

Lesson 3: Limiting Factors in Ecosystems

- 20–B1.4k explain how limiting factors influence organism distribution and range; *e.g.*,
- *abiotic factors: soil, relative humidity, moisture, ambient temperature, sunlight, nutrients, oxygen*
 - *biotic factors: competitors, predators and parasites*

In the last lesson we examined specific factors that affect ecosystems.

In this lesson, you will see how these and other factors limit populations and communities within ecosystems.

Biotic Potential

- **Biotic potential** is the maximum number of offspring that a species could produce if resources were unlimited
- A species biotic potential is determined by 4 factors:

			
Factor: birth potential Description: The maximum number of offspring per birth Example: Whooping crane females lay two eggs per year, and usually only one chick survives.	Factor: capacity for survival Description: The number of offspring that reach reproductive age Example: The female sea turtle lays many eggs, but only a few of her offspring even reach the sea, and fewer still reach maturity.	Factor: breeding frequency Description: The number of times that a species reproduces each year Example: Elk mate only once per year, during the fall.	Factor: length of reproductive life Description: The age of sexual maturity and the number of years the individual can reproduce Example: African elephants reach sexual maturity at about 15 years of age, but may reproduce until they are 90.

Ord's Kangaroo Rat

Kangaroo rats are able to breed all year long if conditions are favorable. However, only one or two breeding cycles are common.

Age of reproduction is usually about 83 days old.

Gestation is approximately 30 days, and individual females can have two litters per year.

Litter size averages about 3.5 young per female.

Annual survival rate in a population of kangaroo rats is about 10%

Limiting Factors

- A limiting factor is an abiotic or biotic factor that prevents a species from reaching its biotic potential

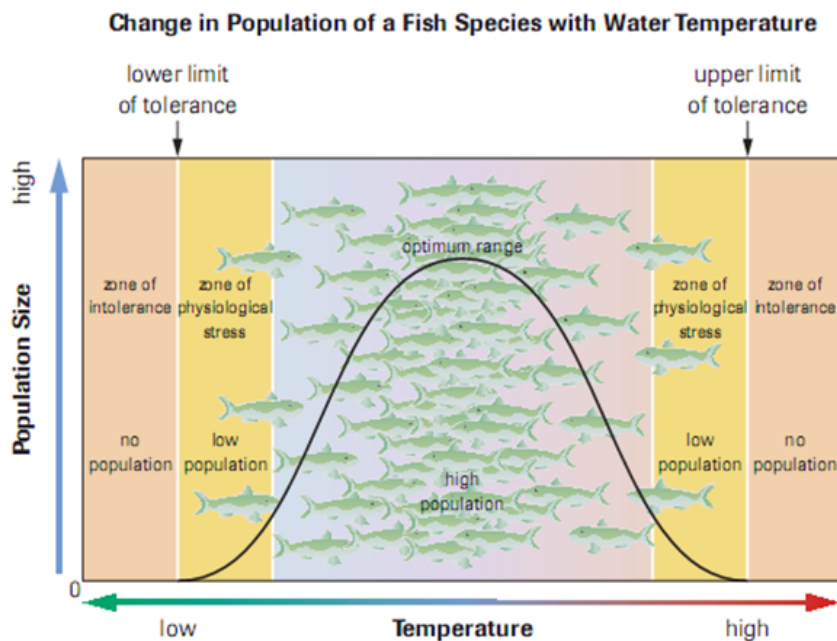
Table 1 Factors That Limit Populations

	Factors that cause a population to increase	Factors that cause a population to decrease
Abiotic	favourable light favourable temperature favourable chemical environment	too much or too little light too cold or too warm unfavourable chemical environment
Biotic	sufficient food low number or low effectiveness of predators few or weak diseases and parasites ability to compete for resources	insufficient food high number or high effectiveness of predators many or strong diseases and parasites inability to compete successfully for resources

- Think about a population of white-tailed deer. In your group, come up with 3 specific examples of limiting factors for each biotic and abiotic. Include a short explanation of how the factor limits the population.

Limits of Tolerance

- survival and reproduction of an organism depend on
 - o the presence of nutrients
 - o the ability of the organism to withstand the abiotic factors in the environment
- **law of the minimum:** the nutrient in least supply is the one that limits growth
- **law of tolerance:** an organism can survive within (tolerate) a certain range of an abiotic factor; above and below the range it cannot survive
 - o greater this range of tolerance, the greater the organism's ability to survive



Density Independent and Density Dependent Factors

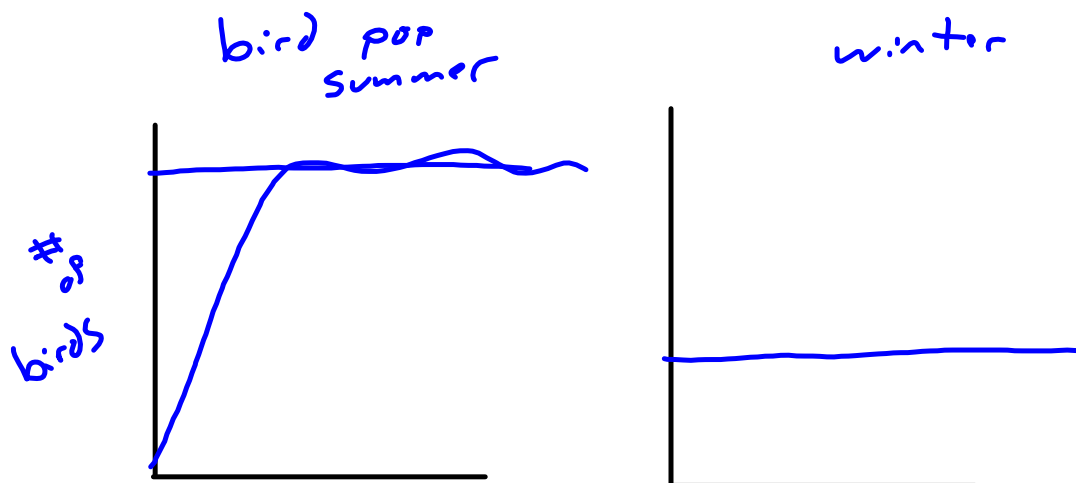
- population density refers to the number of species found in a given area
 - o ex. The density of grizzly bears in Jasper National Park is 11 bears / 1000km²
- Density-independent factors affect members of a population regardless of population density
- Density-dependent factors affect a population because of the density of the population

Table 2 Factors That Cause Changes in Populations

Density-independent factors	Density-dependent factors
<ul style="list-style-type: none"> • flood • fire • spraying with pesticides • change in climate or temperature • destruction of habitat • drought 	<ul style="list-style-type: none"> • food shortage • competition for mates, breeding areas (habitat) • disease caused by a microorganism or parasite • introduction of an exotic species • increased predation • competition for water and other resources

Carrying capacity

- carrying capacity is the maximum number of individuals of a species that can be supported **at the time** by an ecosystem
- A population can exceed the carrying capacity of the ecosystem, but not for long



Lesson 3 Review Questions

1. Four factors regulate population growth. Using an example of a nonhuman population, explain how each factor would affect the population size.

2. Cedar waxwings are one of the few birds that can withstand the cold and lack of available food during our winters. To ease the strains of winter, bird watchers in Lethbridge
 - (a) Would the seeds alter the carrying capacity of the ecosystem? Explain.

 - (b) Provide a hypothesis that explains why bird watchers have noted an increase in the falcon population in recent years.

3. A scientist studying wolves near Canmore notes a steady decline in the population of wolves for four consecutive years.
 - (a) Make a prediction about how the population of wolves will affect the population of moose. Give your reasons.

 - (b) Assuming that humans are not the cause of the wolf population decline, would it be reasonable to conclude that the wolf population will continue to decline until there are
 - (c) What might cause the wolf population to begin increasing again?

 - (d) Using a flow chart, explain how changes in the wolf population would affect the plant community surrounding Canmore.

1. (a) Create a table like Table 3 and classify the following information within it.

- Larger mammals generally live longer than smaller ones.
- Pregnant female elephants carry their young for nearly 18 months.
- Elephants reach sexual maturity at 15 years.
- Elephants usually produce one offspring each birth.
- Most elephants wait more than 5 years between births.
- Female elephants care for their young for more than 10 years.
- Mice often produce litters of 6 or more.
- After about 6 weeks, mice reach sexual maturity.
- In a natural setting few mice are older than 2 years.
- A pregnant female mouse will carry her young for 22 days.
- Mice will breed every 6 weeks or less.

Biotic potential	Elephant	Mouse
birth potential		
capacity for survival		
breeding frequency		
maturity		

(b) Refer to your table and write a paragraph comparing the biotic potentials of elephants and mice.

2. A researcher conducts a study to find a possible biological control for pine bark beetles, an insect considered a pest by the forestry industry. The researcher sets up four different studies of predators and the pine bark beetle. The populations of prey and predator are monitored over many different generations. The graphs in Figure 4 show changes in populations over time.

(a) Which species is most likely the best controlling agent? Give your reasons.

(b) Sometimes the eggs of a predator are eaten by its prey. Which predator might serve as a food source for its prey? Give your reasons.

