Population growth

Population is the numeral counting of plants, animals, or other organisms. This changes over time and space and interact with their environment. This very interaction determines the population growth i. e. how the size of the population is changing over time.

In theory, any kind of organism could take over the Earth just by reproducing.

Population ecologists use a variety of mathematical methods to model population dynamics (how populations change in size and composition over time). Some of these models represent growth without environmental constraints, while others include "ceilings" determined by limited resources. Mathematical models of populations can be used to accurately describe changes occurring in a population and, importantly, to predict future changes.

Population growth rates

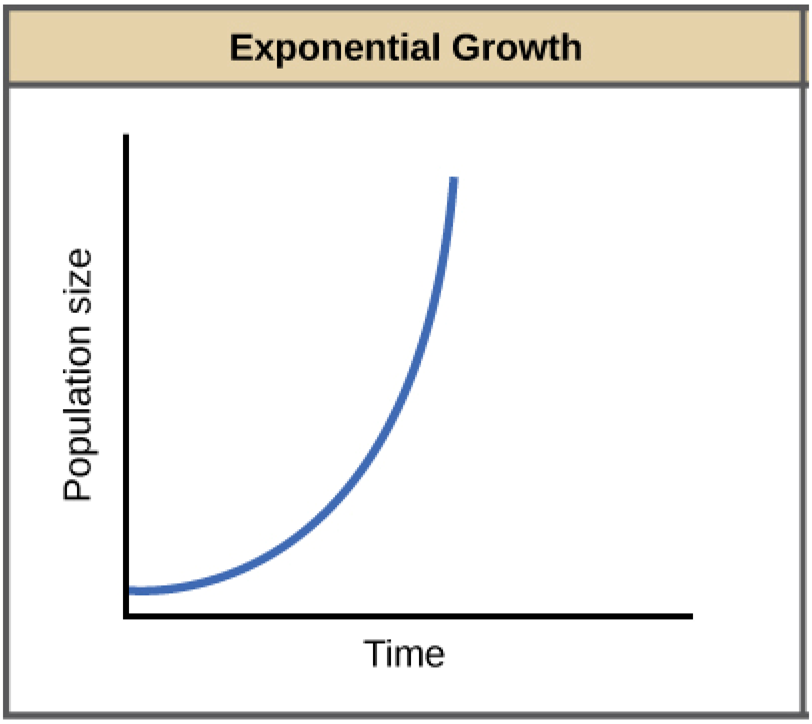
Exponential growth

In exponential growth, the population's growth rate increases over time, in proportion to the size of the population.

Example:

Bacteria grown in the lab provide an excellent example of exponential growth. Bacteria reproduce by binary fission (splitting in half), and the time between divisions is about an hour for many bacterial species.

The key concept of exponential growth is that the population growth rate the number of organisms added in each generation increases as the population gets larger. When population size, NNN, is plotted over time, a J-shaped growth curve is made.



Formula for this kind of growth is denoted by

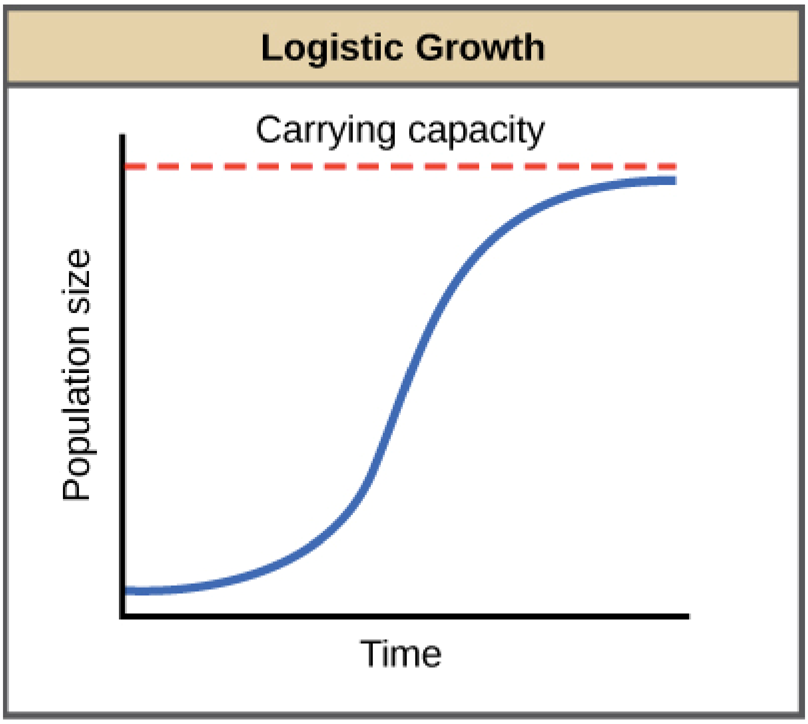
$$\frac{\Delta N}{\Delta t} = rN.$$

r_{max}r, start subscript, m, a, x, end subscript is the maximum per capita rate of increase for a particular species under ideal conditions, and it varies from species to species. For instance, bacteria can reproduce much faster than humans, and would have a higher maximum per capita rate of increase. The maximum population growth rate for a species, sometimes called its biotic potential, is expressed in the following equation:

Logistic growth

Exponential growth is not a very sustainable state of affairs, since it depends on infinite amounts of resources.

Exponential growth may happen for a while, if there are few individuals and many resources. But when the number of individuals gets large enough, resources start to get used up, slowing the growth rate. Eventually, the growth rate will plateau, or level off, making an S-shaped curve. The population size at which it levels off, which represents the maximum population size a particular environment can support, is called the carrying capacity, or K.



S-Shaped curve representing logistic growth

Such type of growth is represented by following equation:

$$\frac{\Delta N}{\Delta t} = rN\left(\frac{K-N}{K}\right).$$

Factors determine carrying capacity

Basically, any kind of resource important to a species' survival can act as a limit. For plants, the water, sunlight, nutrients, and the space to grow are some key resources. For animals, important resources include food, water, shelter, and nesting space. Limited quantities of these resources results in competition between members of the same population, or intraspecific competition (intra- = within; -specific = species).

Intraspecific competition for resources may not affect populations that are well below their carrying capacity—resources are plentiful and all individuals can obtain what they need. However, as population size increases, the competition intensifies. In addition, the accumulation of waste products can reduce an environment’s carrying capacity.

Examples of logistic growth

Yeast, a microscopic fungus used to make bread and alcoholic beverages, can produce a classic S-shaped curve when grown in a test tube. In the graph shown below, yeast growth levels off as the population hits the limit of the available nutrients. (If we followed the population for longer, it would likely crash, since the test tube is a closed system – meaning that fuel sources would eventually run out and wastes might reach toxic levels).

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