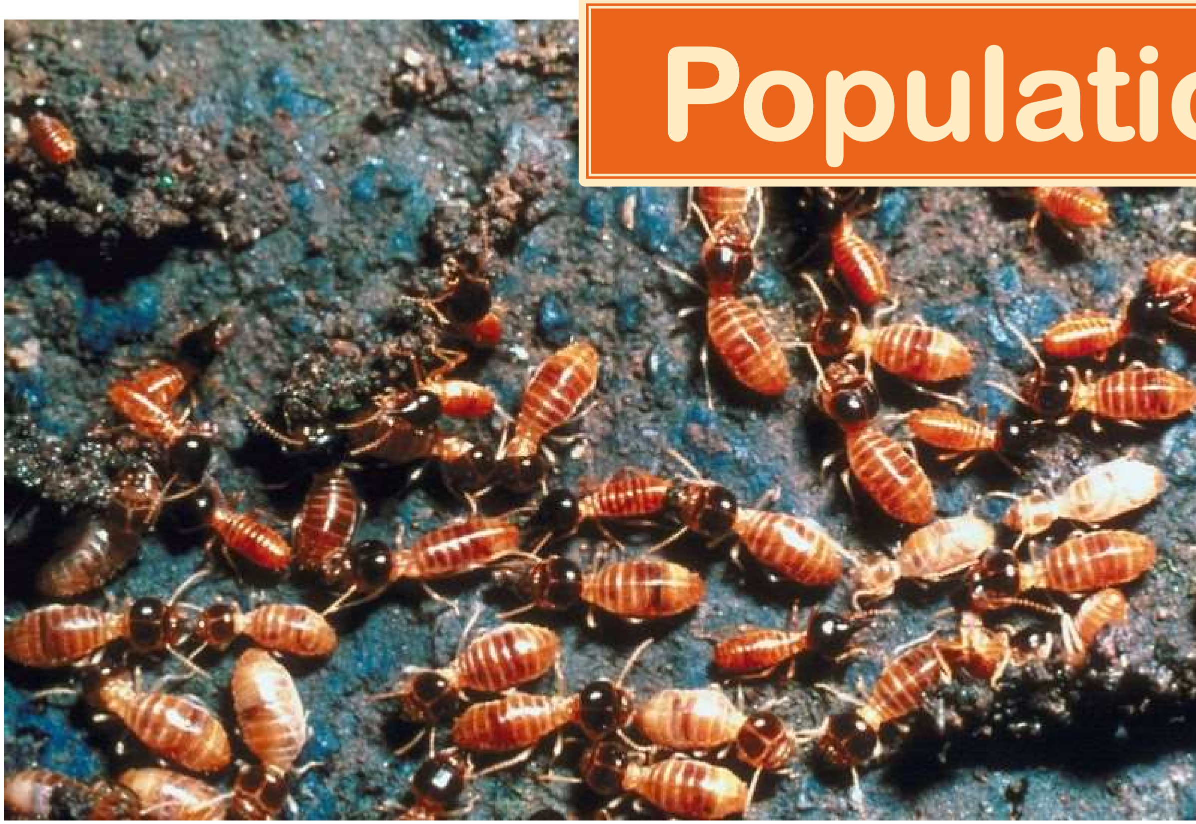
# Population Dynamics



All populations are dynamic, meaning that they: change in size and composition over time.

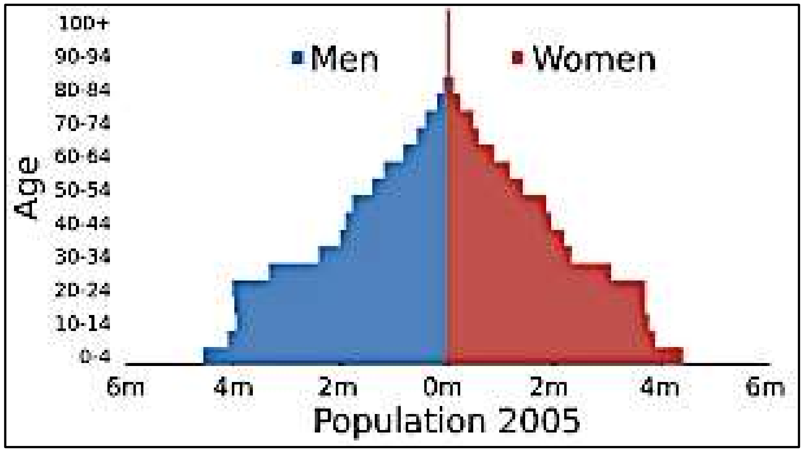
To understand the changes that are taking place in a population, the following must be considered:

1. Birth rate:
   the number of births occurring in a given period of time.
2. Death rate or mortality rate:
   the number of deaths in a given period of time.
3. Life expectancy:
   the length of time an individual is expected to live.

# Age Structure

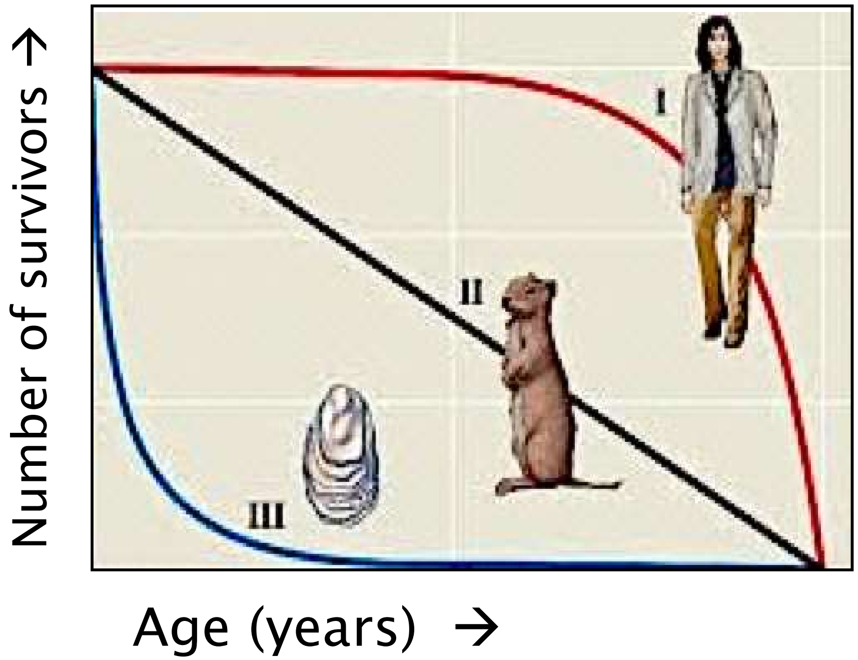
Age Structure:
The distribution of individuals among different ages in a population.

The future growth of a population is predicted using "age-structure diagrams."
For example, a population with a large number of very young individuals is predicted to have a higher growth rate in the future when these individuals reach reproductive age.




Age structures are often presented in [graphs](graphs).

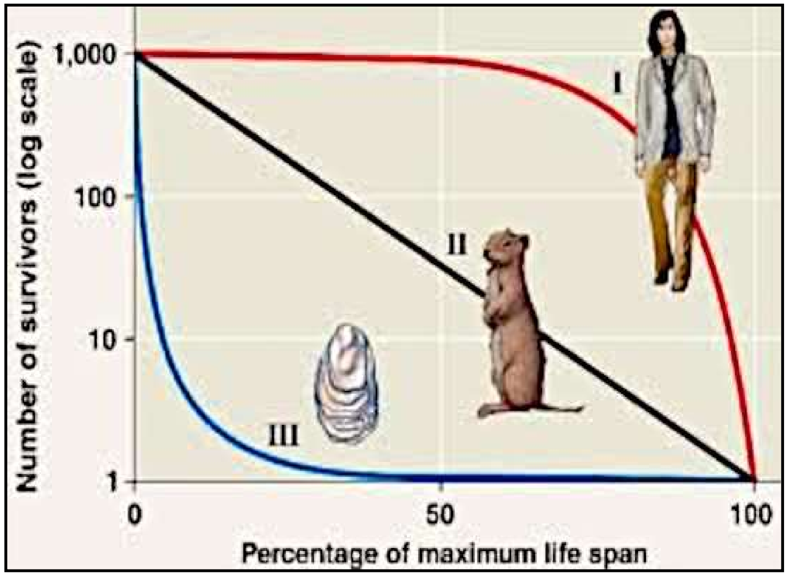
# Patterns of Mortality




The mortality rate of the individuals in the population generally follows one of the following patterns.

These are called _survivorship curves_ because they show the likelihood of _survival_ at different _ages_ throughout the lifetime of the organism.

# Type I Survivorship Curve:

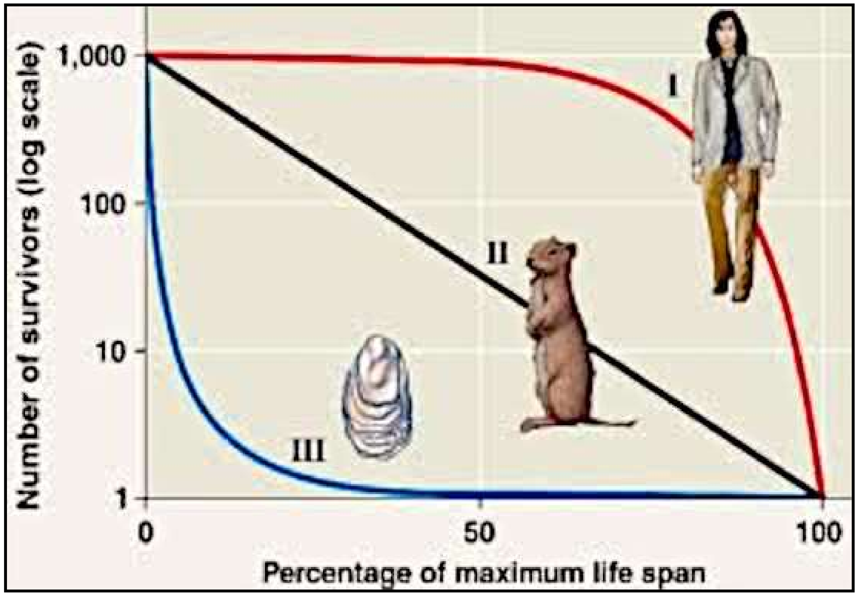



a) This curve is: flat at the start, indicating a low death rate in the early and middle stages of life.

b) It drops steeply near the end indicating: a high death rate as the organisms become older.

c) An example is large mammals that produce very few offspring, but provide them with good care.

# Type II Survivorship Curve:



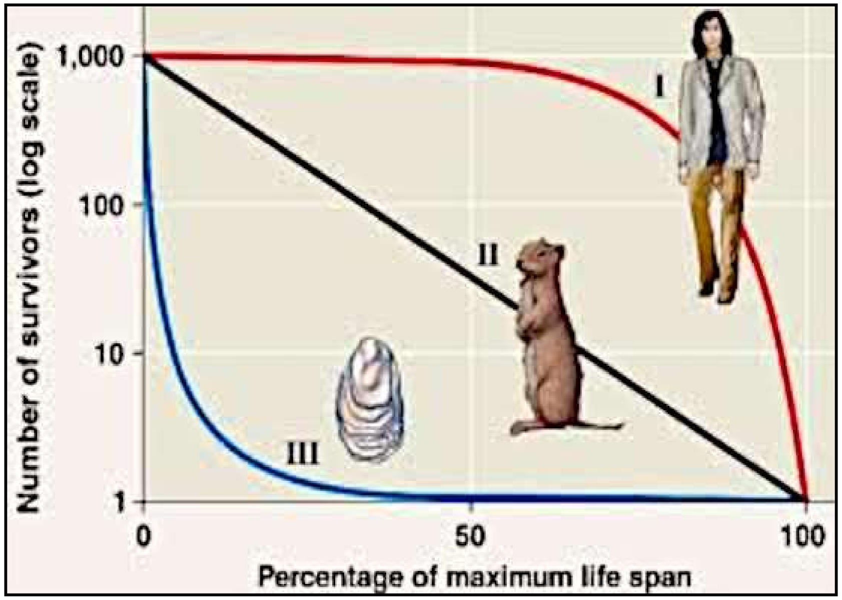

a) This curve is: intermediate to the above 2 curves.

b) There is a constant *death rate* over the organism's life span.

c) The probability of dying does not change throughout life.

d) This may occur in rodents and lizards.

# Type III Survivorship Curve:

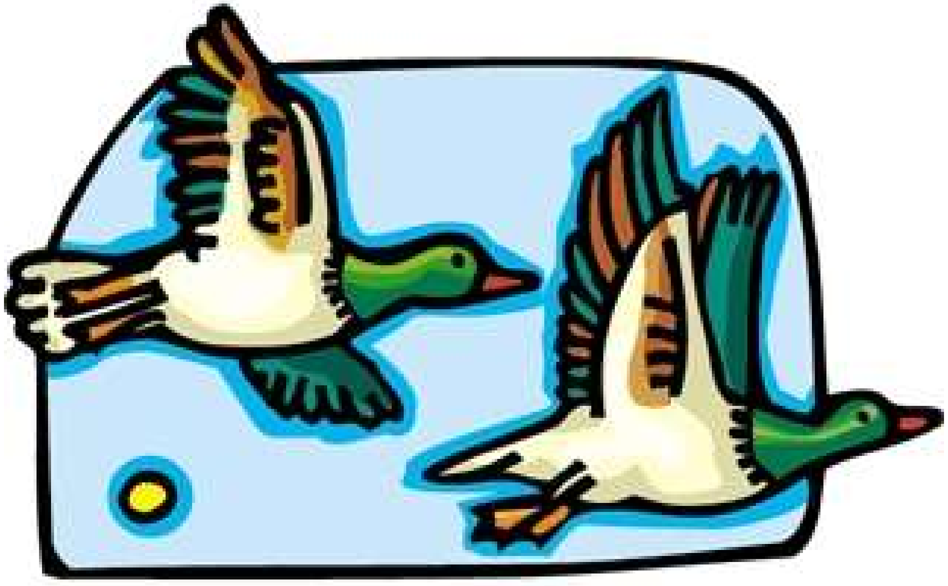



a) This curve drops sharply at the start, indicating:
a high death rate among the young.

b) It flattens out as death rates:
decline for the few that do survive the early die-off.

c) This would include organisms that produce:
large numbers of offspring, but provide them with little or no care.

d) Examples include:
fishes, many plants, and most marine invertebrates.



Two processes increase the size of the population: birth rate and immigration.

Two processes decrease the size of the population: death rate and emigration.

# When studying population density, some questions to be answered are:

1. Why is the birth rate unusually high (or low)?

2. Why are more individuals dying than normal?

3. Is there a reason for an unusually high immigration or emigration?

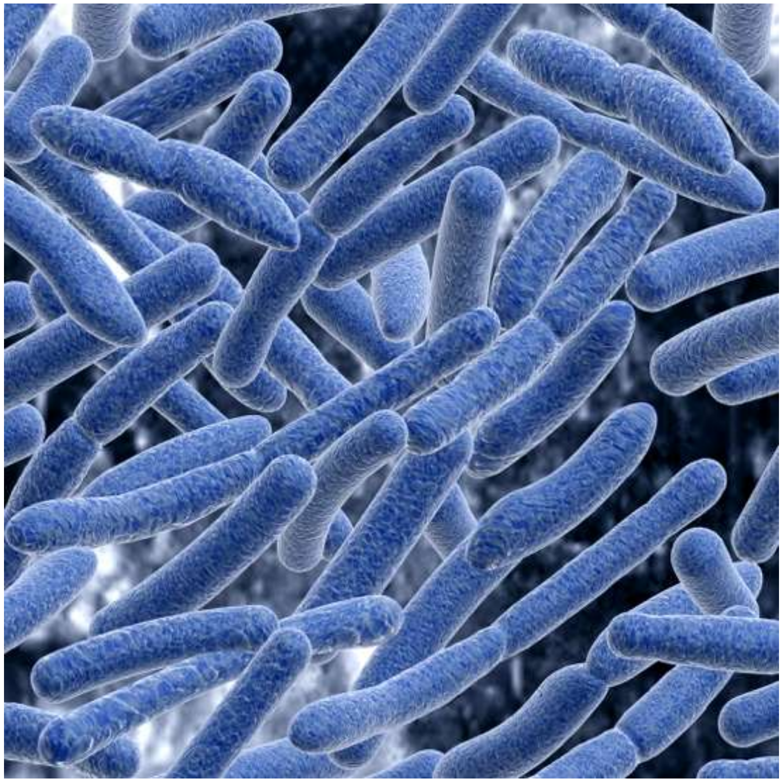
# Exponential Growth

Under what conditions would rapid growth occur in a population?

- ✧ There would have to be plenty of space and an abundance of food.
- ✧ There could be no predators or disease.

If all factors for reproduction and growth are ideal, the population might grow exponentially.

Exponential growth describes a population that is increasing rapidly. The larger the population gets, the faster it grows.

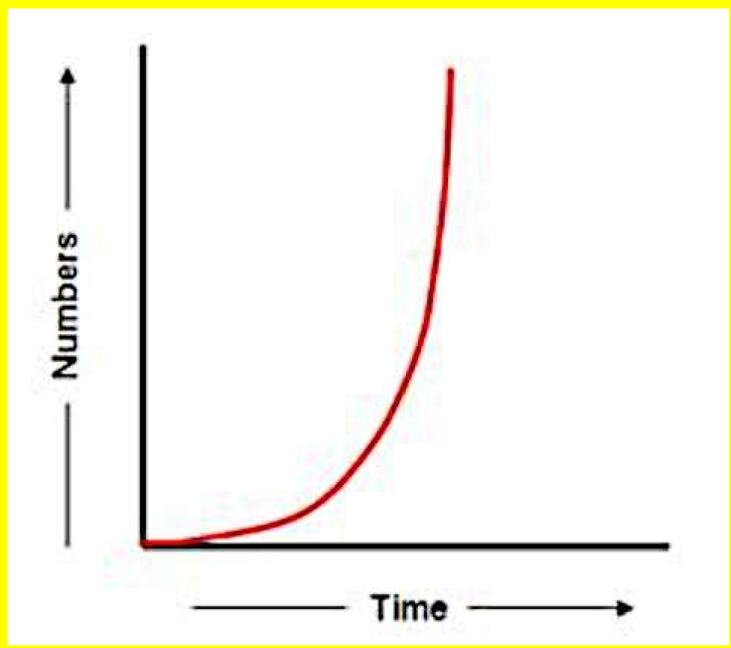


For example: A single bacterium can reproduce by dividing into *two* cells every 20 minutes.

At the end of the first 20 minutes, there would be two bacterial cells.

At the end of 40 minutes, *four* cells will have been produced, and by the end of the first hour, there would be *eight* cells.

This growth doesn't seem too impressive at first.
But, if the number of cells doubles every 20 minutes, then at the end of one day the colony would contain $4.72 \times 10^{21}$ cells (4,720,000,000,000,000,000,000 cells!)



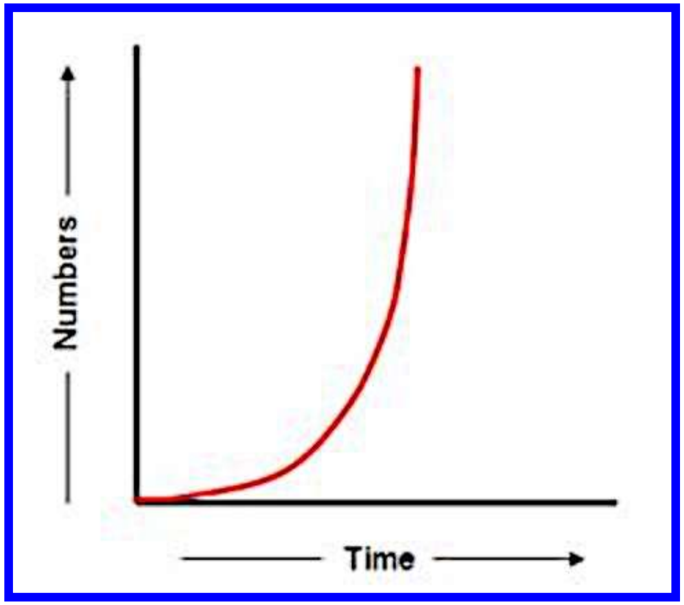

Exponential Growth:
This occurs when the members of the population are reproducing at a constant rate.

At first, the population seems to be growing **slowly**, but over time, the power of exponential growth can produce a population of extremely **large** size.

Under **ideal** conditions, with **unlimited** resources, a population will grow exponentially.

When exponential growth is viewed on a graph, the pattern of growth is a J-shaped curve.

A J-shaped curve indicates the population is growing exponentially.




In reality, populations cannot continue to grow exponentially for very long.

Resources will become scarce and wastes will accumulate, limiting growth.

In addition, competition for the limited resources will intensify as the population grows.

## Limiting Factor:

Any factor that restrains the growth of a population. Limiting factors may be space to grow, food, water, etc.

# Carrying Capacity

Exponential growth does NOT continue in natural populations for very long.

At first a population may appear to be experiencing exponential growth, but as resources become less available, the growth of the population will slow or stop.

# How will resources be limited during the growth of the population?

a) Food will become:
more and more scarce.

b) There may be:
water shortages.

c) A _disease_ might be introduced into the population.

d) The population will:
run out of space.

e) Additional _predators_ may be attracted to the rising _prey_ population.

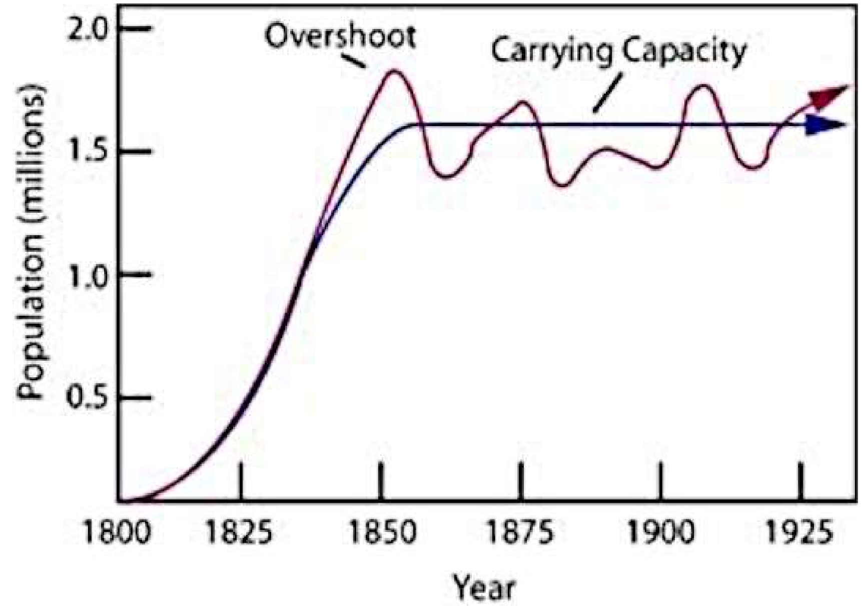
f) There will be increased _competition_ between the members of the group.

g) The accumulation of:
wastes could lead to an increase in diseases and poor health.

Eventually a growing population will reach the *carrying capacity* of the environment.

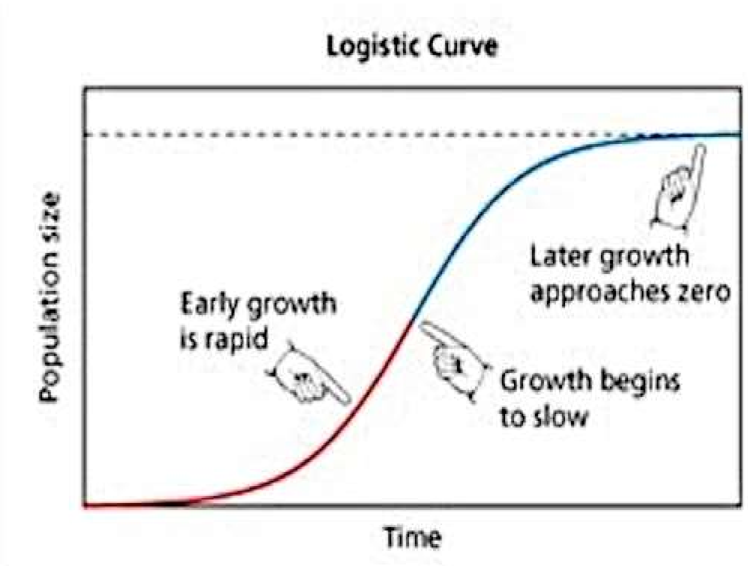
The carrying capacity is: the number of individuals the environment can support over a long period of time.

The overshoot in the graph to the right indicates that the population has exceeded the carrying capacity of the environment. Many members of the population will die or starve, causing the population size to drop below the carrying capacity.




The size of the population will fluctuate above and below the carrying capacity of the environment.

# Logistic Growth

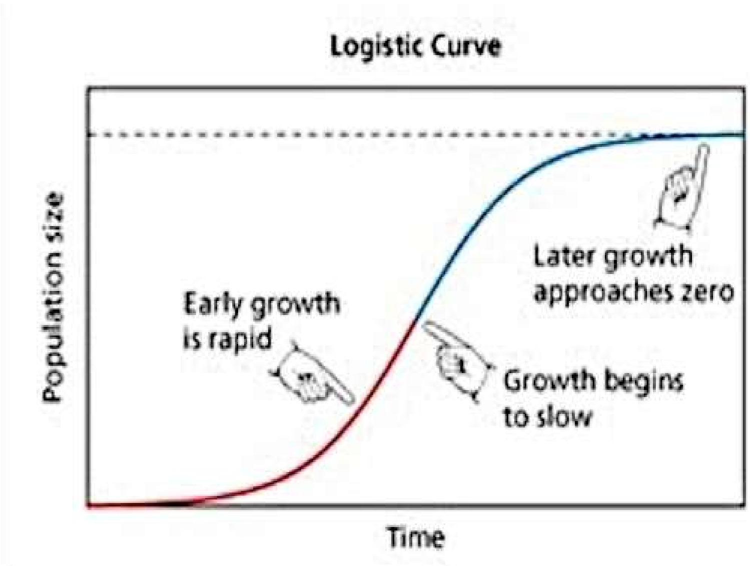



**A graph of logistic growth looks like a stretched out** letter "S"**.**

## Logistic Growth:

A model of population growth in which growth slows or stops following a period of exponential growth.

# Logistic Growth



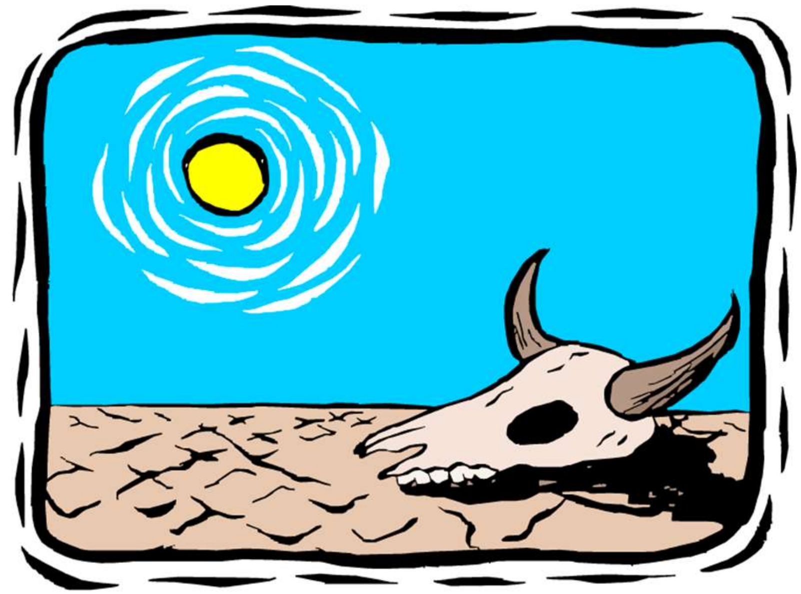

When the population size is _small_, birth rates are _high_ and death rates are _low_, causing the population to grow nearly _exponentially_.

When the population is at the carrying capacity: the birth rate equals the death rate, and growth stops.

As the population reaches the carrying capacity, the growth rate _slows_.

# Assumptions of the Exponential Model and the Logistic Mode

One assumption made by both models is that:
the carrying capacity is constant and does not fluctuate.
In reality, the carrying capacity changes with the environment.
During a drought in a prairie, there would be less vegetation. Fewer prairie dogs would survive since there is less plant matter to eat. The carrying capacity is *lower than normal.*



The exponential model and the logistic model are not accurate representations of real populations, but they are:
useful tools that scientists can use to study populations.

# Limits to Growth

No population can undergo exponential growth forever.

There are…

…limits to how fast and how big a population can grow.

Examples of limiting factors include:

1. Competition
2. Predation
3. Parasitism and disease
4. Drought and other climate extremes
5. Human disturbances

## Limiting Factors:

A limiting factor is a factor that causes population growth to decrease.

1. A limiting factor that depends on population size is called a density-dependent limiting factor.

# Density-Dependent Factors

2. This means that the limiting factor only becomes "limiting" when: the population density reaches a certain level.

Population density refers to the …

… number of organisms per unit area.

Density-dependent limiting factors include:

- ✓ competition
- ✓ predation
- ✓ parasitism and disease
- ✓ shortages of food
- ✓ shortage of nesting sites.

As a population becomes more and more crowded, organisms will have to compete with one another for: food, water, sunlight, space to grow, and nesting sites.


Competition is a *density-dependent factor.*

The more individuals that live in the population: the sooner they will use up the available resources.

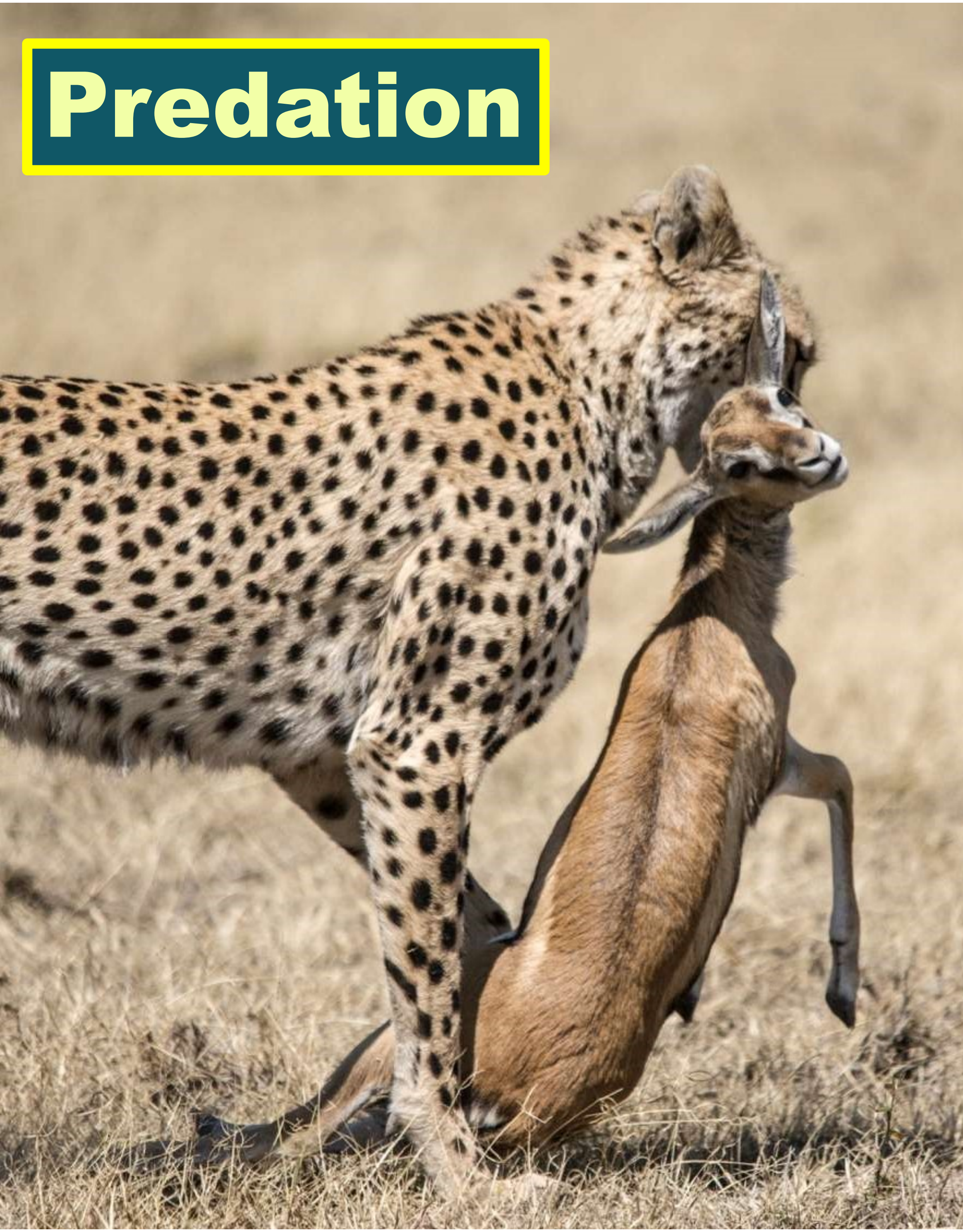
The greater the population size becomes, the more *intense* the competition for resources.

Competition may also occur between populations consisting of separate species.

# Predation

Predation: The interaction between two different organisms in which one captures and feeds on the other.

# Predation



Predator: In a predator-prey relationship, the predator is:
the organism that feeds upon the other.

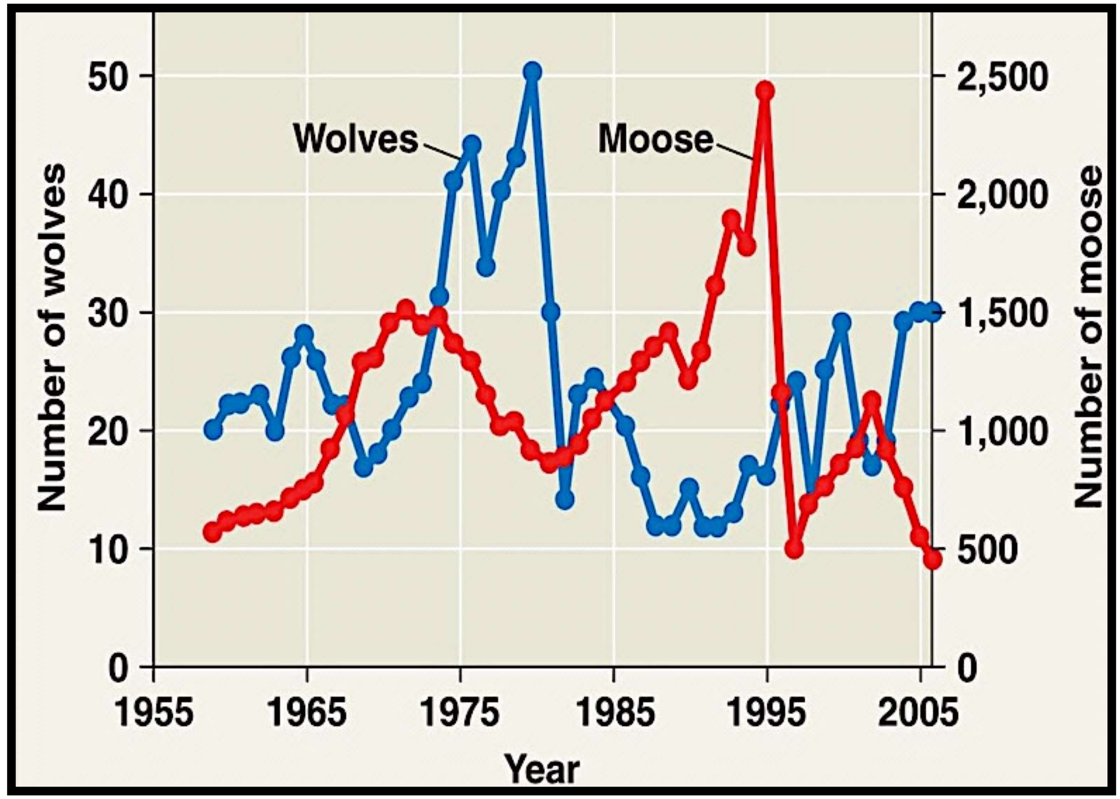
Prey: In a predator-prey relationship, the prey is:
the organism that is the food source for the other.

The predator–prey relationship is one of the best known methods of …

… controlling the size of a population.

Study the graph to the right. Notice that an increase in prey population is followed by an increase in predator population.

As the predator population increases, they kill more prey, and the prey population drops.




As the prey population drops, the predators have less food to eat, so the predator population declines.

This relationship controls: the size of each population.

# Parasitism and Disease

1. Parasite:
   An organism that feeds upon another living organism.
2. Host:
   The organism that the parasite feeds upon.

3. This is very similar to a predator-prey relationship, and can also control the size of the population.

4. The parasite takes nourishment and nutrition from the host. The host is weakened and may eventually die.

# Territoriality

A territory is a space that …

… an animal defends against encroachment by other individuals, usually of its own species.

The territory becomes a resource for which individuals must compete.

The benefit of a territory is that the "owner" of the territory has:

***unlimited use of the resources found there without competition from others.***

The density-independent factors affect:
all populations in similar ways, regardless of the size of the population.

# Density-Independent Factors

Examples of density-independent factors include:

a) Unusual weather or natural disasters such as floods and fires.

b) Certain human activities, such as the damning of a river, or clear-cutting a forest.

# These factors (fires, floods, etc.) would affect ….
# ….. any population of any size.

In response to density-independent factors, populations may experience a "crash" where the population is nearly eliminated.

If one population is nearly decimated, it may also affect another population if the second population depends on the first as a food source.