Population Growth Patterns

Predict What might happen to populations that cannot get enough resources?

Imagine you leave an apple in your locker over winter break. Upon your return to school, you open your locker door to find a cloud of fruit flies. When you left school, the fly population in your locker was zero—now it's at least 100! Your locker ecosystem had a huge change in its fruit fly population. This, hopefully, is not a normal occurrence in your locker, but changes in population sizes and densities in ecosystems are normal responses to changes in resource availability.

Population Size

FIGURE 6: A population of elephants has both young and old individuals.

How might biologists track the population size of a species, such as a group of elephants? To accurately track the population over time, they would need to account for four factors: immigration, emigration, births, and deaths.

Immigration and emigration have to do with individuals entering and leaving a population. For example, if a disturbance occurred in a nearby habitat, some elephants might immigrate, or move into, a new population. Then, competition could increase, causing some elephants to move out of the population, or emigrate, to a new area.

Births and deaths also change a population size over time. Individuals have offspring, which adds more members to the population. Some individuals die each year, which reduces the population.

Explain Which factors lead to an increase in a population, and which factors lead to a decrease in a population?

The growth rate of a population can be measured with an equation that takes into account these four factors:

$$r = (b + i) - (d + e)$$

In this equation, r = population growth rate, b = birth rate, i = immigration rate, d = death rate, and e = emigration rate. We can apply these factors to our locker ecosystem example. A small population of fruit flies immigrated into the locker in search of food. The population increased due to the birth of a new group of fruit flies. Those flies that did not die when you swatted them in surprise emigrated away from the locker when you threw the apple away.

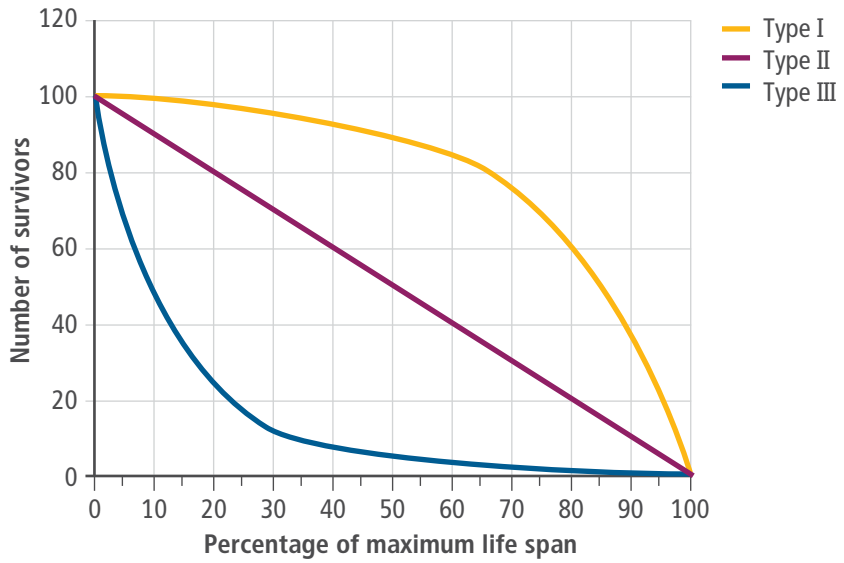
Problem Solving As part of a long-term elephant study, biologists counted individuals in a population of elephants each spring. In one year, there were 18 males and 34 females. Over the following year, each female gave birth, from which 28 offspring survived. Predators killed 9 elephants. A construction project cleared 50 acres of nearby forested land, causing 5 males and 19 females to immigrate into the study area. Competition for females increased, resulting in the emigration of 10 males to a new territory in search of mates. Calculate the growth rate of this population.

Survivorship Curves

Biologists are also interested in the reproductive strategy of a population. Reproductive strategies include behaviors that can improve the chances of producing offspring or behaviors that can increase the survivorship rate of offspring after birth. Parental care is an example of a reproductive strategy. Parental care is especially important for species that produce offspring that cannot take care of themselves. By protecting their young, parents are better able to make sure their young stay alive until they can survive on their own. A population's reproductive strategies can be assessed using a survivorship curve. Figure 7 shows the three types of survivorship curves.

Survivorship Curves

FIGURE 7: There are three main types of survivorship curves.



A survivorship curve is a simplified diagram that shows the number of surviving individuals over time from a measured set of births. By measuring the number of offspring born in a year and following those offspring through until death, survivorship curves give information about the life history of a species.

Some species have a small number of offspring, and many of the offspring live long enough to reach old age. Mammals and other large animals generally exhibit this Type 1 survivorship curve. Other species have a large number of offspring, but many of these offspring do not survive long enough to reproduce. Many invertebrates, fish, and plants exhibit this Type III survivorship. A fish may lay hundreds or thousands of eggs, but only a small percentage of its offspring will survive to adulthood.

Between these two extremes is a third type of survivorship, in which the survivorship rate is roughly equal at all stages of an organism's life. At all times, these species have an equal chance of dying, whether from disease or as a result of predation. Organisms such as birds, small mammals, and some reptiles exhibit this Type II survivorship.

Analyze Can a survivorship curve be used to determine whether or not a species cares for their young? Explain your answer.

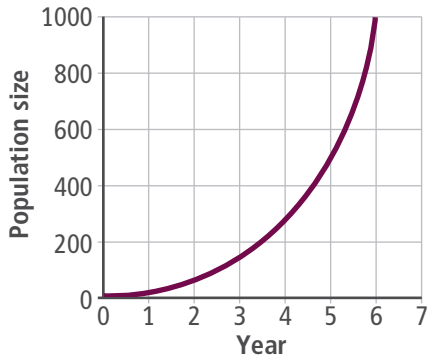
Collaborate With a partner, discuss which type of survivorship humans exhibit.

Exponential and Logistic Growth

Population growth depends on the environment and available resources. The rate of growth for a population is directly determined by the amount of available resources. A population may grow very rapidly, or it may grow slowly over time.

Analyze According to the graph in Figure 8, during which time period is population growth occurring at the fastest rate?

FIGURE 8: Exponential Growth



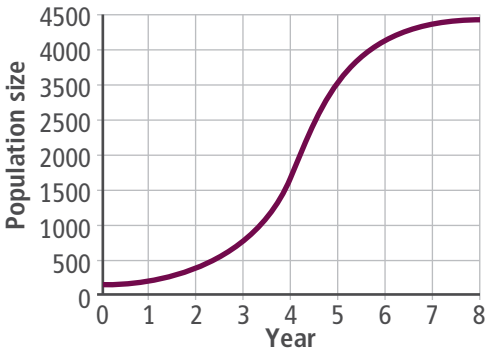
Exponential Growth

Almost any species that lives in ideal conditions of available resources, space, and other factors will rapidly increase in population. This type of growth, called exponential growth, occurs when a population size increases dramatically over a relatively short amount of time. As shown in Figure 8, a graph of exponential growth looks like a J-shaped curve.

Exponential growth may occur when a species moves into a previously uninhabited area. A real-world example of exponential growth in a population occurred in 1859, when an Australian landowner brought 24 rabbits into the country for sport hunting and released them into the wild. With no predators, abundant space, and plentiful resources, the rabbit population grew exponentially and spread across the country. After many unsuccessful attempts to control the population, Australian officials estimate today's population to be between 100 and 200 million rabbits.

Analyze According to the graph in Figure 9, when would you expect competition among individuals to be the least?

FIGURE 9: Logistic Growth



Logistic Growth

When a population is growing exponentially, resources are plentiful and there are no factors to interfere with survivability. However, most populations face limited resources and thus show a logistic growth pattern. During logistic growth, a population begins with a period of slow growth followed by a period of exponential growth before leveling off at a stable size. A graph of logistic growth takes the form of an S-shaped curve, as shown in Figure 9. During the initial growth period, resources are abundant, and the population is able to grow at a quick rate. Over time, resources are reduced, and growth starts to slow. As resources become even more limited, the population levels off at a size the environment can support.

Explain When wolves were reintroduced into Yellowstone National Park, the populations of many other species began to change.

1. Which factors would scientists want to measure in order to learn how each population changed over time?
2. How would scientists know if populations were increasing or decreasing over time?
3. How might the introduction of wolves change the growth patterns of other species?