

important species. The study of population dynamics focuses on the complex interactions between biotic and abiotic factors that cause variation in population sizes.

### Stability and Fluctuation

Populations of large mammals were once thought to remain relatively stable, but long-term studies have challenged that idea. For instance, the moose population on Isle Royale in Lake Superior has fluctuated substantially since around 1900. At that time, moose from the Ontario mainland 25 km away colonized the island, likely by swimming to it or by walking across the lake when it was frozen over. Wolves, which rely on moose for most of their food, reached the island around 1950 by walking across the frozen lake. The lake has not frozen over in recent years, and both populations appear to have been isolated from immigration and emigration since then. Despite this isolation, the moose population experienced two major increases and collapses during the last 50 years (Figure 53.19).

What factors cause the size of the moose population to change so dramatically? Harsh weather, particularly cold, wet winters, can weaken moose and reduce food availability, decreasing the population size. When moose numbers are low and the weather is mild, food is readily available and the population grows quickly. Conversely, when moose



### Territoriality

Territoriality can limit population density when space becomes the resource for which individuals compete. Cheetahs (*Acinonyx jubatus*) use a chemical marker in urine to warn other cheetahs of their territorial boundaries. The presence of surplus, or nonbreeding, individuals is a good indication that territoriality is restricting population growth.

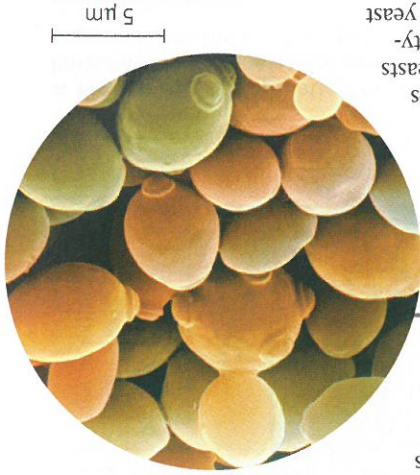


### Intrinsic Factors

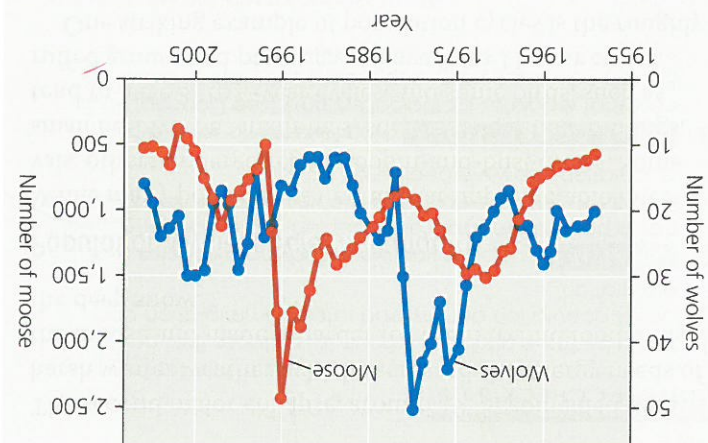
Intrinsic physiological factors can regulate population size. Reproductive rates of white-footed mice (*Peromyscus leucopus*) in a field enclosure can drop even when food and shelter are abundant. This drop in reproduction at high population density is associated with aggressive interactions and hormonal changes that delay sexual maturation and depress the immune system.

### Toxic Wastes

Yeasts, such as the brewer's yeast *Saccharomyces cerevisiae*, are used to convert carbohydrates to ethanol in winemaking. The ethanol that accumulates in the wine is toxic to yeasts and contributes to density-dependent regulation of yeast population size. The alcohol content of wine is usually less than 13% because that is the maximum concentration of ethanol that most wine-producing yeast cells can tolerate.



▲ Figure 53.19 Fluctuations in moose and wolf populations on Isle Royale, 1959–2011.



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numbers are high, factors such as predation and an increase in the density of ticks and other parasites cause the population to shrink. The effects of some of these factors can be seen in Figure 53.19. The first major collapse coincided with a peak in the numbers of wolves from 1975 to 1980.