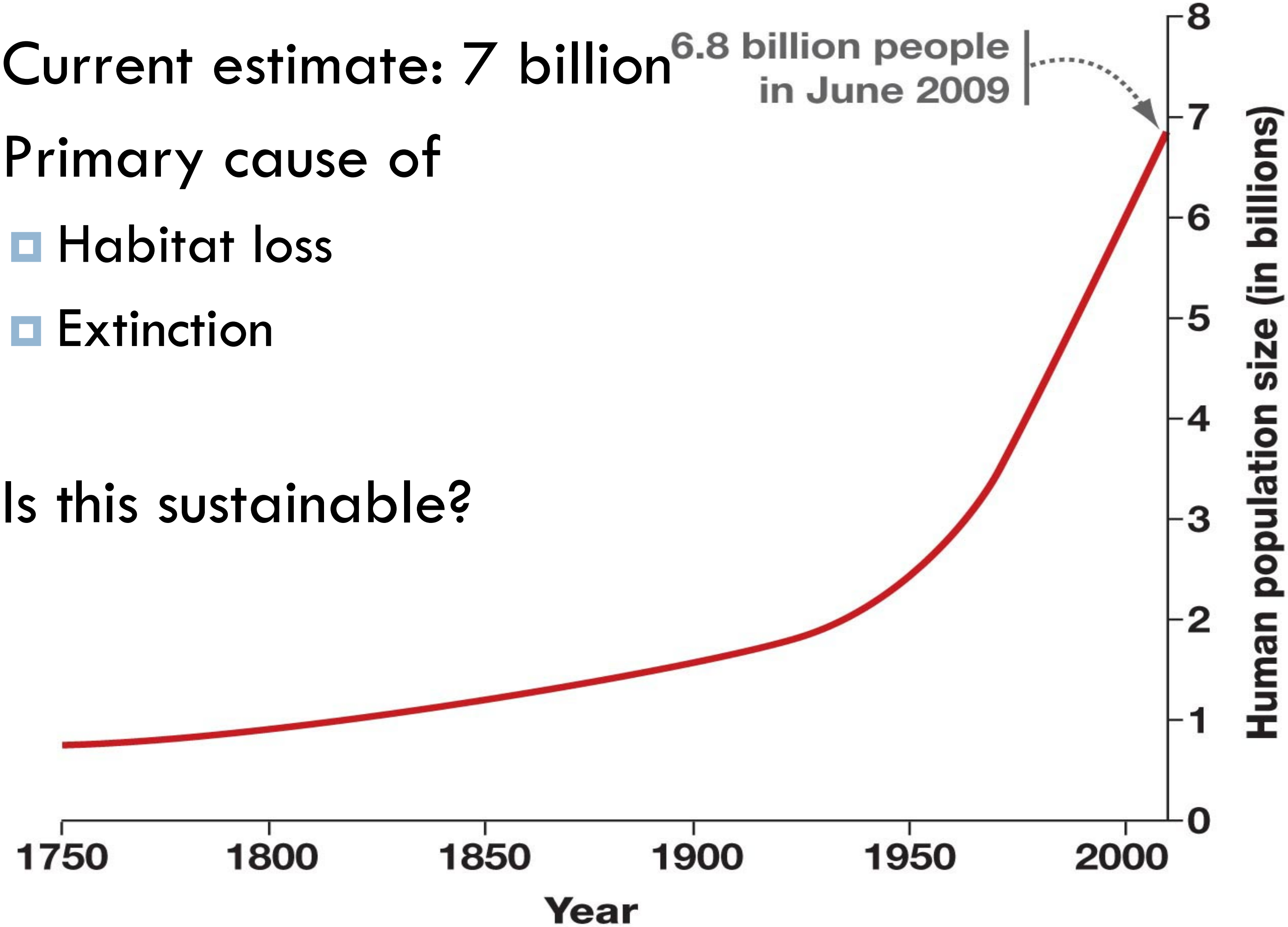


Human age structure



Human population growth rate

- Current estimate: 7 billion
- Primary cause of
  - Habitat loss
  - Extinction
- Is this sustainable?



Human population growth rate

- Dependent on fertility rates
- Has it peaked?
  - Since 1970 growth rate dropping
  - 1990-95: 1.46%
  - Now: 1.2%