Chapter 8 Understanding Populations

Section 1: How Populations Change in Size

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Objectives

- **Describe** the three main properties of a population.
- **Describe** exponential population growth.
- **Describe** how the reproductive behavior of individuals can affect the growth rate of their population.
- **Explain** how population sizes in nature are regulated.

What Is a Population?

- A **population** is a group of organisms of the same species that live in a specific geographical area and interbreed.
- A population is a reproductive group because organisms usually breed with members of their own population.
- The word *population* refers to the group in general and also to the size of the population, or the number of individuals it contains.

Properties of Populations

- **Density** is the number of individuals of the same species in that live in a given unit of area.
- **Dispersion** is the pattern of distribution of organisms in a population. A population's dispersion may be even, clumped, or random.
- Size, density, dispersion, and other properties can be used to describe populations and to predict changes within them.

How Does a Population Grow?

- A population gains individuals with each new offspring or birth and loses them with each death.
- The resulting population change over time can be represented by the equation below.

- **Growth rate** is an expression of the increase in the size of an organism or population over a given period of time. It is the birth rate minus the death rate.
- Overtime, the growth rates of populations change because birth rates and death rates increase or decrease.
- For this reason, growth rates can be positive, negative, or zero.
- For the growth rate to be zero, the average number of births must equal the average number of deaths.
- A population would remain the same size if each pair of adults produced exactly two offspring, and each of those offspring survived to reproduce.
- If the adults in a population are not replaced by new births, the growth rate will be negative and the population will shrink.

How Fast Can a Population Grow?

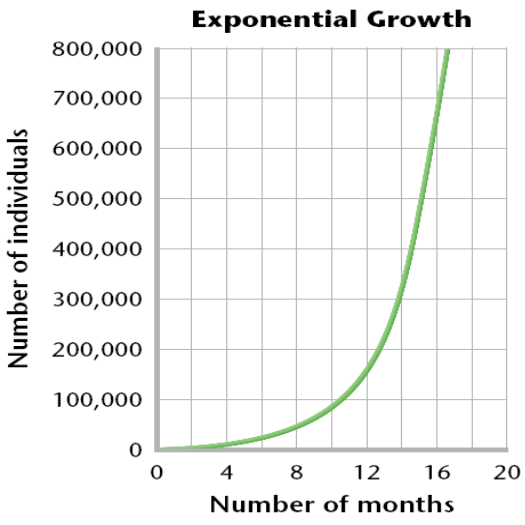
- Populations usually stay about the same size from year to year because various factors kill many individuals before they can reproduce.
- These factors control the sizes of populations.
- In the long run, the factors also determine how the population evolves.

Reproductive Potential

- A species' biotic potential is the fastest rate at which its populations can grow. This rate is limited by reproductive potential.
- **Reproductive potential** is the maximum number of offspring that a given organism can produce.
- Some species have much higher reproductive potentials than others. Darwin calculated that it could take 750 years for a pair of elephants to produce 19 million descendants. While bacteria could produce that in a few days or weeks.
- Reproductive potential increases when individuals produce more offspring at a time, reproduce more often, and reproduce earlier in life.
- Reproducing earlier in life has the greatest effect on reproductive potential.
- Reproducing early shortens the generation time, or the average time it takes a member of the population to reach the age when it reproduces.
- Small organisms, such as bacteria and insects, have short generation times and can reproduce when they are only a few hours or a few days old.
- As a result, their populations can grow quickly.
- In contrast, large organisms, such as elephants and humans, become sexually mature after a number of years and therefore have a much lower reproductive potential than insects.

Exponential Growth

- **Exponential growth** is logarithmic growth or growth in which numbers increase by a certain factor in each successive time period.
- Exponential growth occurs in nature only when populations have plenty of food and space, and have no competition or predators.
- For example, population explosions occur when bacteria or molds grow on a new source of food.
- In exponential growth, a large number of individuals is added to the population in each succeeding time period.

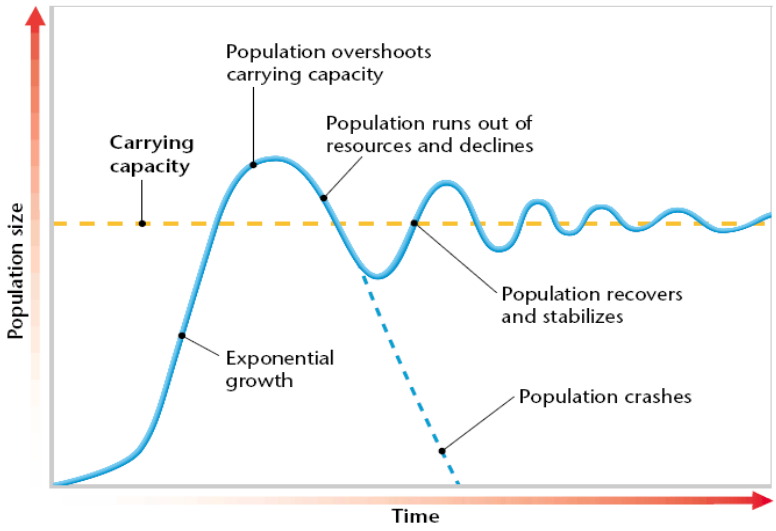


What Limits Population Growth?

- Because natural conditions are neither ideal nor constant, populations cannot grow forever.
- Eventually, resources are used up or the environment changes, and deaths increase or births decrease.
- Under the forces of natural selection in a given environment, only some members of any population will survive and reproduce. Thus, the properties of a population may change over time.

Carrying Capacity

- **Carrying capacity** is the largest population that an environment can support at any given time.
- A population may increase beyond this number but it cannot stay at this increased size.
- Because ecosystems change, carrying capacity is difficult to predict or calculate exactly. However, it may be estimated by looking at average population sizes or by observing a population crash after a certain size has been exceeded.



Resource Limits

- A species reaches its carrying capacity when it consumes a particular natural resource at the same rate at which the ecosystem produces the resource.
- That natural resource is then called a *limiting resource.*
- The supply of the most severely limited resources determines the carrying capacity of an environment for a particular species at a particular time.

Competition Within a Population

- The members of a population use the same resources in the same ways, so they will eventually compete with one another as the population approaches its carrying capacity.
- Instead of competing for a limiting resource, members of a species may compete indirectly for social dominance or for a territory.
- Competition within a population is part of the pressure of natural selection.

Competition Within a Population cont.

- A territory is an area defended by one or more individuals against other individuals.
- The territory is of value not only for the space but for the shelter, food, or breeding sites it contains.
- Many organisms expend a large amount of time and energy competing with members of the same species for mates, food, or homes for their families.

Two Types of Population Regulation

- Population size can be limited in ways that may or may not depend on the density of the population.
- Causes of death in a population may be density dependent or density independent.

Population Regulation

- When a cause of death in a population is density dependent, deaths occur more quickly in a crowded population than in a sparse population.
- This type of regulation happens when individuals of a population are densely packed together.
- Limited resources, predation and disease result in higher rates of death in dense populations than in sparse populations.

Population Regulation

- When a cause of death is density independent, a certain proportion of a population may die regardless of the population's density.
- This type of regulation affects all populations in a general or uniform way.
- Severe weather and natural disasters are often density independent causes of death.