

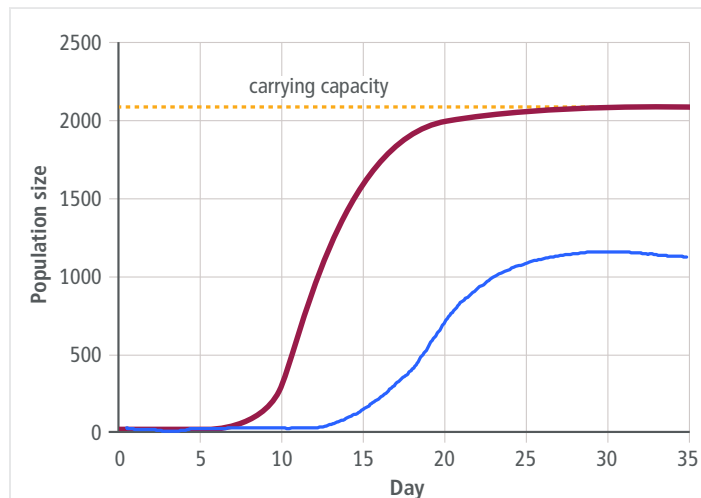
# Factors That Limit Population Growth

Because natural conditions are neither ideal nor constant, populations cannot grow forever. Instead, resources are used up or an ecosystem changes, causing deaths to increase or births to decrease within a population.

## Carrying Capacity

The **carrying capacity** of an environment is the maximum population size of a species that a particular environment can normally and consistently support in terms of resources. As shown in Figure 10, once a population hits this limit, certain factors then keep it from continued growth. These factors include availability of resources such as food, water, and space, as well as competition among individuals.

The carrying capacity of an environment can change at any given time. For example, sudden and rapid flooding could reduce the availability of food or shelter in an ecosystem. This change would lower the environment's carrying capacity. As a result, fewer individuals would be supported by the environment. When conditions improve, however, the carrying capacity would increase, and the environment would again be able to support a larger population of that particular species.



**FIGURE 10:** An environment's carrying capacity limits the growth of a population.



**Predict** How might this graph change if an ecosystem experienced drought conditions?

## Limiting Factors

Many factors can affect the carrying capacity of an environment for a population of organisms. A factor that has the greatest effect in keeping down the size of a population is called a **limiting factor**. There are two categories of limiting factors—density-dependent and density-independent.

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Hands-On Activity

### Modeling Carrying Capacity

Model predation and the effects of environmental changes on a population and the environment's carrying capacity.

niche=  
role in  
ecosystem

## Density-Dependent Limiting Factors

**Density-dependent factors** are factors that are affected by the number of individuals in an area. The larger the population, the greater the effect. Density-dependent limiting factors include the following:

**Competition** Both plants and animals compete among themselves for needed resources. As a population becomes more dense, the resources are used up, limiting how large the population can grow.

**Predation** The relationship between predator and prey in an environment is ongoing and constantly changing. Predator populations can be limited by the number of available prey, and the prey population can be limited by being caught for food.

**Parasitism and disease** Parasites are much like predators as they live off their hosts, weakening them, and even sometimes killing them. Parasites and disease spread more quickly through dense populations. The more crowded an area becomes, the easier it is for parasites and disease to spread.



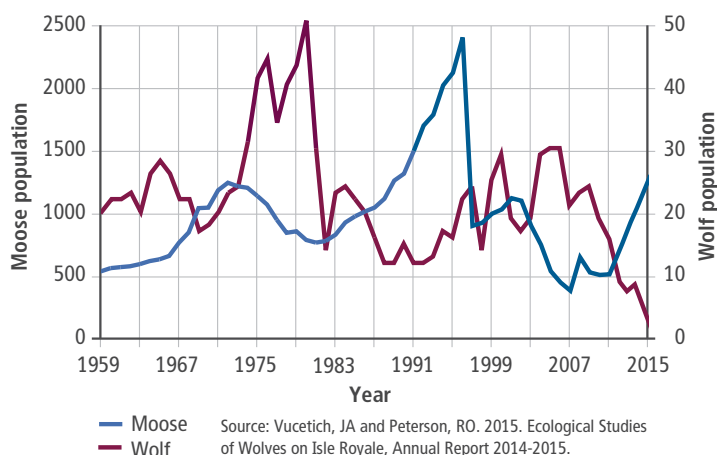
## Data Analysis

### Moose-Wolf Interactions on Isle Royale

For over 50 years, the wolf and moose populations on Isle Royale in Lake Superior served as a classic example of how predator-prey interactions limit population growth. As shown in Figure 11, changes in population size occur in an offset manner. In other words, it takes some time for an increase or decrease in one population to affect the other. Over time, the populations rise and fall in a pattern.

#### Density-Dependent Limiting Factors

**FIGURE 11:** Predator-Prey Interactions on Isle Royale



**Analyze** Study the graph showing the moose-wolf interactions on Isle Royale.

1. Based on this graph, what is the most likely explanation for the increase in the moose population between 1989 and 1995?
2. In 2016, the wolf population on Isle Royale declined to only two individuals. How will the lack of wolves affect the moose population? Will the moose population grow exponentially? Explain your answers.

## Density-Independent Limiting Factors

**Density-independent factors** are factors that can impact a population regardless of its density. These factors include things such as:

**Weather** Any weather-related event such as a drought, flood, frost, or severe storm can wipe out a population or destroy their sources of food, water, or shelter.

**Natural disasters** Volcanic eruptions, earthquakes, tsunamis, and fires usually result in a sudden decrease in population size.

**Human activity** Habitats, and sometimes entire ecosystems, are degraded or even completely destroyed by human activities such as forest clearing, draining of wetlands for land development, and habitat fragmentation by roads and fences.

**FIGURE 12:** Forest fires kill plants and animals and force animal populations to flee.



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### Limiting Factors

Go online to view an animation of limiting factors in an ecosystem.



**Explain** Why is fire considered a density-independent limiting factor?

Human activities have had a significant effect on populations. For example, the introduction of nonnative species has caused population crashes in many parts of the world where biodiversity is an important part of ecosystem stability. Nonnative species are species that are brought into ecosystems in which they do not normally live. In some cases, the nonnative species may outcompete one or more native species for resources. Because of the complex network of ecosystems, such effects could alter the ecosystem food web. In some extreme cases, the extinction of a species may occur.



**Gather Evidence** When wolves were reintroduced into Yellowstone National Park, scientists noticed that the populations of elk and coyotes decreased. They also noticed that populations of beaver and willow trees increased. Describe the factors that might have led to these changes in the different populations, and explain how these factors would affect the carrying capacity of the environment for each species.