

"The hungry world cannot be fed until and unless the growth of its resources and the growth of its population come into balance. Each man and woman—and each nation—must make decisions of conscience and policy in the face of this great problem."
— *Lyndon B. Johnson*

TOPICS INCLUDE:

- Population Growth
- Demographic Data
- Rule of 70
- Age-Structure Pyramids
- Impact of Growth

AP ENVIRONMENTAL SCIENCE



UNIT 3: POPULATION

II. POPULATION(10-15%)

A. Population Biology Concepts–

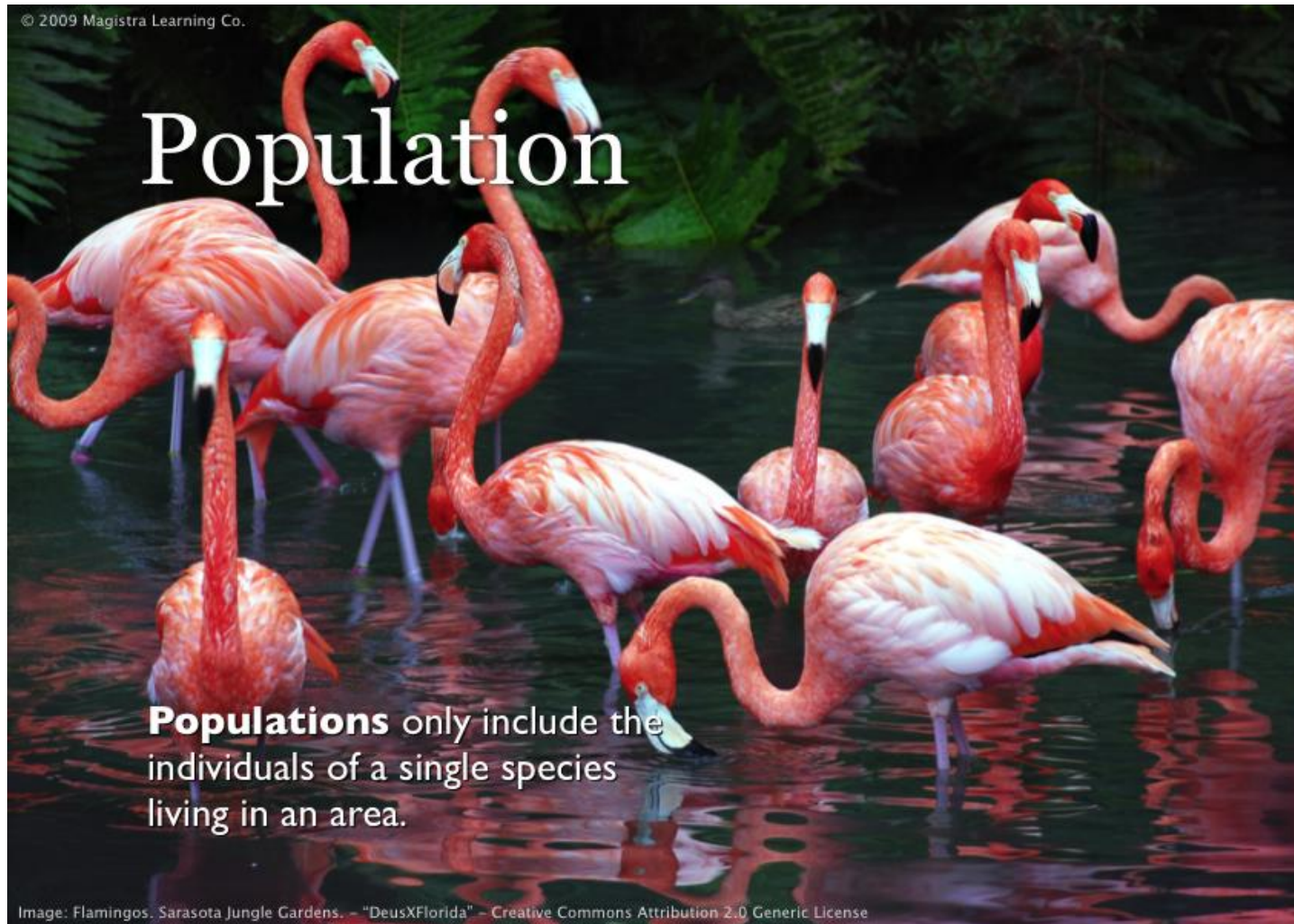
(Population ecology; carrying capacity; reproductive strategies; survivorship)

B. Human Population

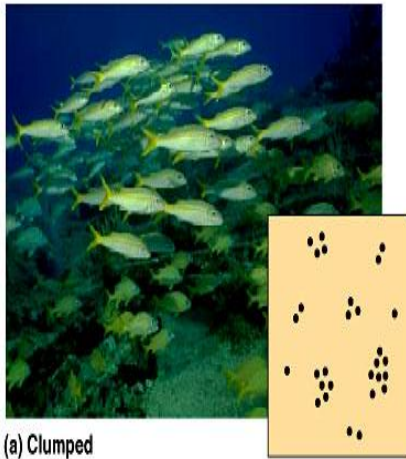
1. Human population dynamics
(Historical population sizes; distribution; fertility rates; growth rates and doubling times; demographic transition; age structure diagrams)
2. Population size
(Strategies for sustainability; case studies; national policies)
3. Impacts of population growth
(Hunger; disease; economic effects; resource use; habitat destruction)



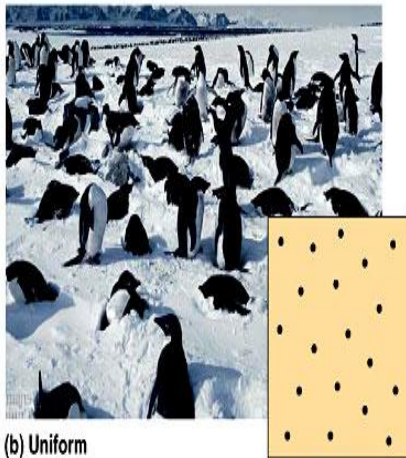
WHAT IS A POPULATION??



POPULATION DENSITY



(a) Clumped



(b) Uniform



(c) Random

- # of individuals in a given area
- Uniform
 - equally spaced
- Clumped/Clustered
 - individuals associate in small groups
- Random
 - no particular pattern

MEASURING A POPULATION

- ◉ **Direct Count**

- count all
- EX: Census

- ◉ **Quadrant**

- grid of sample squares
- count fraction of population
- estimate total population
- EX: plants, trees (non-sessile)

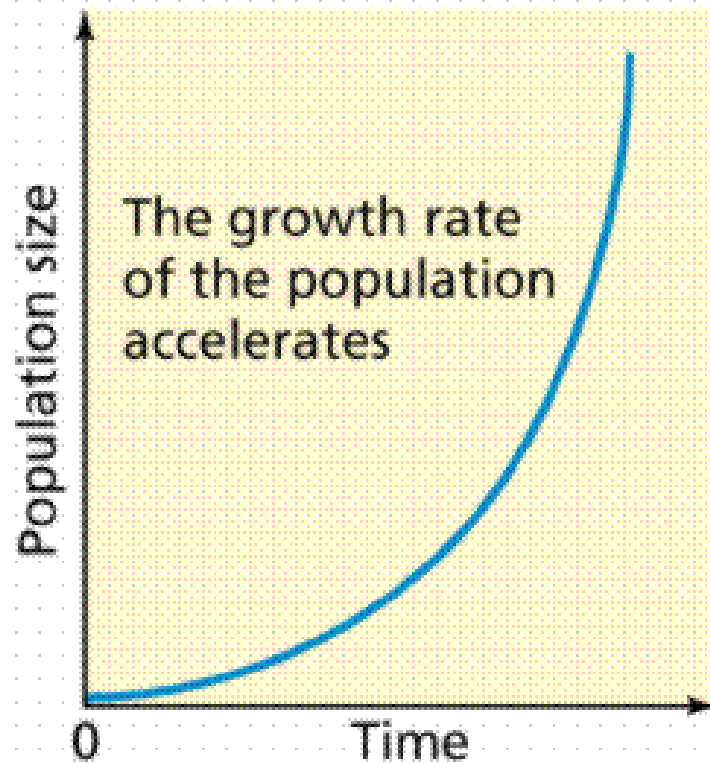
- ◉ **Capture-Recapture**

- count & mark sample population in given area & then release
- Repeat procedure several days
- estimate mobile population
- EX: beetles, butterflies, dolphin

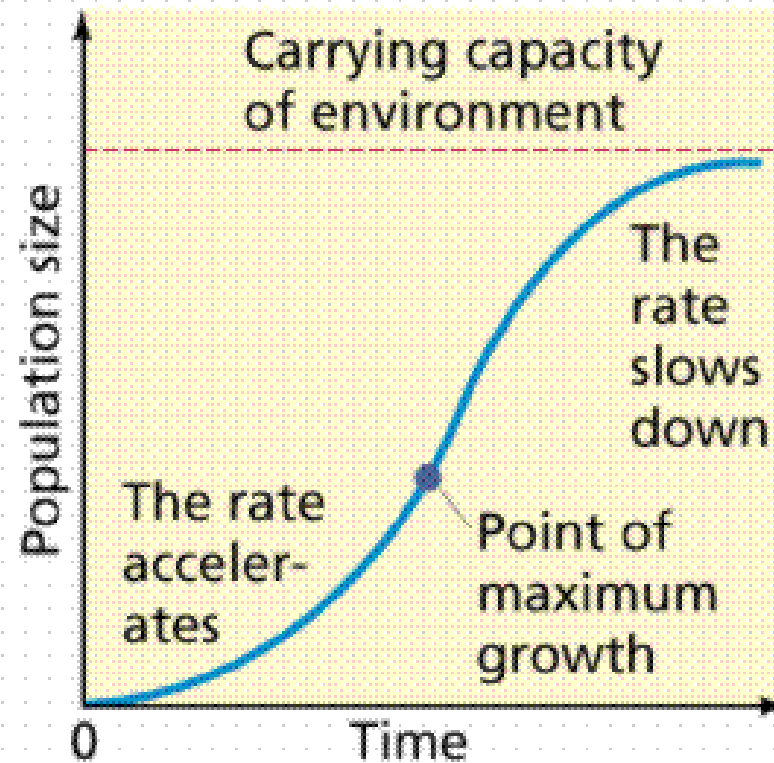


POPULATION GROWTH

(a) Exponential (un-restricted) growth



(b) Logistic (restricted) growth



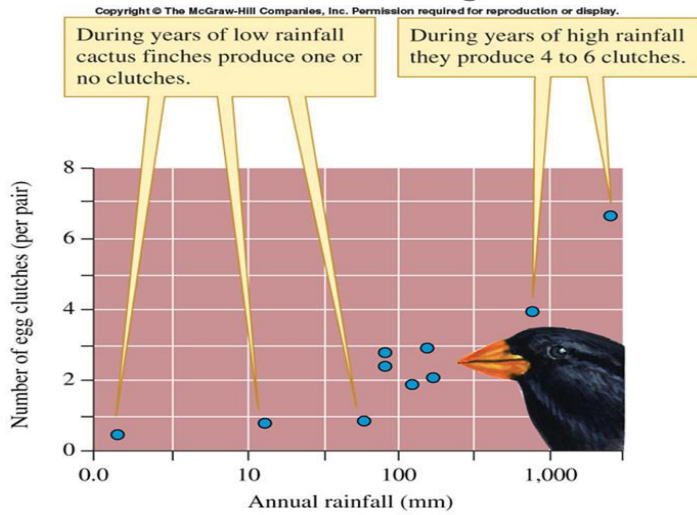
LIMITING FACTORS

Density-dependent

- not related to size of population
- EX: food supply, temperature, weather, habitat destruction

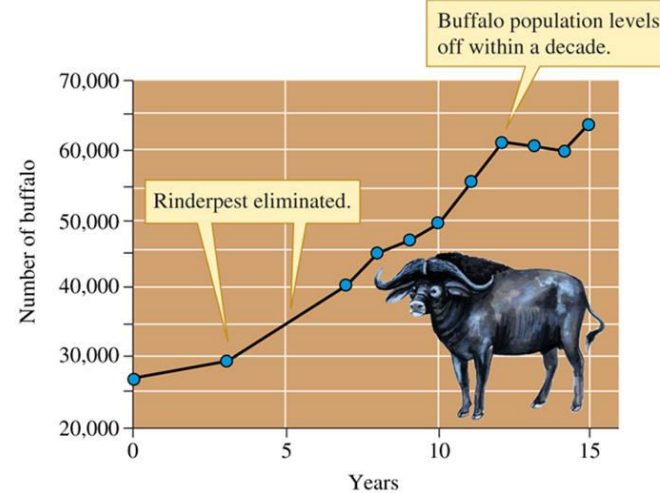
Density-independent

- exert their effect as population size increases
- EX: competition for resources, predation, disease, behavioral changes



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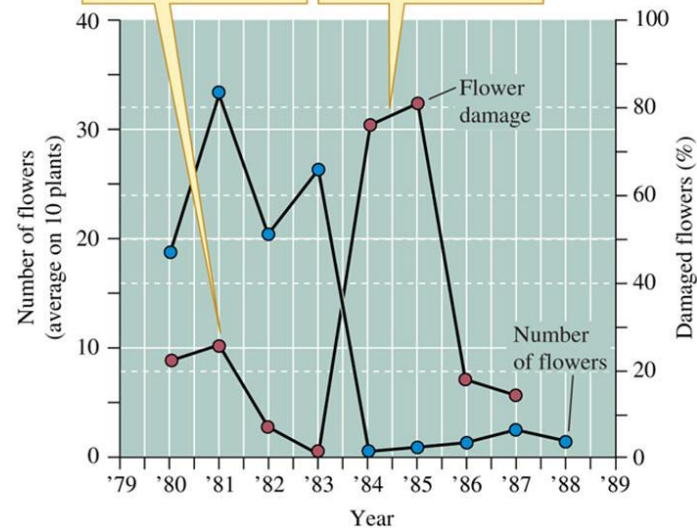
When rinderpest, a disease of cattle and their relatives, was eliminated from the Serengeti, the buffalo population began to grow.



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When cactus flowers are abundant, damage by finches is low.

Damage increases when flower abundance is low.



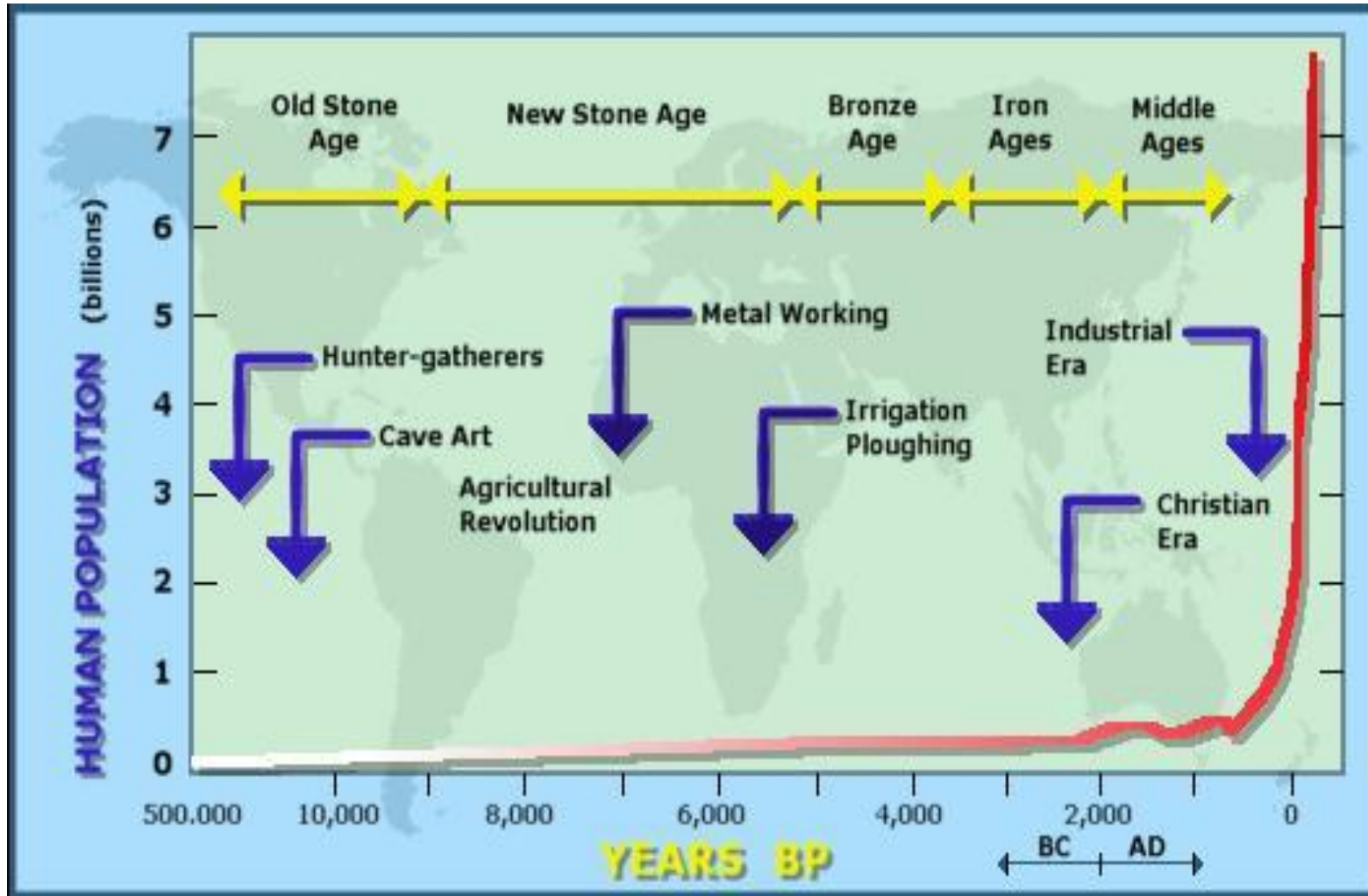
R-SELECTED VS K-SELECTED SPECIES

- ◉ R = intrinsic rate of growth (biotic potential)
- ◉ K= carrying capacity (upper limit for population)

R vs. K Selected Species

- **K selected** species live in populations that are at or near equilibrium conditions for long periods of time. Competitive for limited resources is very important in these environments.
 - Examples; lemurs, giraffes, elephants, bats
- **R selected** species live in populations that are highly variable. The fittest individuals in these environments have many offspring and reproduce early.
 - Examples; mosquitoes, *Daphnia*, goldenrod

HUMAN POPULATION

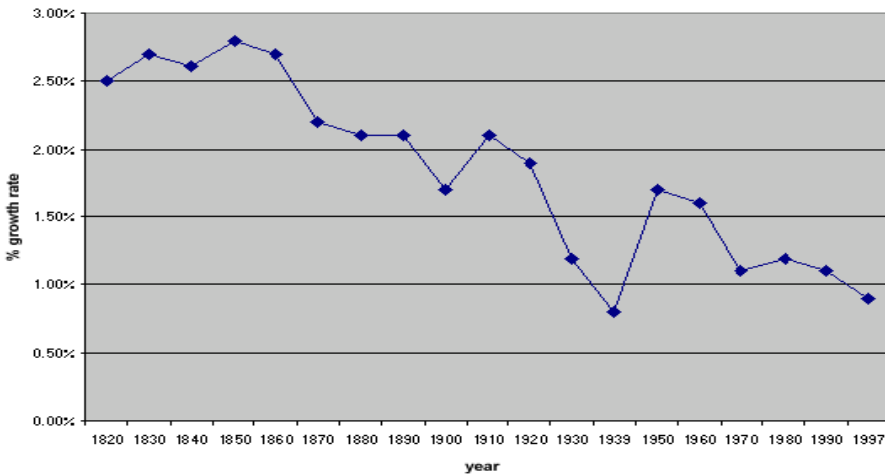


POPULATION GROWTH RATE

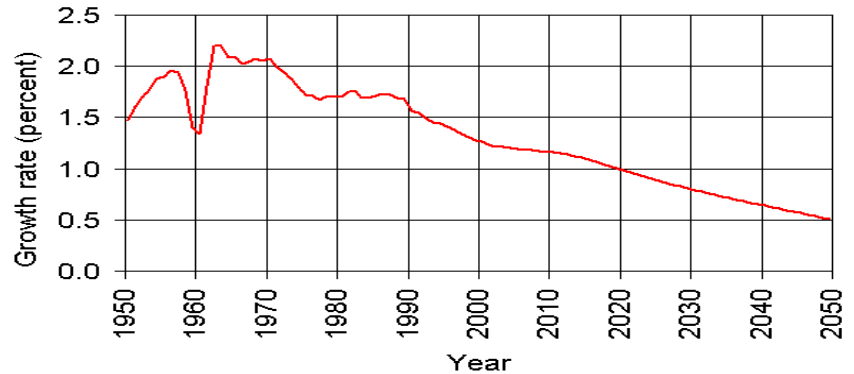
Annual rate of population change (%) =

$$\frac{[(\text{birth rate} - \text{death rate})]}{10}$$

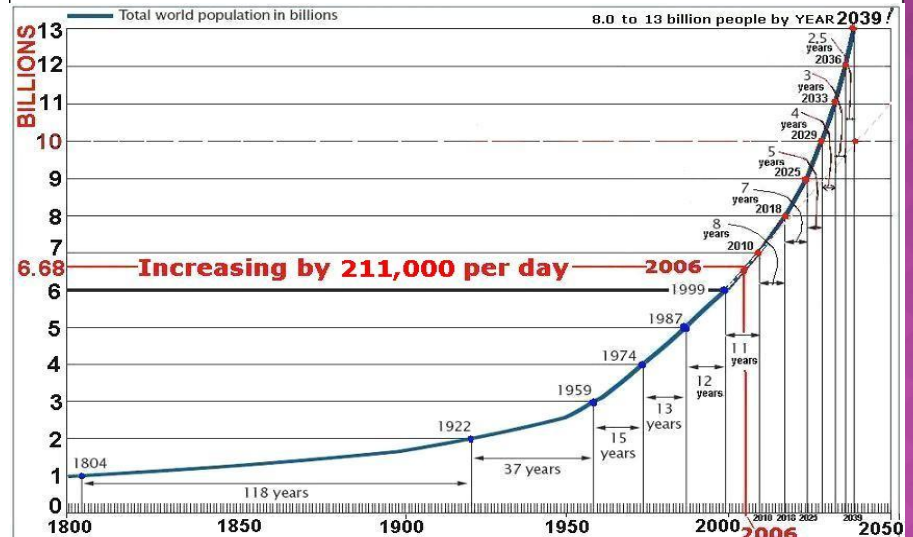
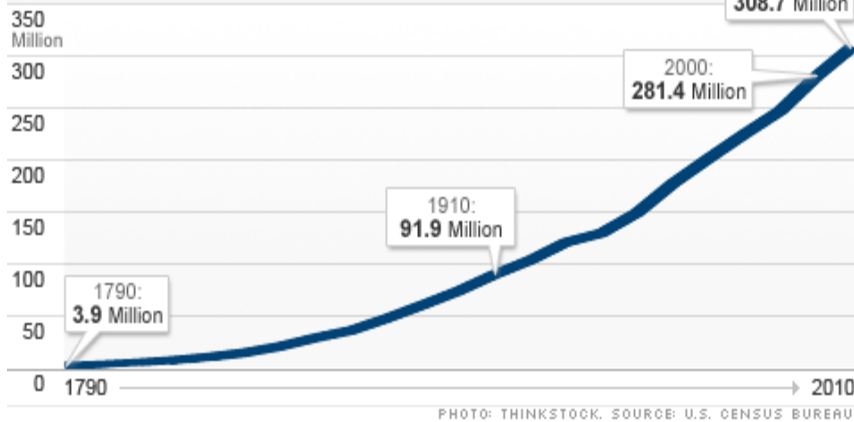
U.S. Annual population growth rate



World Population Growth Rates: 1950-2050



U.S. POPULATION



THE RULE OF 70

RULE OF 70

$$\begin{array}{l} \text{number} \\ \text{of years} \\ \text{to} \\ \text{double} \end{array} = \frac{70}{\begin{array}{l} \text{annual} \\ \text{percentage} \\ \text{growth rate} \end{array}}$$

Example:

The doubling time of a population growing at 2% each year is 70 divided by 2 or 35 years.

DEMOGRAPHICS

- ◉ **Total Fertility Rate (TFR)** = average # of children born to woman during her lifetime
- ◉ **Replacement-level Fertility** = average # of children a couple must bear to replace themselves in the population (average is about 2.1 (some children die before reproductive age))
- ◉ **Infant Mortality Rate (IMR)** = # of babies out of every 1000 births who die before reaching 1st birthday
- ◉ **Crude Birth Rate (CBR)** = # births per 1000 people in population
- ◉ **Crude Death Rate (CDR)** = # deaths per 1000 people in population
- ◉ **Immigration** = migration of people INTO a population
- ◉ **Emigration** = migration of people OUT of a population

FACTORS INFLUENCING BIRTH RATES & FERTILITY RATES

- ◉ **marriage age**
 - high in countries where women marry young (below 25)
- ◉ **education**
 - decrease as level of education increase
- ◉ **affluence**
 - lower in affluent areas
- ◉ **child labor**
 - higher in countries where children are part of labor force
- ◉ **opportunities for women**
 - low when women have access to employment & education
- ◉ **availability of birth control**
 - reduced with widespread availability & use of birth control methods
- ◉ **religious/cultural belief**
 - high in countries where large families are deemed desirable

FACTORS AFFECTING DEATH RATES

○ nutrition

- better nutrition & increased food production
- reduced deaths due to starvation

○ sanitation, water, hygiene

- improvements reduce IMR and lengthened life expectancy

○ medicine & public health

- improvements in medical technology
- health care delivery (antibiotics, immunizations, insecticides)
- reduced deaths of diseases (smallpox, measles, influenza, etc)

AGE-STRUCTURE

- ◉ distribution of males & females in different age groups
- ◉ Key factors:
 - # females in reproductive and pre-reproductive age groups affect future growth (TFR determine births)
 - compare them to infer social changes within country
 - compare social condition among different countries
 - broad base = high population momentum; high IMR, poor health care, cultural preference large families, lack of opportunities for women
 - narrow base = low population momentum, aging population, slow growth, could lead to negative growth

Three Patterns of Population Change

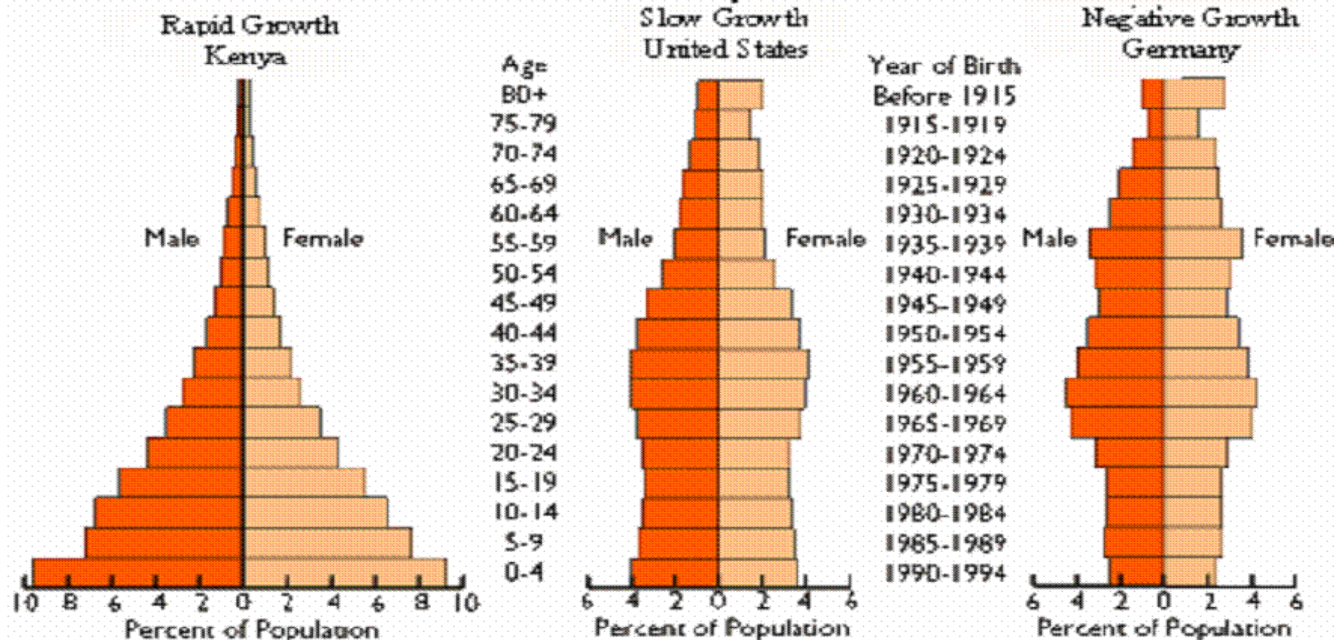
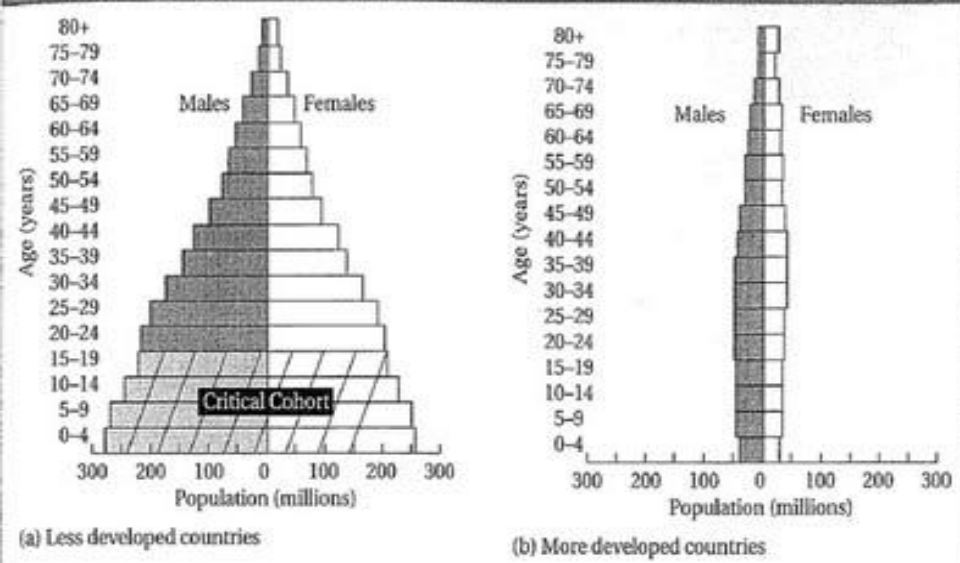
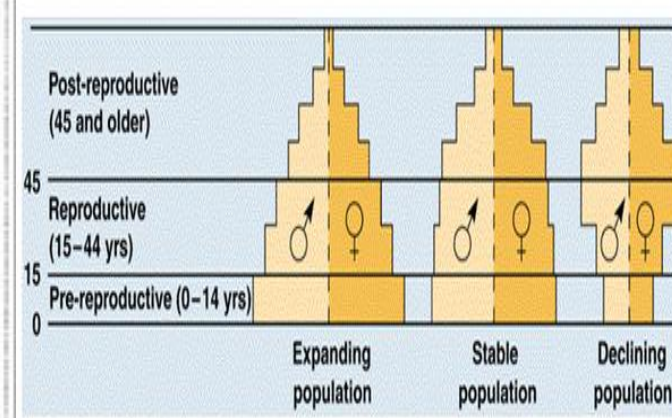


FIGURE 6.5 Population by Age and Sex (Population Pyramids): Less Developed and More Developed Countries, 1998



1994 Edition, New York, 1994

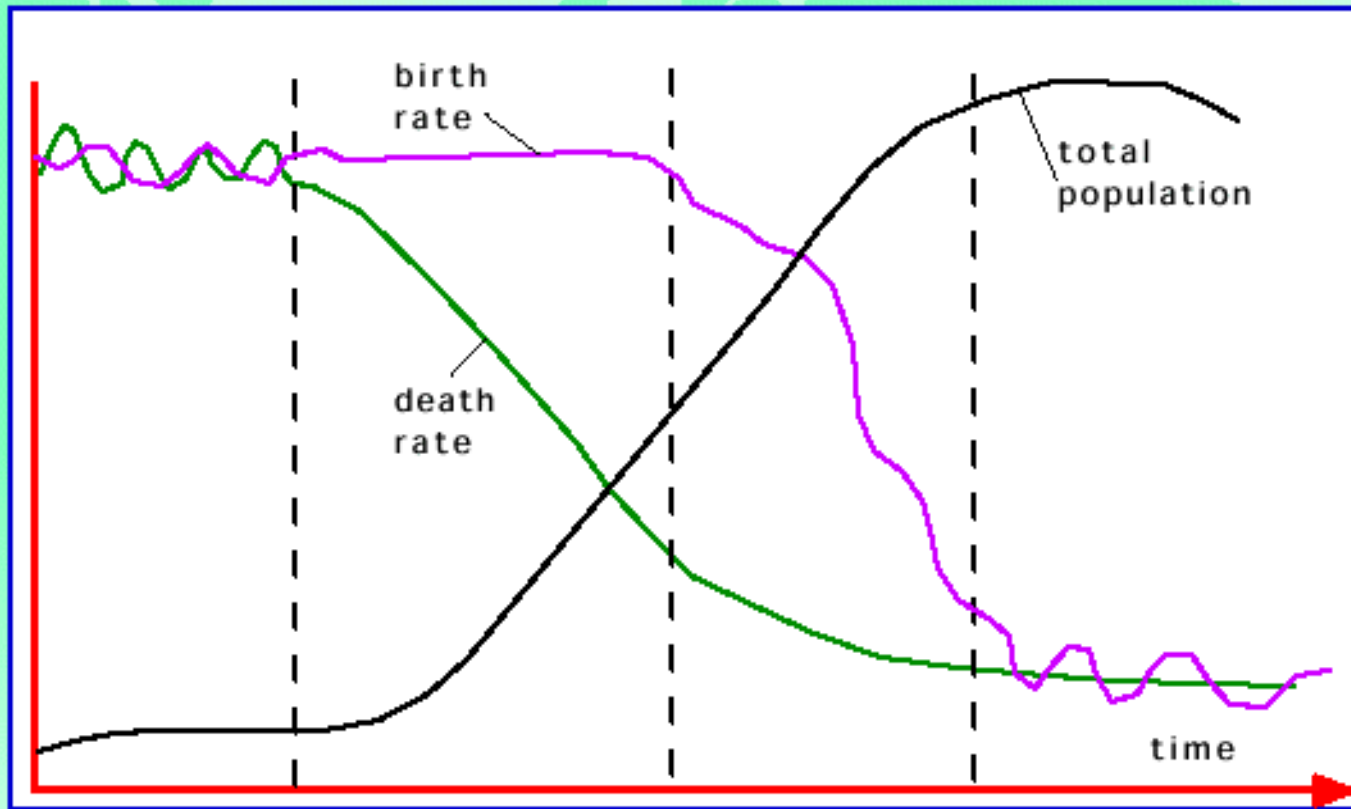
PRB



Source: Population Reference Bureau, 1998 World Population Data Sheet (Washington, D.C.: Population Reference Bureau, 1998). Reprinted with permission.

DEMOGRAPHIC TRANSITION

The Demographic Transition



Stage 1

High birth rate
high, but fluctuating
death rate

Stage 2

Declining death rates
and continuing high
birth rates

Stage 3

Declining birth
and death rates

Stage 4

Low death rates
and low, but
fluctuating birth rates

DEMOGRAPHIC TRANSITION

STAGE 1: PRE-INDUSTRIAL

- ◉ birth rates and death rates are both high
- ◉ modern medicine had not yet developed techniques to lengthen life substantially
- ◉ standards of personal hygiene were comparatively low
- ◉ both rates fluctuated depending on circumstances
- ◉ no demographic transition has occurred

DEMOGRAPHIC TRANSITION

STAGE 2: TRANSITIONAL

- ◉ standards of hygiene and more modern medical techniques began to drive the death rate down
 - leading to a significant upward trend in population size
- ◉ birth rate remained high, as much of the economy was based on agriculture.
- ◉ Mexico is currently between this and the following stage
- ◉ Stage 2 and 3 are indicative of a partial or first demographic transition

DEMOGRAPHIC TRANSITION

STAGE 3: INDUSTRIAL

- ◉ urbanization decreases the economic incentives for large families
- ◉ cost of supporting an urban family grew and parents were more actively discouraged from having large families
- ◉ the birth rate started to drop, ultimately coming close to the death rate
- ◉ increased population in Europe led to tremendous societal pressures that caused large scale migration (e.g., to the USA) and extensive global colonialization

DEMOGRAPHIC TRANSITION

STAGE 4: POSTINDUSTRIAL

- ◉ characterized by a higher, but stable, population size
- ◉ birth and death rates were both relatively low
- ◉ standard of living became much higher than during the earlier periods
- ◉ developed world remains in the fourth stage of its demographic transition
- ◉ Example: Sweden
 - countries having completed the second or a full demographic transition

DEVELOPED VS DEVELOPING

- To determine a country's development, these statistics are usually considered by the United Nations
 1. GDP (Gross Domestic Product)
 2. Life Expectancy
 3. Literacy Rate
 4. Education
 5. Healthcare System

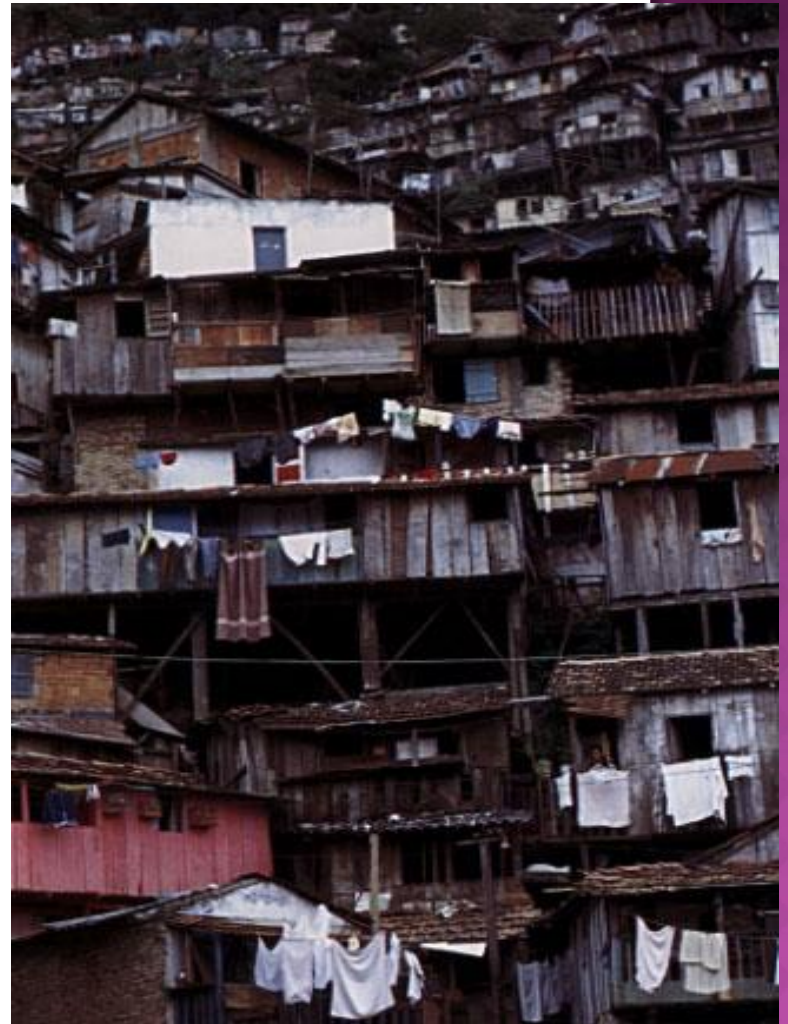
DEVELOPING COUNTRY

- Usually refers to countries with low levels of ECONOMIC DEVELOPMENT
- few factories
- limited technology
- limited transportation and communication systems
- subsistence farming or herding
- rural population
- low per capita GNP
- lower standard of living.

Little industry, low standard of living, and low income

-BUT-

High population



DEVELOPED COUNTRY

- ◉ a modern industrial society with a well-developed economy
- ◉ many factories
- ◉ modern technology
- ◉ efficient transportation
- ◉ communication systems
- ◉ commercial agriculture
- ◉ urban population
- ◉ high per capita GNP (gross national product)
- ◉ higher standard of living



STRATEGIES FOR SUSTAINABILITY

○ Family planning

→ education on human sexuality, childcare, and contraception

○ Social & economic incentives

→ subsidies or aid from government (tax relief, debt relief, low-cost housing, medical care)

→ Penalties for having more children than replacement level (fines, withdrawal of benefits)

○ Policies & laws

→ Pronatalist (encourage births & large families)

- 1930's France paid families government subsidies for raising children & paid maternal salary to women who had more than 2 children

→ Antinatalist (discourage births & encourage small families)

- China & Singapore raised legal age of marriage to shorten a woman's period of fertility
- 1980's low-cost housing or subsidies were reduced when women had more than 2 children

CASE STUDY: UNITED STATES

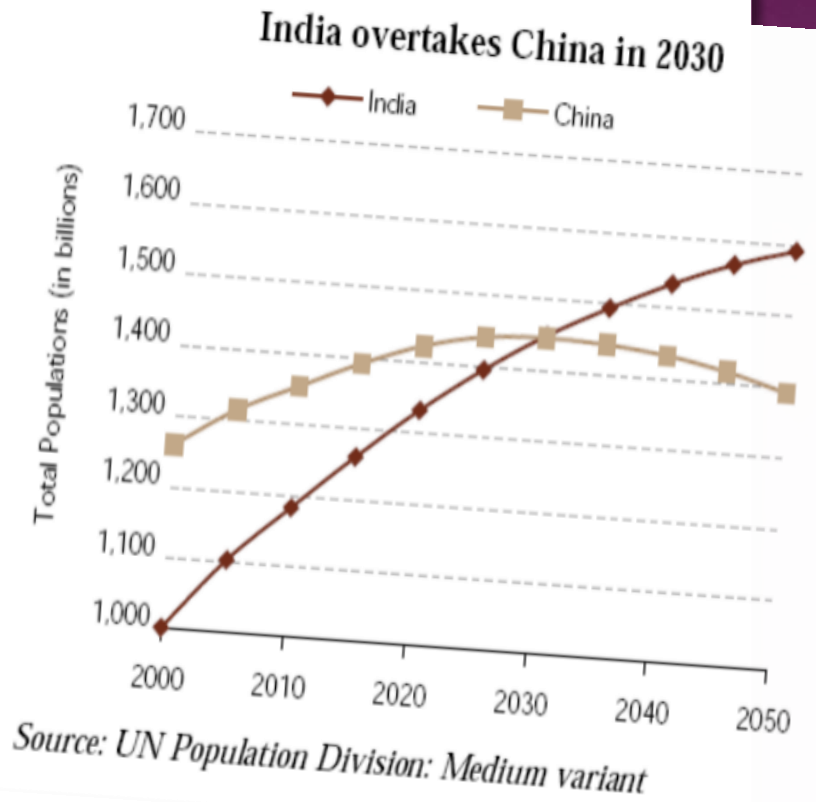
SLOW GROWTH RATE COUNTRY

- ◉ no official population policy because rights lie among individual families not government
- ◉ major factor contributing to growth is immigration (legal & illegal)
- ◉ US policies
 - tax laws: income tax deductions for families & child tax credits
 - abortion laws: legal limits to abortion
 - welfare laws: child benefits
 - sex education: regulated @ local & state level; influenced by social & religious beliefs

CASE STUDY: INDIA

RAPIDLY GROWING POPULATION

- India occupies 2.4% of the world's land area and supports over 17.5% of the world's population
- 1952 government initiated family planning, education, age of marriage and employment policies (not successful)
- 21st century economy is improving, may reduce population growth



CASE STUDY: CHINA

STEMMING A RAPIDLY GROWING POPULATION

- ◉ 1/6 of world population but only 7% of world's farmable land
- ◉ 1960 policies
 - family planning
 - extensive health care
 - education and employment
 - social security
 - marriage age



CASE STUDY: CHINA

STEMMING A RAPIDLY GROWING POPULATION

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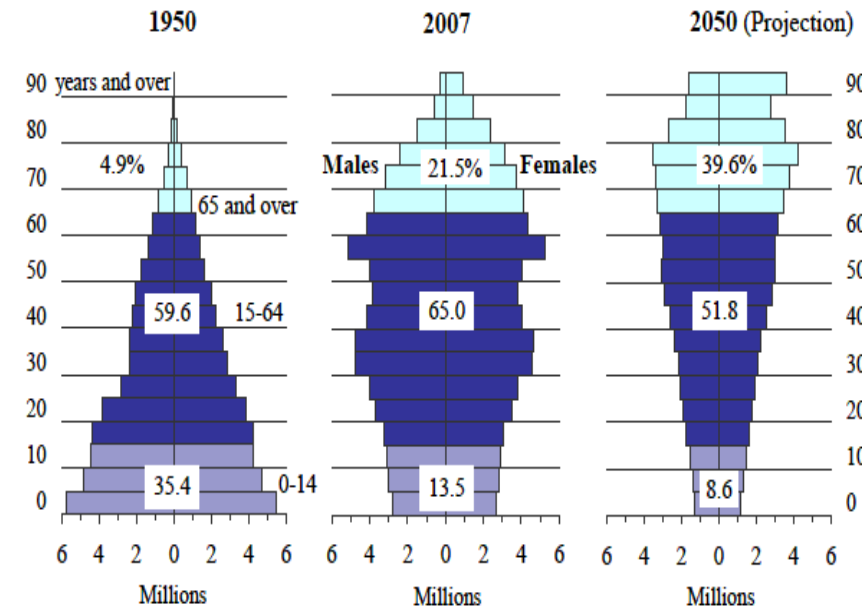


CASE STUDY: JAPAN

SUCCESS IN REDUCING POPULATION GROWTH

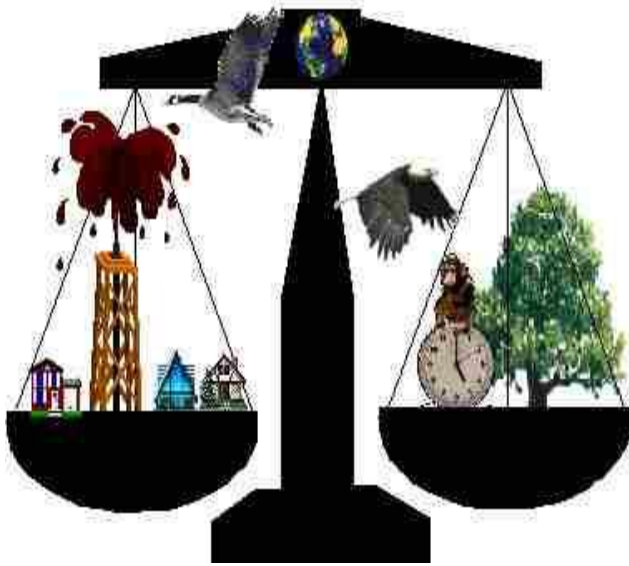
- After WWII, reduced its rapid population by family planning policies (liberal abortion law, access to contraceptives, improving health care, improving pensions)
- Japan approaching zero growth
 - aging & overall decline of workforce (automated industry)
 - aging population will require greater economic demand on governments health care & pension system while reducing tax base

Figure 2.3
Changes in the Population Pyramid



Source: Statistics Bureau, MIC; Ministry of Health, Labour and Welfare.

IMPACT OF POPULATION GROWTH



- Hunger
- Poverty
- Disease
- Depletion of resource (water, energy, minerals)
- Living space (urbanization)
- Habitat destruction