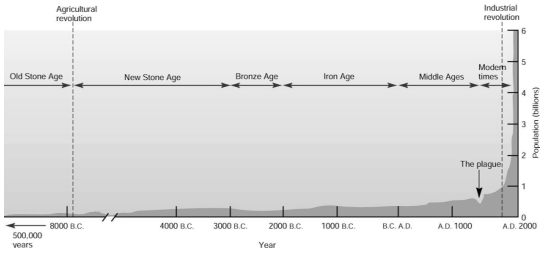
Human Populations

Human Population History



Demography

- **Demography** - the statistical study of human populations, especially with reference to size, density, distribution, fertility, mortality and migration.
- This information can be used to make predictions about population change

Growth rate versus rate of natural increase

- On a global scale, births and deaths are most important determinants of population growth, but in considering local or national populations migration is an important factor
- Emigration = exiting
- Immigration = moving in

Doubling time

- Number of years until a population doubles in size assuming a constant rate of natural increase (RNI)
  Doubling time = 70 / RNI

*This time can be derived by dividing the natural logarithm of 2 by the exponent of growth, or approximated by dividing 70 by the percentage growth rate (more roughly but roundly, dividing 72: see the rule of 72).

*In finance, the **rule of 72**, the **rule of 70** and the **rule of 69** are methods for estimating an investment's doubling time. The number in the title is divided by the interest percentage per period to obtain the approximate number of periods (usually years) required for doubling.

- At the RNI in 2000 (1.4), the doubling time for the global population was 50 years, so global population was predicted to be 12 billion in 2050 and 24 billion in 2100
- The current RNI is 1.2 so doubling time is 58.3 years

Fertility

- 'Potential for reproduction in a population'
- **Fertility rate** is number of births per 1000 women of child-bearing age (15-49)

$$= \frac{\text{\# live births}}{\text{\# women aged 15-49}} \times 1000$$

- **Total fertility** = average number of children per woman

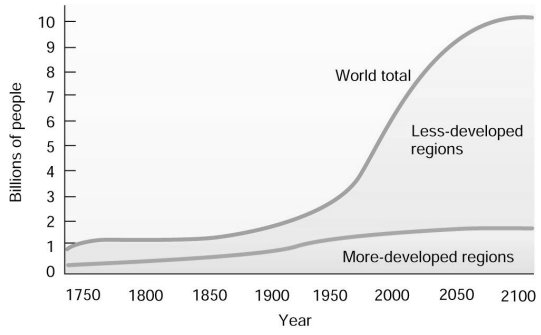
Fertility - continued

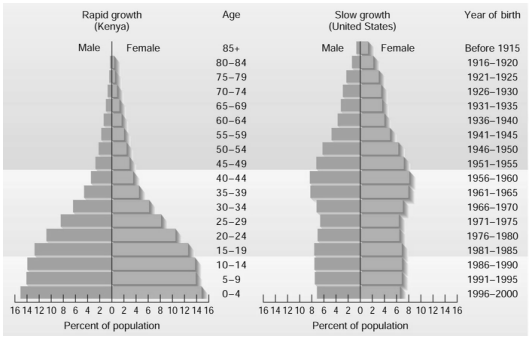
- A value of **2.1** for total fertility will result in no net change in population size (replacement level fertility).
- Replacement level is higher than 2 because there are more males than females and not all females survive to reproduce
- In developing countries a total fertility greater than 2.1 is required for replacement due to high mortality rates (2.2 to 3)

Two Demographic Worlds

- First is poor, young, and rapidly growing.
  - Less-developed countries.
    - Africa, Asia, Latin America
    - Contain 80% of world population, and will account for 90% of projected growth.
- Second is wealthy, old, and mostly shrinking.
  - North America, Western Europe, Japan.
    - Average age is about 40.
    - Populations expected to decline.

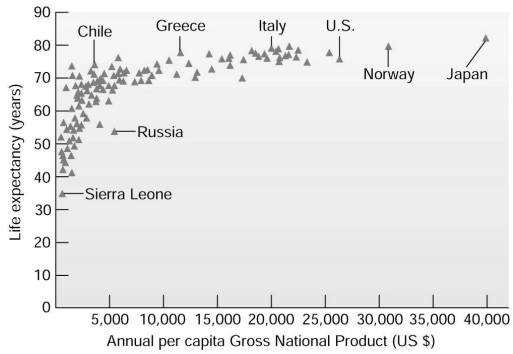
Estimated Human Population Growth





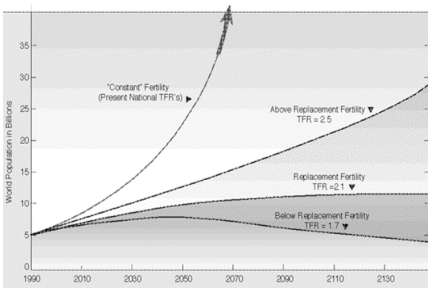
Life Span and Life Expectancy

- Life Expectancy - Average age a newborn can expect to attain in any given society.
  - Declining mortality is the primary cause of most population growth in last 300 years.
  - Worldwide, average has risen from 40 to 65.5 over the past century.
    - Greatest progress has been in developing countries.



Models used to predict growth of human populations

- 1. Graphical extrapolation
- Three possible paths of population growth
  - High: TF decrease to 2.5 (from 2.7) by 2050
  - Medium: TF at 2.1 by 2050
  - Low: TF stabilize at 1.35 to 1.60



More modeling

2. Computer simulations
3. Statistical / demographic tables
   - **Life tables** are very powerful tools in demography
     Used to simulate lifetime mortality experience of a population
   - Birth and death rates can vary with age (crude birth / death rates are overall estimates)
   - Birth rate is 0 during immature stages
   - Death rate is highest in very young and very old humans

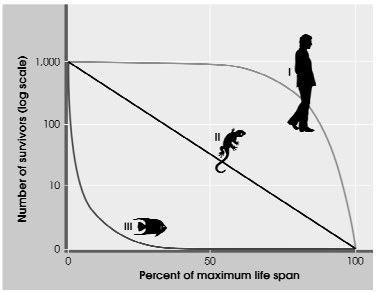
Life tables

- The best way to measure age-specific mortality and survivorship is to follow one **cohort** (group of individuals born at the same time) until the last one dies and record the number dying at each interval
- Impossible with long lived species and highly motile or cryptic species
- Instead we take an instantaneous sample of age (or size) structure of population
- We can use these data to construct a life table

Survivorship curves

- Data from life tables can be used to make survivorship and mortality curves
- Type I - high mortality late in life e.g. humans, elephants, K-strategists
- Type II - constant mortality rate e.g. anemones, asexual reproducers
- Type III - high mortality early e.g. insects, plants, fishes, turtles, r-strategists

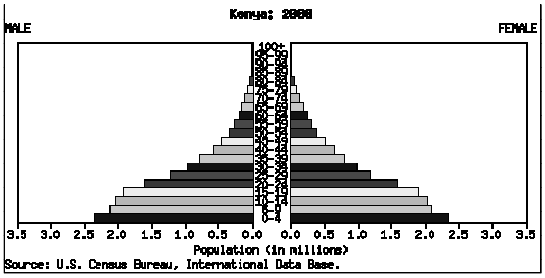
Survivorship in Populations



More modeling

- 4. Population pyramid models
  - http://www.census.gov/ipc/www/idb/
  - Broad based pyramids suggest that a population will grow rapidly
  - Other information from pyramids…
  - Sex ratio, life expectancy, birth rate, effects of specific events (e.g. war, baby booms)

Developing Countries: Kenya



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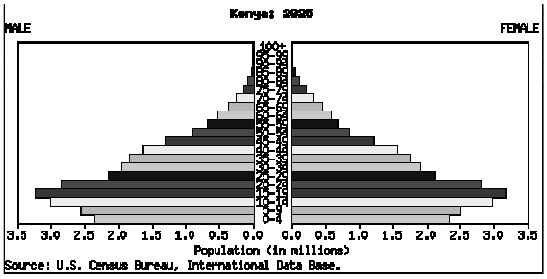

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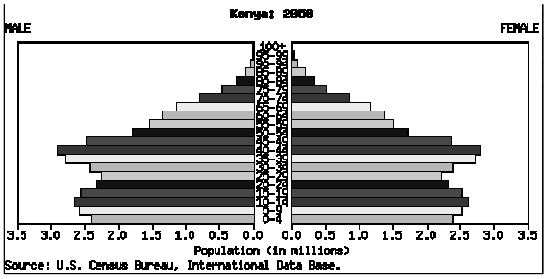
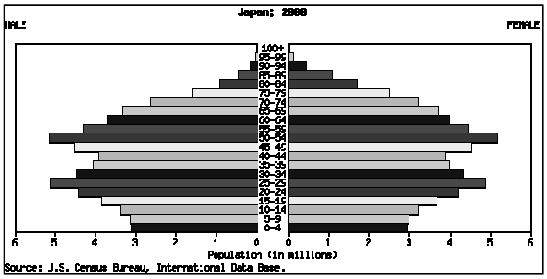


Developed Countries: Japan



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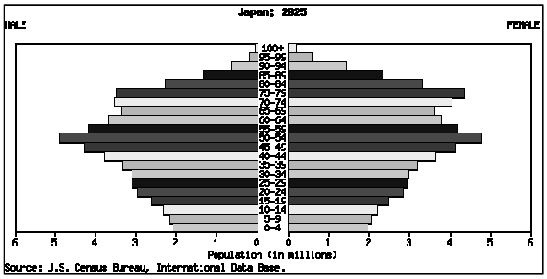

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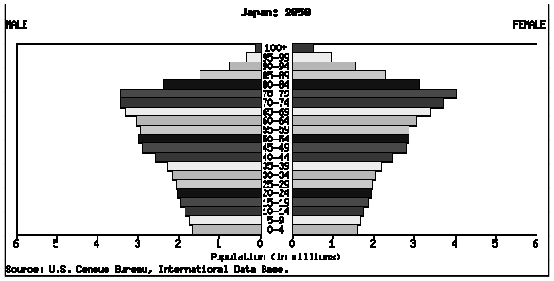
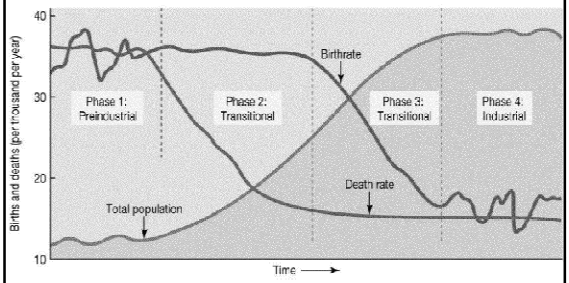


5. Demographic Transition Model



Limits to Human Population Growth

- What are the problems with establishing carrying capacity for a human population?
  - Range of resources is greater than any other species
  - As one resource becomes limiting, we substitute another in its place
  - Resource requirements are determined by lifestyles, which vary with populations and with time
  - Technological developments continually change the resources required and the amount of each
  - We import resources that we need, enabling us to grow beyond the boundaries set by local resources – increasing local carrying capacity. But, it does not affect global carrying capacity! So we are decreasing the carrying capacity somewhere else.

Limits to Human Population Growth

- What is our (the U.S.) impact on the carrying capacity of other nations / regions of the world?

Limits to Human Population Growth

- Human carrying capacity is determined by
  - the rate of energy and material consumption,
  - the level of pollution and
  - the extent of human interference in global life support systems.
- While recycling, reuse and remanufacturing reduce these impacts, they can also increase human carrying capacity.
- As you recycle, reuse, remanufacture, and reduce energy consumption it affects your local carrying capacity, as well as the global one.

Limits to Human Population Growth

- Role of national and international policies:
  - Domestic and international development policies that target a **decrease in the death rate** through agricultural development, improved public health and sanitation, and better service infrastructure may stimulate **rapid population growth** by lowering mortality without significantly affecting fertility.
  - Some analysts believe that birth rates will come down by themselves as economic welfare improves and that the population problem is therefore better solved through policies to stimulate economic growth.
  - How does the demographic transition play into this?

Limits to Human Population Growth

- Role of national and international policies:
  - Education about birth control encourages family planning.
  - Parents may be dependent on their children for support in their later years and this may create an incentive to have many children.
  - Urbanization may also be a factor in reducing crude birth rates. How?
    - Cost more to have children in the city.
  - Policies directed toward the education of women, enabling women to have greater personal and economic independence, may be the most effective method for reducing population pressure.
  - What are the religious and cultural influences on family size?

Limits to Human Population Growth

- Because technology plays such a large role in human life, many economists argue that human carrying capacity can be expanded continuously through technological innovation.
- For example, if we learn to use energy and material twice as efficiently, we can double the population or the use of energy without necessarily increasing the impact (load) imposed on the environment.
  - However, to compensate for foreseeable population growth (possibly doubling between the years 2000 and 2040) and the economic growth that is deemed necessary, especially in developing countries, it is suggested that efficiency would have to be raised by a factor of 4 to 10 to remain within global carrying capacity.