Population Ecology

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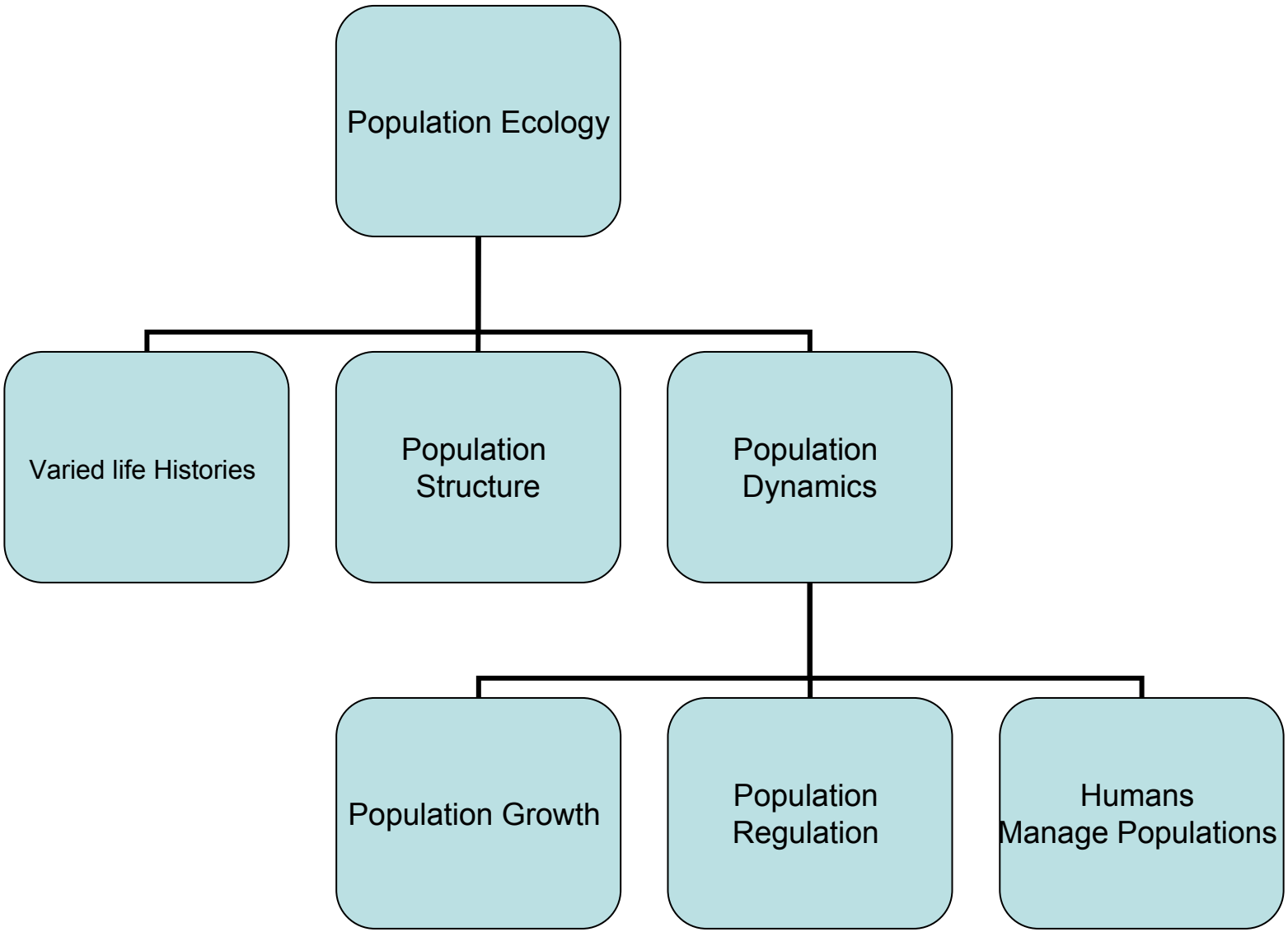
Population Ecology

- **Population ecology** is a major subfield of ecology—one that deals with the dynamics of species populations and how these populations interact with the environment.


Population Ecology
Varied life Histories
Population Structure
Population Dynamics
Population Growth
Population Regulation
Humans Manage Populations

Population Ecology

- Ecology, or **ecological science**, is the scientific study of the distribution and abundance of living organisms and how the distribution and abundance are affected by interactions between the organisms and their environment.

Population Ecology

- The environment of an organism includes both physical properties, which can be described as the sum of local abiotic factors such as insolation (sunlight), climate, and geology, as well as the other organisms that share its habitat.

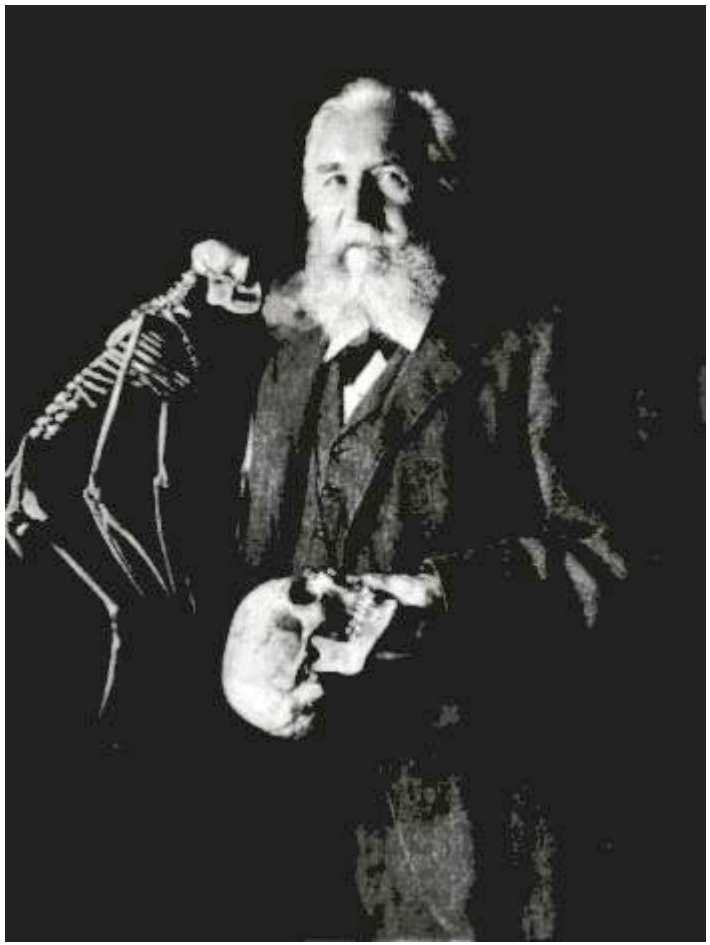
Population Ecology

- The term *oekologie* was coined in 1866 by the German biologist Ernst Haeckel, although it seems that Henry David Thoreau had already invented it in 1852; the word is derived from the Greek οικος (*oikos*, "household") and λόγος (*logos*, "study"); therefore "ecology" means the "study of the household [of nature]".

Population Ecology

- The word "ecology" is often used in common parlance as a synonym for the natural environment or environmentalism. Likewise "ecologic" or "ecological" is often taken in the sense of environmentally friendly.

Population Ecology



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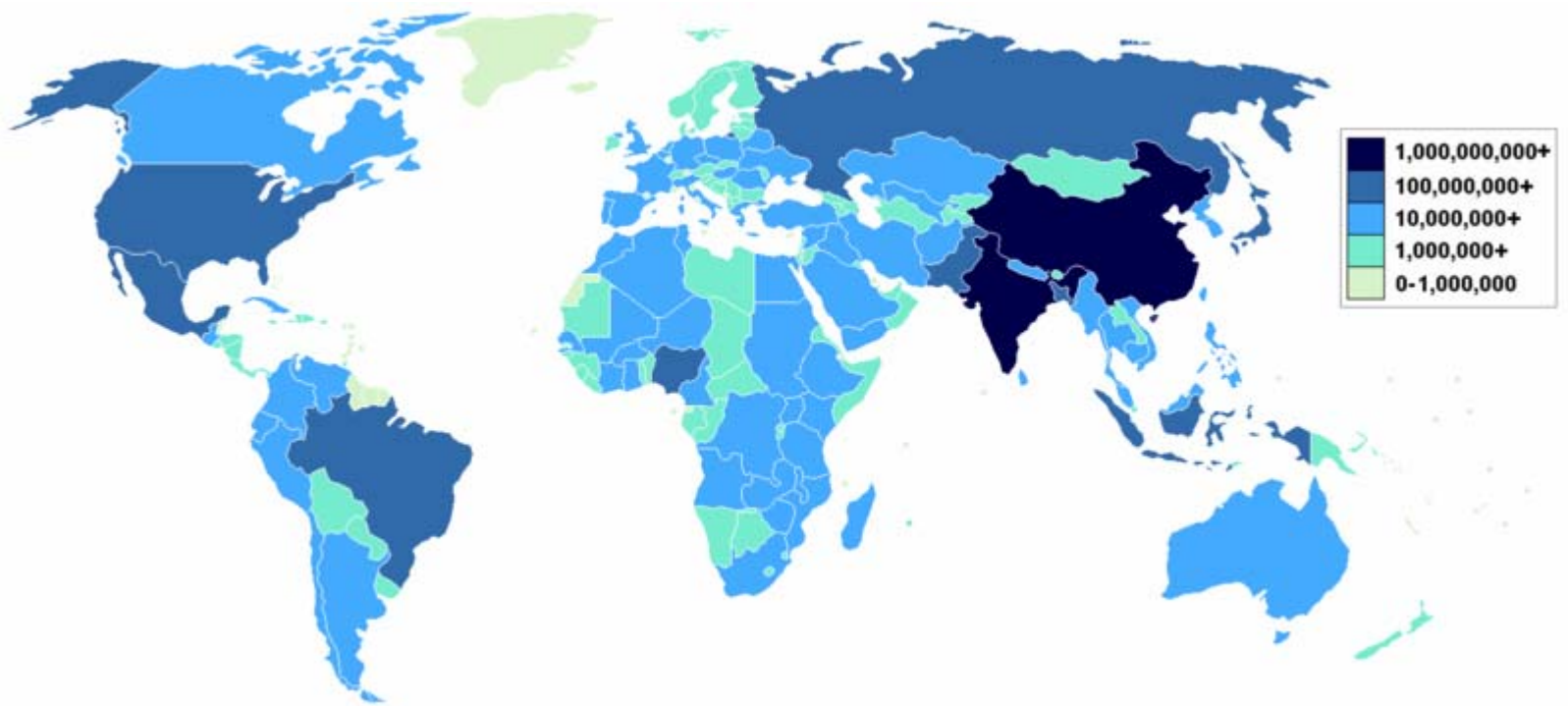
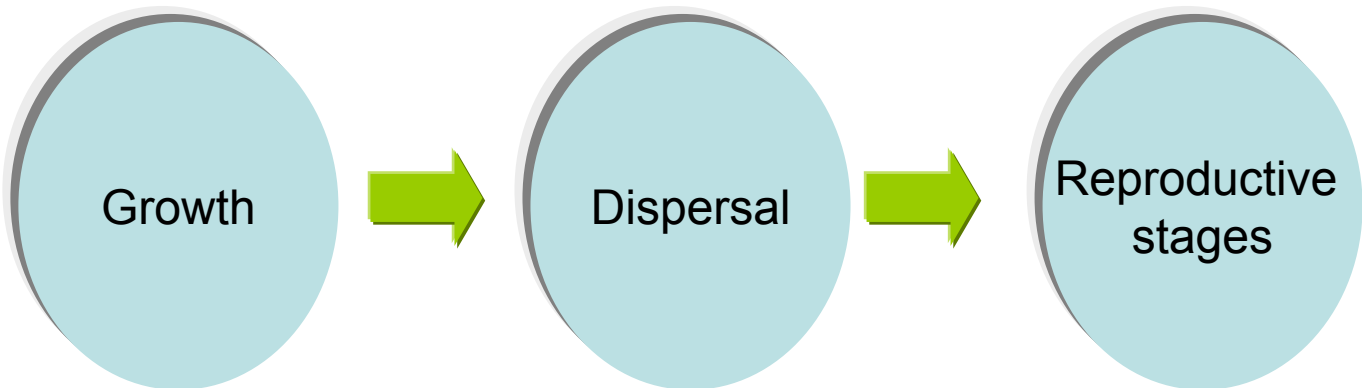
Population

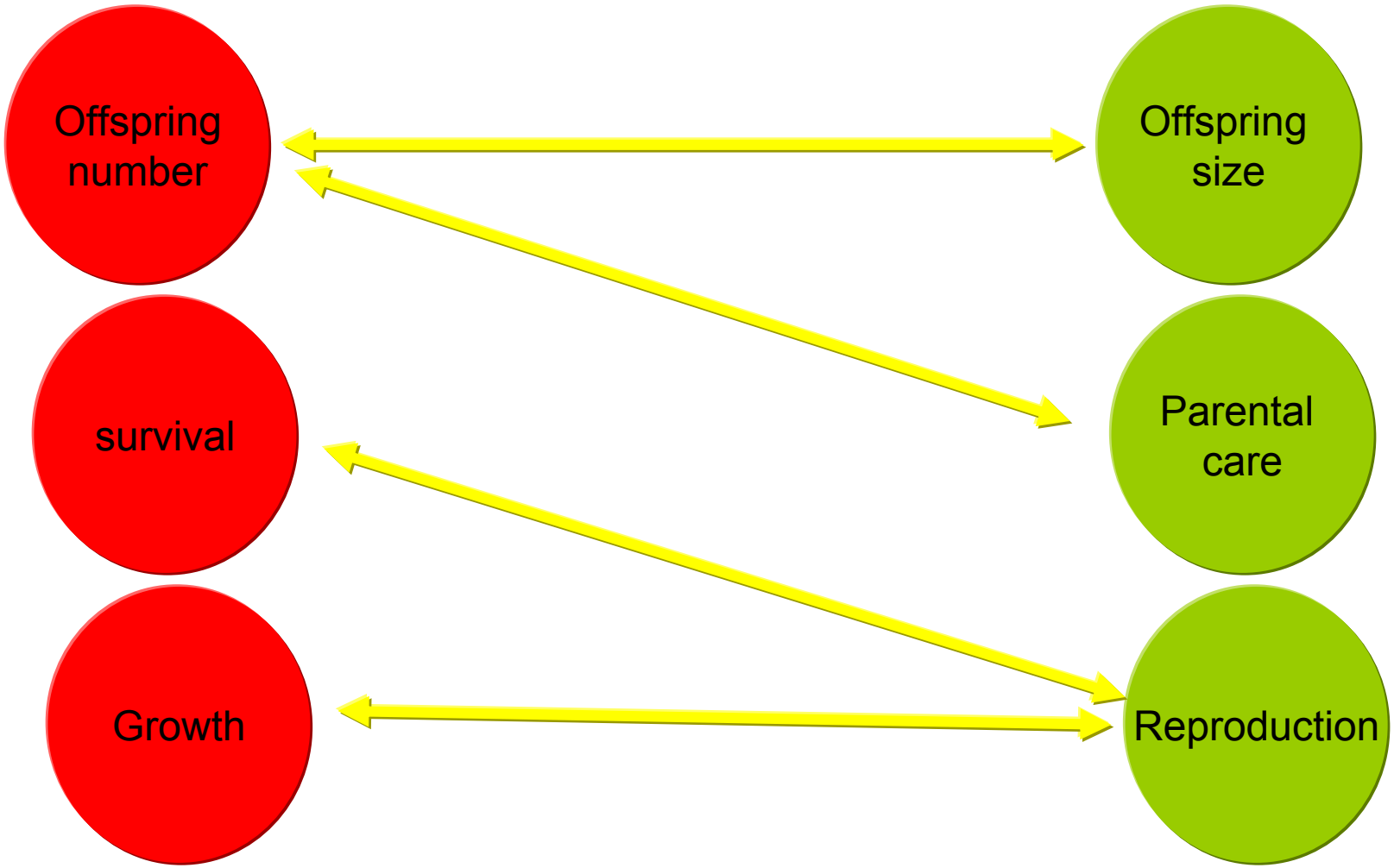


In sociology and biology, a **population** is the collection of people, or organisms of a particular species, living in a given geographic area, or space, usually measured by a census.

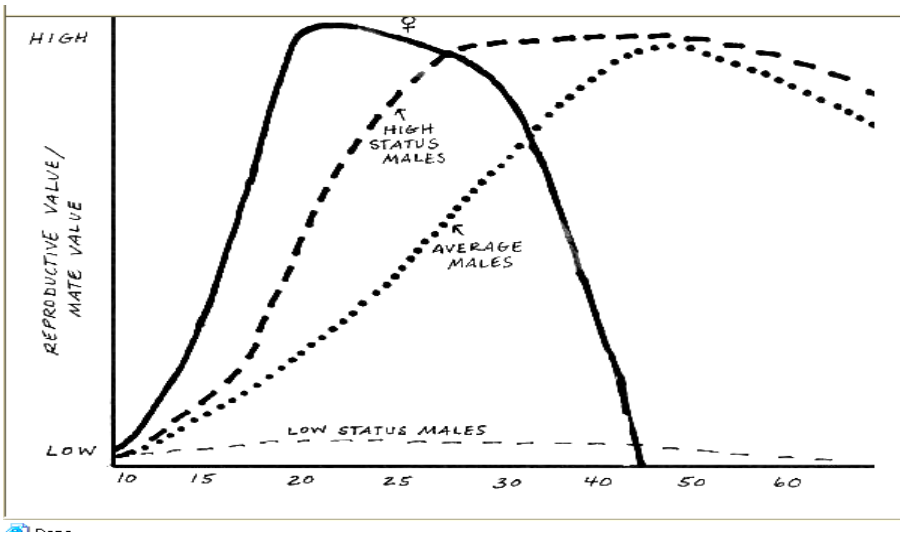
Life Histories of Species



Factors affecting population



Reproductive value



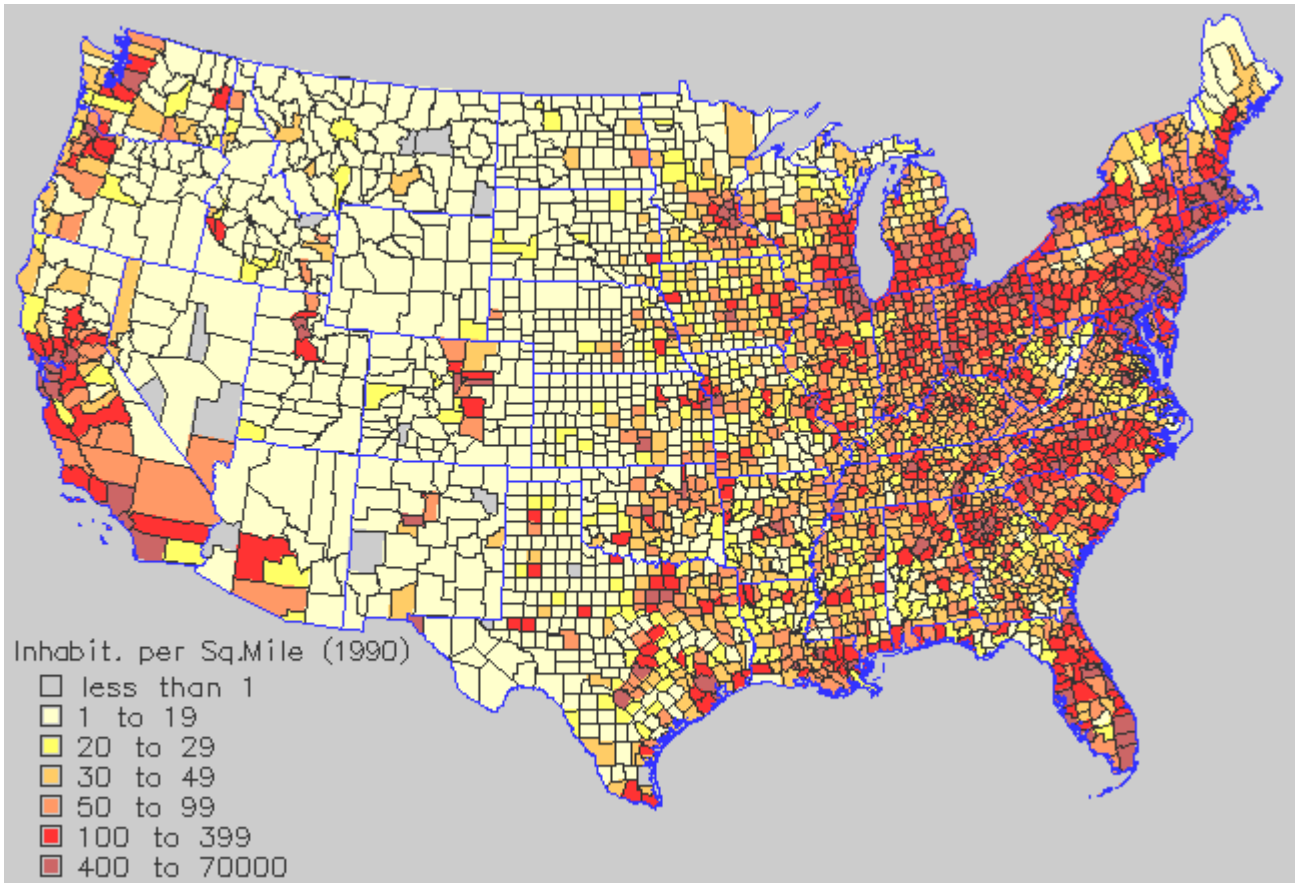
Reproductive value is the average number of offspring that remain to be born to individuals of a particular age. Reproductive value rises to a peak when individuals first begin to reproduce and then declines to zero after reproduction ceases.

In other word, it is the individual's potential current and future reproductive output.

For men, a woman's reproductive value is largely a function of her age, since it correlates highly with current and future fertility.

Generalized Graph of Human Reproductive Value
(After Daly & Wilson, 1988; Figure 4.3, p. 74)

Population density



The number of individuals of a species per unit of area (or volume) is its population density. Dense populations often exert strong influences on populations of other species.

Human Population

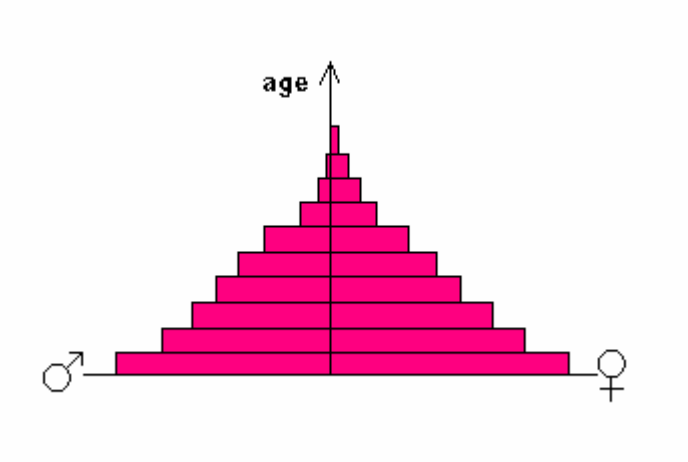
Rank	Country	Population	Density (people/ km²)
—	**World**	**6,661,208,350**	43
1	China	1,315,844,000	136
2	India	1,110,000,000	328
3	United States	301,574,000	30
4	Indonesia	222,781,000	126
5	Brazil	186,405,000	21
6	Pakistan	164,000,000	202
7	Bangladesh	145,000,000	1,002
8	Russia	142,800,000	8
9	Nigeria	131,530,000	139
10	Japan	127,000,000	337
11	Mexico	107,000,000	54

Human Population

Taiwanese people waiting for the Taipei Rapid Transit System in Taipei, Republic of China (Taiwan).

- A crowded street in Japan. Japan has a high population density.

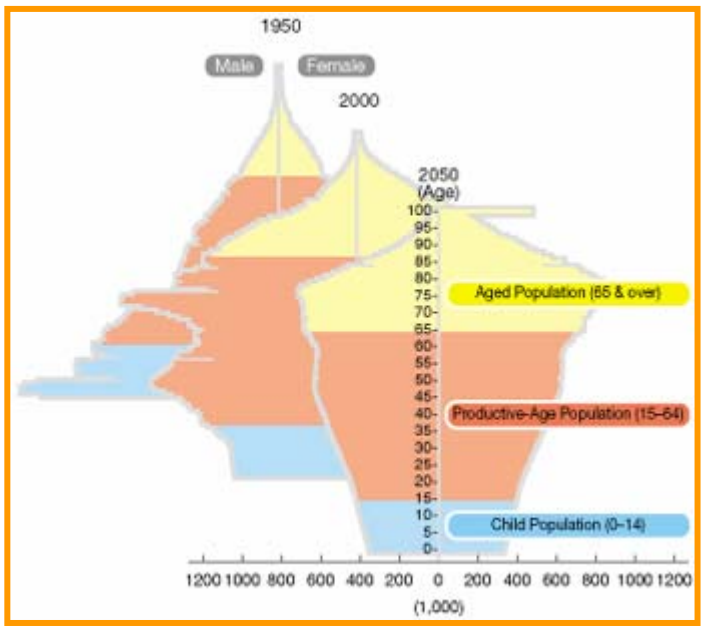
Population Dynamics, changes over time

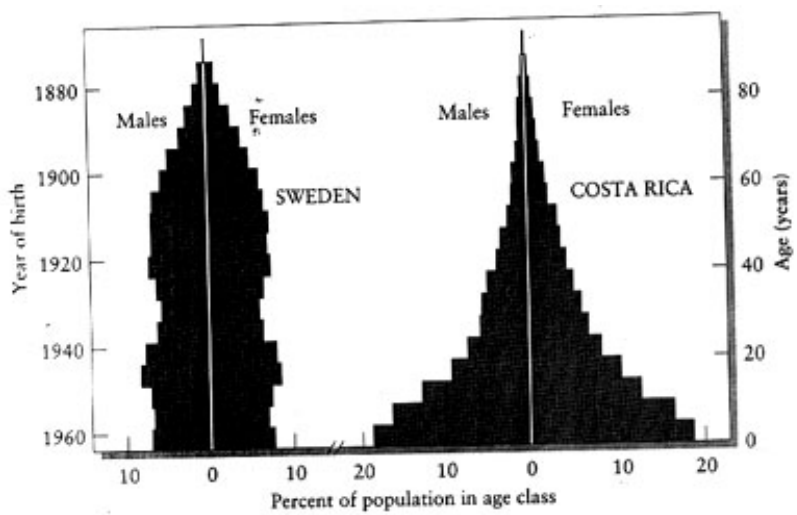


Population Pyramid

- The age and gender distribution of a population within a given nation or region is commonly represented by means of a population pyramid.
- This is a triangular distribution with the portions of the population along the horizontal X-axis and the 5-year age groups (cohorts) along the vertical Y-axis. Male population is shown to the left of the vertical axis and female to the right.

Population Pyramid





- This type of chart displays the development of a population over a period of time.
- Nations with low infant mortality and high longevity will display a more rectangular shape as a majority of the population living to old age. The converse will have a more pyramidal shape with a wide base, reflecting higher infant mortality and greater risk of early death.

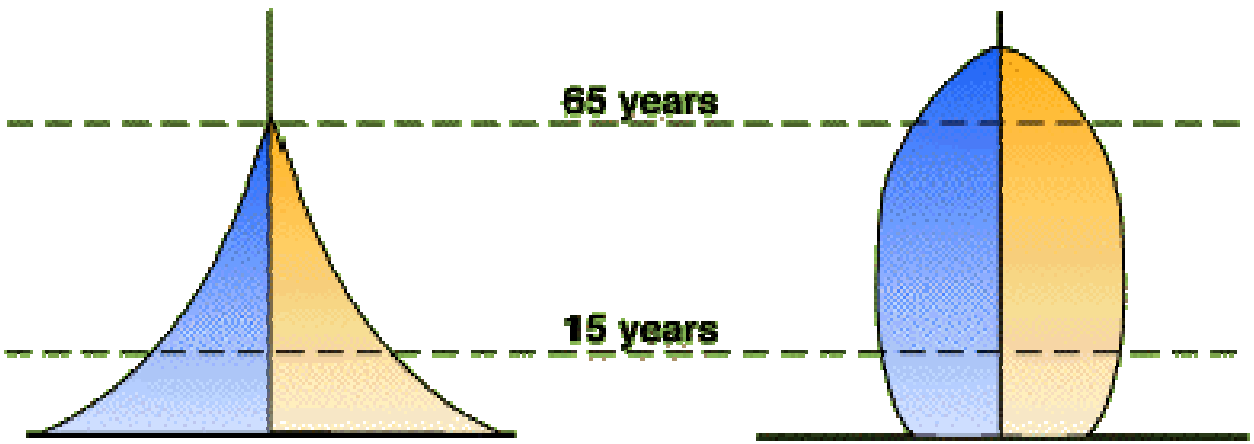
Population Pyramid

Pyramid A

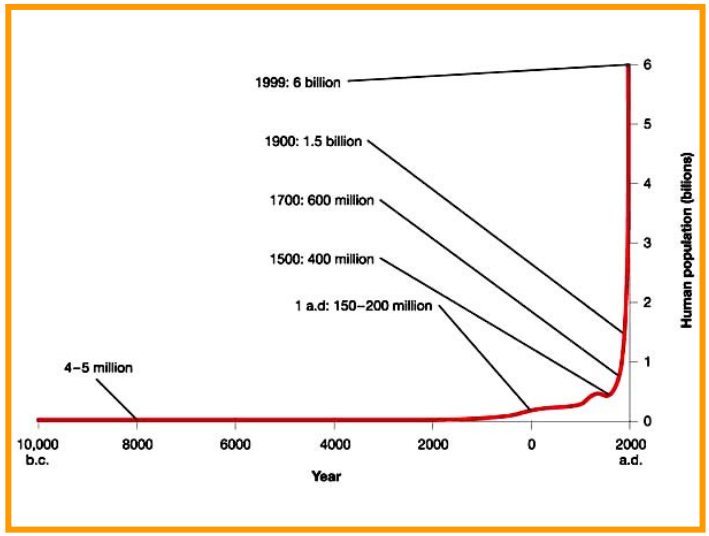
Typical of Developing Countries
High Death Rate
High Birth Rate
Low Life Expectancy

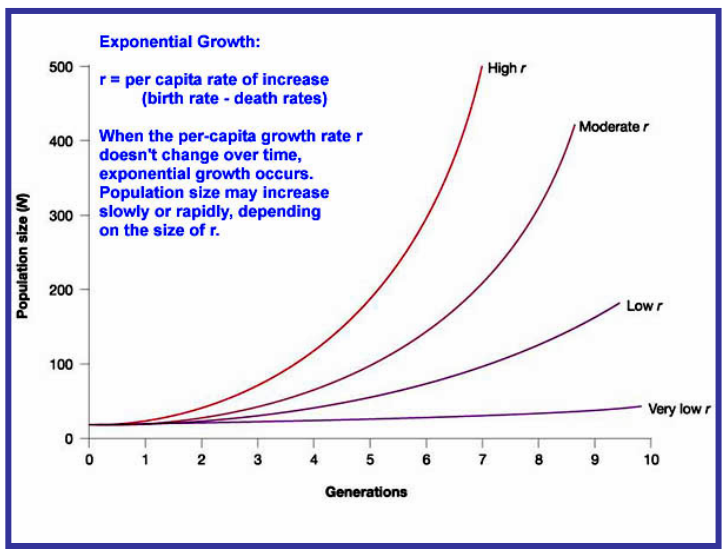
Pyramid B

Typical of Developed Countries
Low Death Rate
Lower Birth Rate
Longer Life Expectancy



Population growth

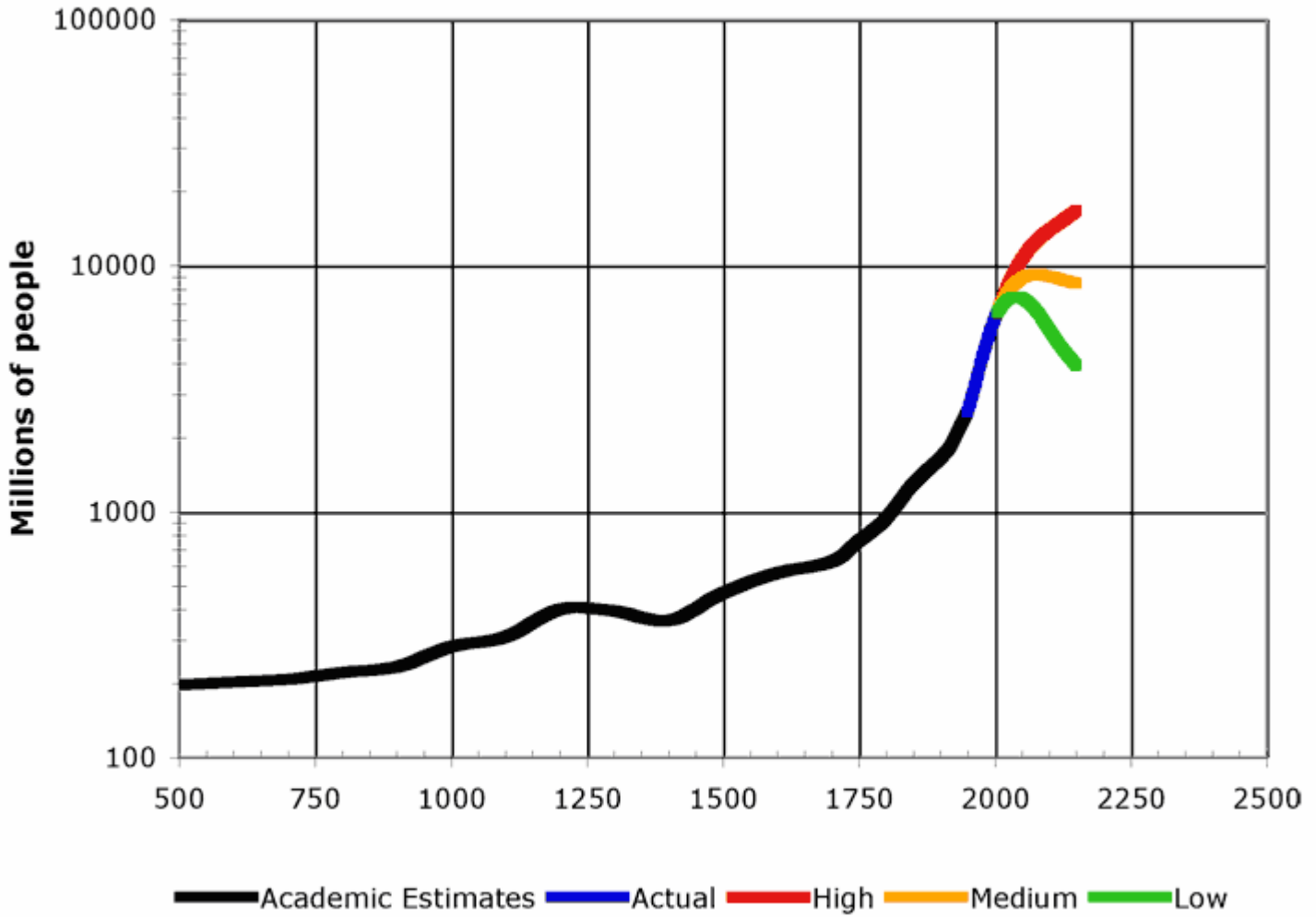




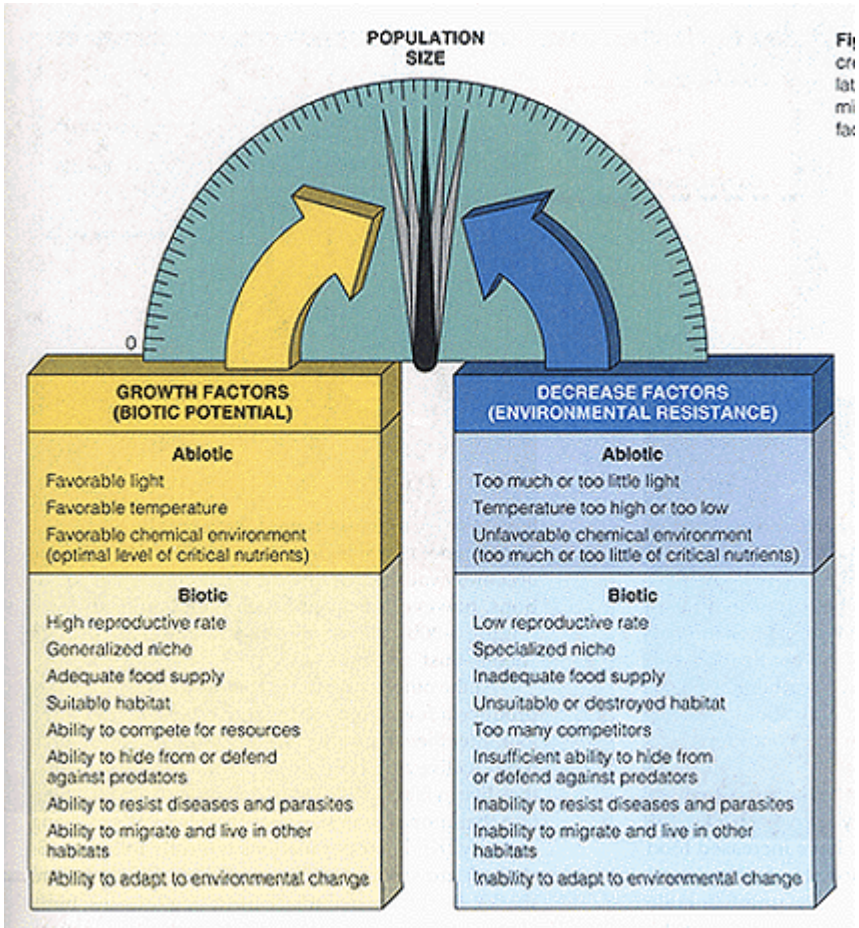
- **Population growth** is change in **population** over time.
- It also can be quantified as the change in the number of individuals in a population per unit time. The term *population growth* can technically refer to any species, but almost always refers to humans, and it is often used informally for the more specific demographic term **population growth rate.**

- All populations have the potential to grow exponentially when they colonize suitable environments.

Population growth



Population growth



Population Growth in limited Environments

No population can maintain exponential growth for very long because environmental limitations cause birth rates to drop and death rates to rise.

The number of individuals of a particular species that an environment can support called the **carrying capacity** is determined by the availability of resources and by disease and predators.

Population growth

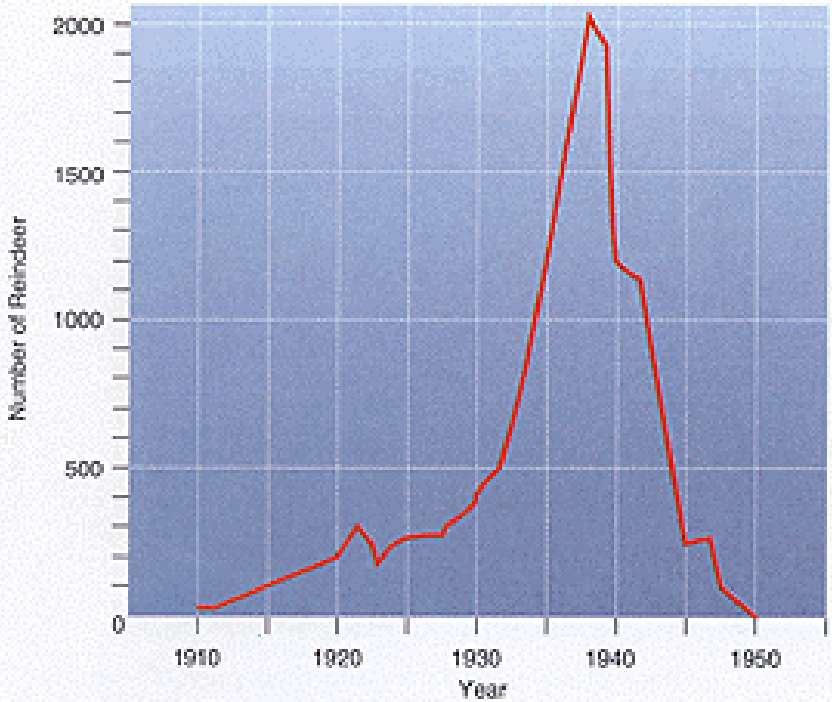
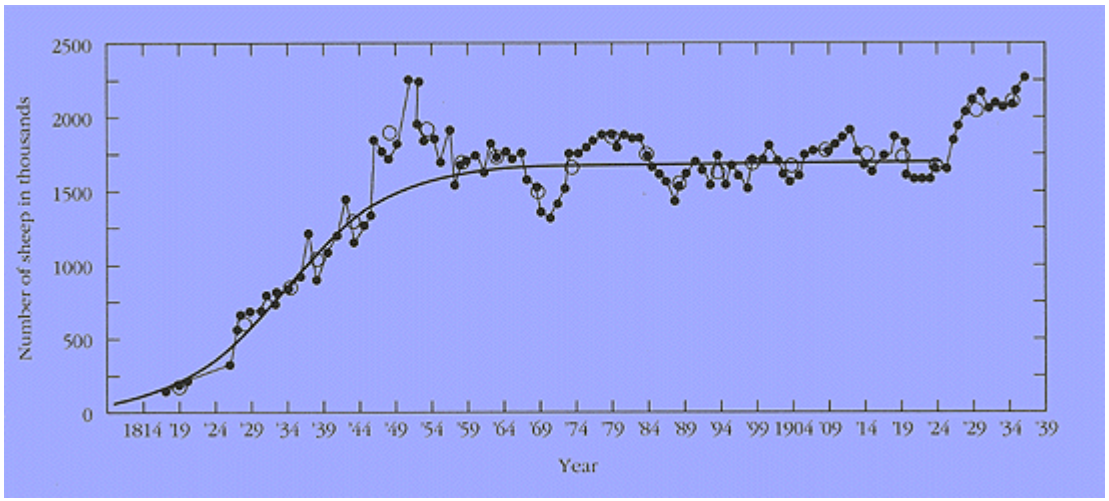


Figure 43-7 Exceeding the carrying capacity can damage the ecosystem, reducing its ability to support the population. In 1911, 25 reindeer were introduced onto one of the Pribilof Islands (St. Paul) in the Bering Sea off Alaska. No predators of reindeer were found on the island. The herd grew exponentially (note the initial J shape) until it reached 2000 reindeer in 1938. At this point, the small island was seriously overgrazed, and the population declined precipitously. By 1950, only eight reindeer survived.

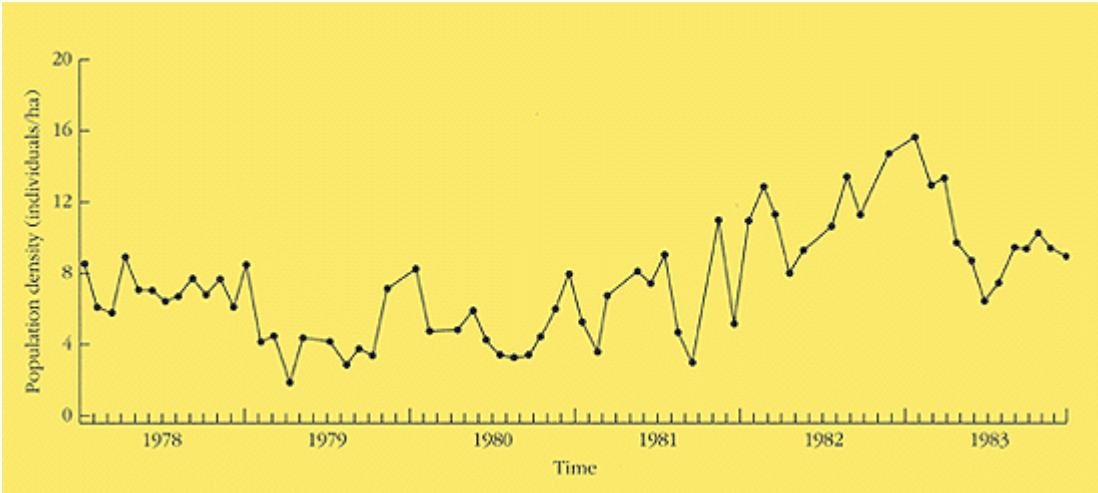
A population in a constant but limited environment at first grows rapidly; but growth rates decrease as the carrying capacity is approached.

Population growth



Population growth of sheep introduced in Tasmania.

Population growth



Changes in population size in the desert kangaroo rat Dipodomys merriami.

Population growth

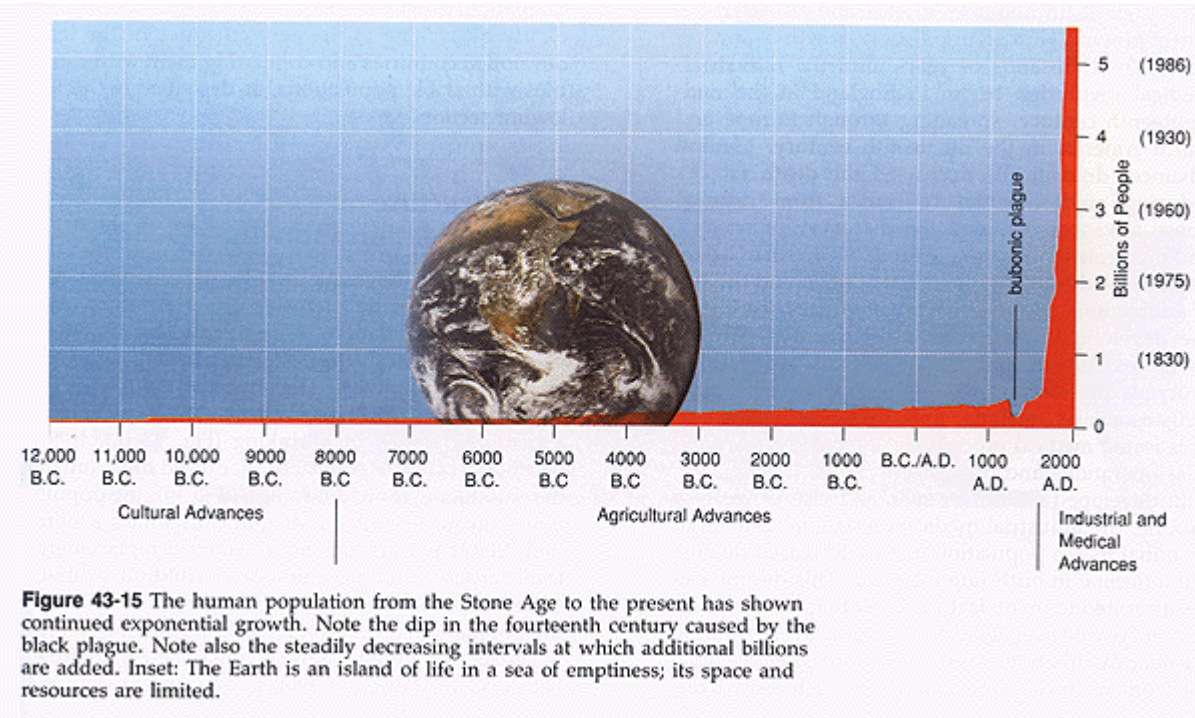


Figure 43-15 The human population from the Stone Age to the present has shown continued exponential growth. Note the dip in the fourteenth century caused by the black plague. Note also the steadily decreasing intervals at which additional billions are added. Inset: The Earth is an island of life in a sea of emptiness; its space and resources are limited.

Metapopulation Dynamics

- A **metapopulation** consists of a group of spatially separated populations of the same species which interact at some level. The term metapopulation was coined by Richard Levins in 1969 to describe a model of population dynamics of insect pests in agricultural fields, but the idea has been most broadly applied to species in naturally or artificially fragmented habitats.

- A metapopulation is generally considered to consist of several distinct populations together with areas of suitable habitat which are currently unoccupied.
- Each population cycles in relative independence of the other populations and eventually goes extinct as a consequence of demographic stochasticity (fluctuations in population size due to random demographic events); the smaller the population, the more prone it is to extinction.

Metapopulation Dynamics

- Although individual populations have finite life-spans, the population as a whole is often stable because immigrants from one population (which may, for example, be experiencing a population boom) are likely to re-colonize habitat which has been left open by the extinction of another population. They may also immigrate into another small population and so rescue it from extinction (called the rescue effect).

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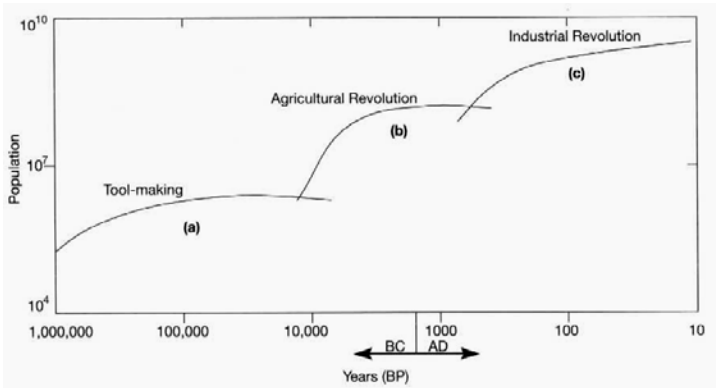
Earth's carrying capacity

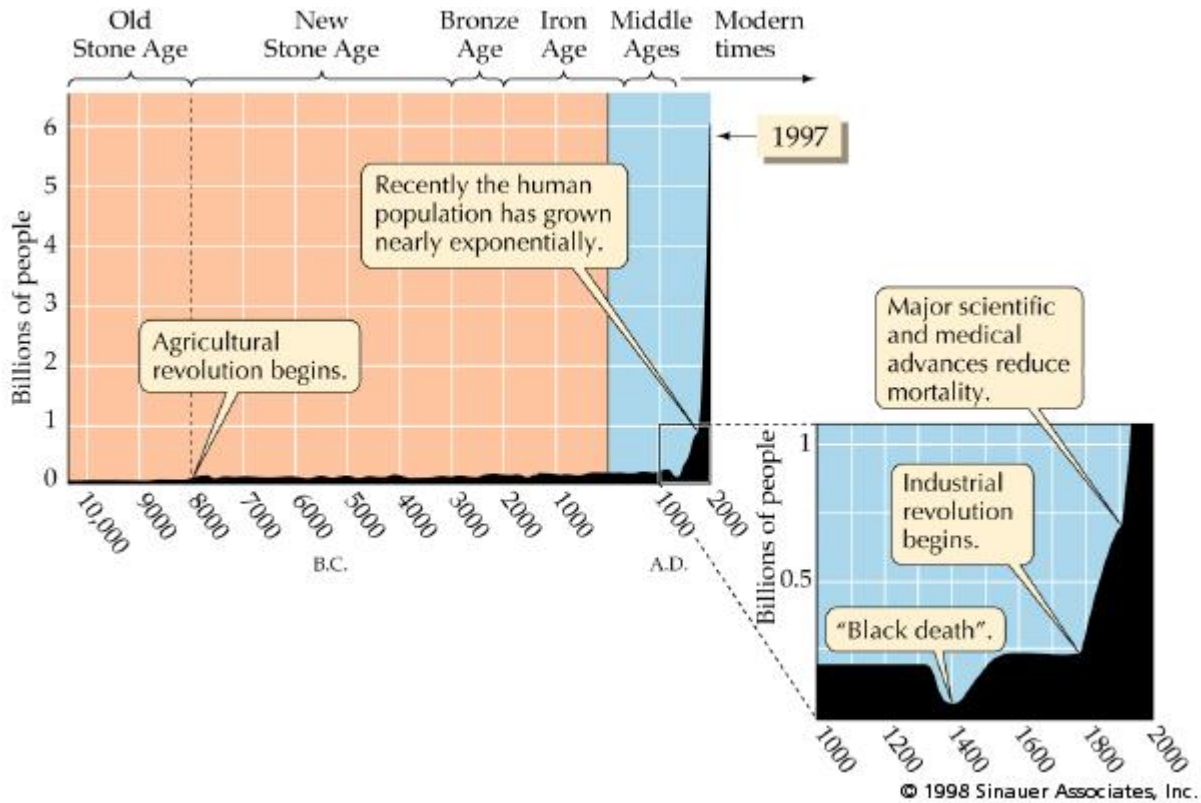
Earth's carrying capacity for humans has been increased several times by technological developments.

Whether the current human population exceeds Earth's carrying capacity is hotly debated.



The above figure is a representation of the growth of the world population in a logarithmic scale for the past million years, indicating the three rapid increases in human population associated with (a) the tool-making or cultural revolution, (b) the agricultural revolution, and (c) the industrial revolution (From Mackenzie 1998, page 242).

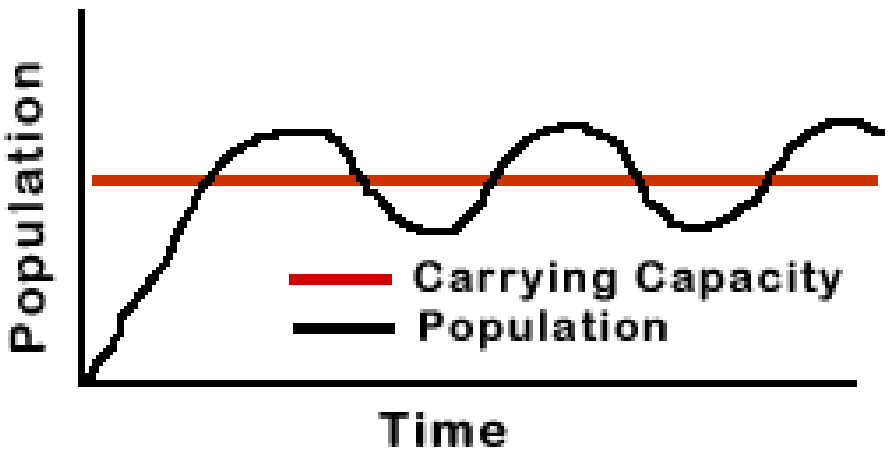
Earth's carrying capacity



Earth's carrying capacity

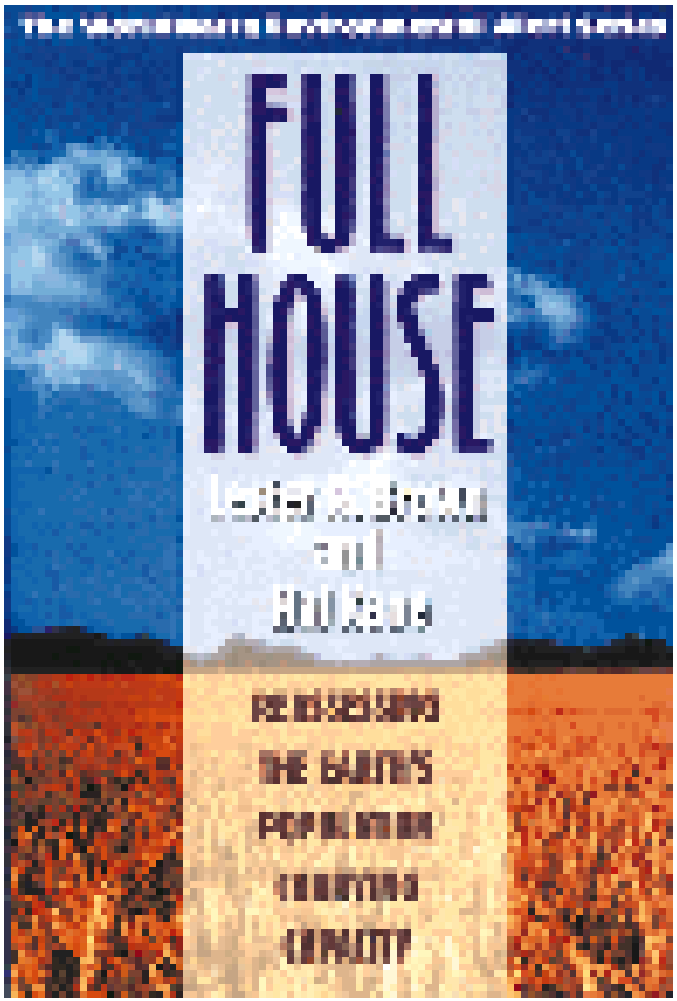
- **Absolute Population:** a measure of number of people on the planet. **Relative Population:** a measure of population density. Population density is usually expressed in units of *people per square kilometer*.
- **Carrying Capacity:** the amount of food that an area of land will yield and, therefore, the number of people that an area of land will support.
- **Realized Intrinsic Rate of Growth** - a measure of the difference between *natality* (birth rate) and *mortality* (death rate).

Earth's carrying capacity

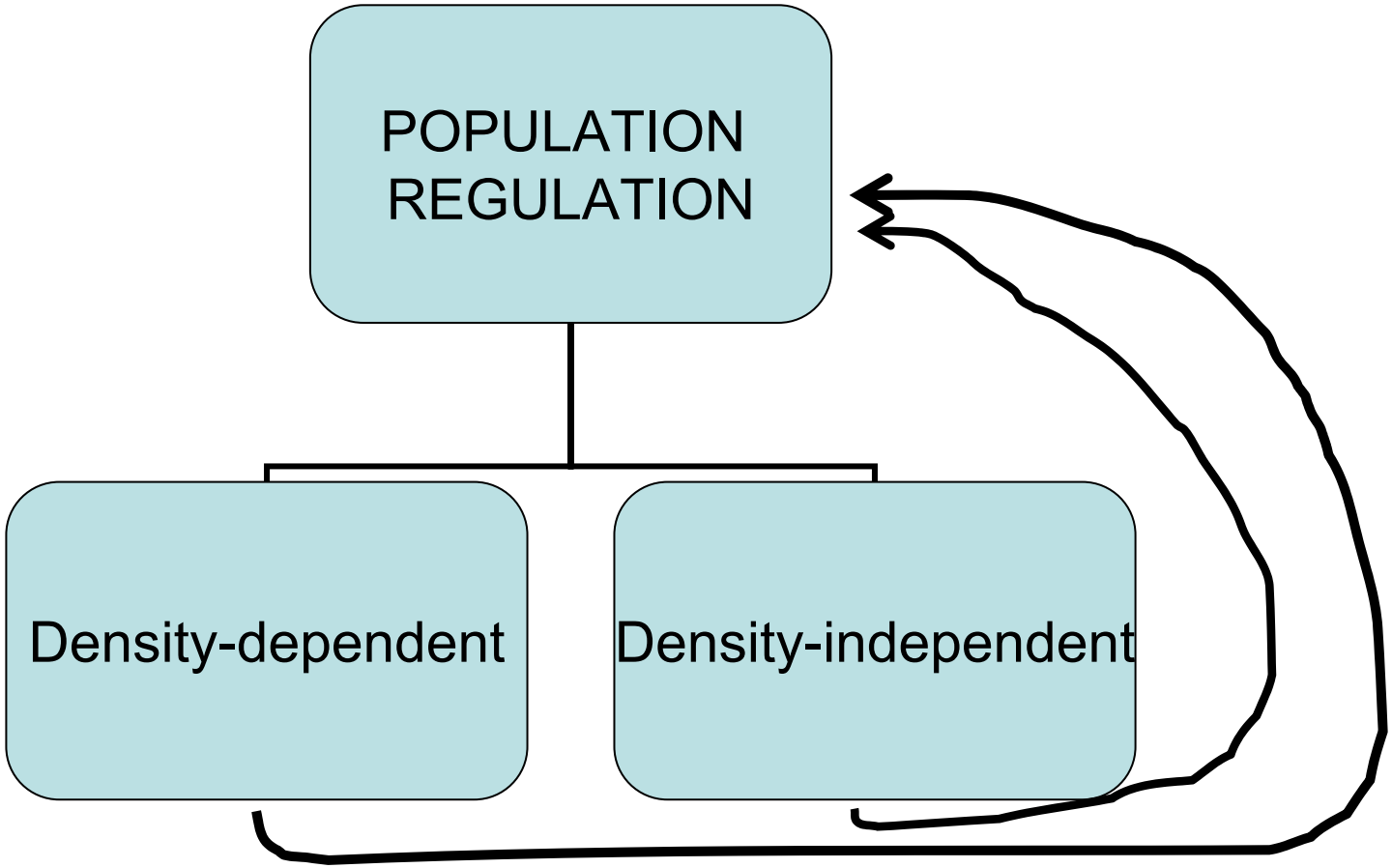


Malthus Approach to Population and Carrying Capacity: human population will increases until carrying capacity is exceeded, resulting in starvation. Human population growth is a biological imperative. **Boserups Approach to Population and Carrying Capacity:** human population will increase only if carrying capacity is increased. Human population growth is culturally determined.

Earth's carrying capacity



- Full House: Reassessing the Earth's Population Carrying Capacity (The Worldwatch Environmental Alert)
- by Lester R. Brown, Hal Kane, Al Kane



Regulation of a population by changes in per capita birth or death rates in response to density

If per capita birth and death rates are unrelated to a population's density

Humans Manage population; wildlife management

- **Wildlife management** is the process of keeping certain wildlife populations at desirable levels determined by wildlife managers.

- Wildlife management is interdisciplinary, integrating science, politics, mathematics, imagination, and logic. It deals with protecting endangered and threatened species and subspecies and their habitats, as well as with non-threatened agricultural pests and game species.

- Aldo Leopold, one of the pioneers of wildlife management, defined it as "the art of making land produce sustained annual crops of wildlife."

Earth's carrying capacity; wildlife management

- Wildlife managers aim to use the best available science to balance the needs of wildlife with their perception of the needs of people. Wildlife management takes into consideration ecological principles such as carrying capacity of the habitat.

- Most wildlife management is concerned with the preservation and control of habitat, but other techniques such as reforestation, predator control techniques such as trapping, re-introduction of species or hunting may also be used to help manage "desirable" or "undesirable" species.

Earth's carrying capacity; wildlife management

- Wildlife management sometimes involves enhancing **keystone resources** in the habitat, such as sources of food, water, and protection. Some examples of artificial enhancements to keystone resources include water sources, nest boxes for cavity-nesting birds, and salt licks to provide minerals to animals.

Earth's carrying capacity; wildlife management

- There are two general types of wildlife management:
- **Manipulative management** acts on a population, either changing its numbers by direct means or influencing numbers by the indirect means of altering food supply, habitat, density of predators, or prevalence of disease. This is appropriate when a population is to be harvested, or when it slides to an unacceptably low density or increases to an unacceptably high level. Such densities are inevitably the subjective view of the land owner, and may be disputed by animal welfare interests.

Earth's carrying capacity; wildlife management

- **Custodial management** is preventive or protective. The aim is to minimize external influences on the population and its habitat. It is appropriate in a national park where one of the stated goals is to protect ecological processes. It is also appropriate for conservation of a threatened species where the threat is of external origin rather than being intrinsic to the system.