

2.3

KEY CONCEPT

Ecosystems are always changing.

BEFORE, you learned

- Populations in an ecosystem interact in different ways
- Organisms can benefit from interactions in an ecosystem
- Organisms can be harmed by interactions in an ecosystem

NOW, you will learn

- How different factors affect the size of a population
- How biological communities get established
- How biological communities change over time

VOCABULARY

limiting factor p. 64
carrying capacity p. 65
succession p. 66
pioneer species p. 66

EXPLORE Population Growth

How does sugar affect the growth of yeast?

PROCEDURE

- 1 Use a marker to label the cups A, B, C. Pour 150 mL of warm water into each cup. Mark the water level with the marker.
- 2 Add 1/2 teaspoon of dry yeast to each plastic cup and stir.
- 3 Add 1/4 teaspoon of sugar to cup B. Add 1 teaspoon of sugar to cup C. Stir.
- 4 Wait 15 minutes. Measure the height of the foam layer that forms in each cup.

MATERIALS

- 3 clear plastic cups
- warm water
- sugar
- dry yeast
- measuring spoons
- measuring cup
- stirring rod
- marker
- ruler



WHAT DO YOU THINK?

- Which cup had the most foam, which cup had the least?
- Describe the effect of sugar on a population of yeast.



Populations change over time.

You may have a strong memory of a park you visited as a little child. You remember collecting pine cones, listening to woodpeckers, and catching frogs. Then you visit again, years later, and the park has changed. Maybe more land has been added, there are more birds and trees. Or maybe the area around the park has been developed. There seem to be fewer woodpeckers, and you can't find any frogs. The community has changed. There are a lot of factors that affect the populations within a biological community. Some have to do with the organisms themselves. Others relate to the habitat.

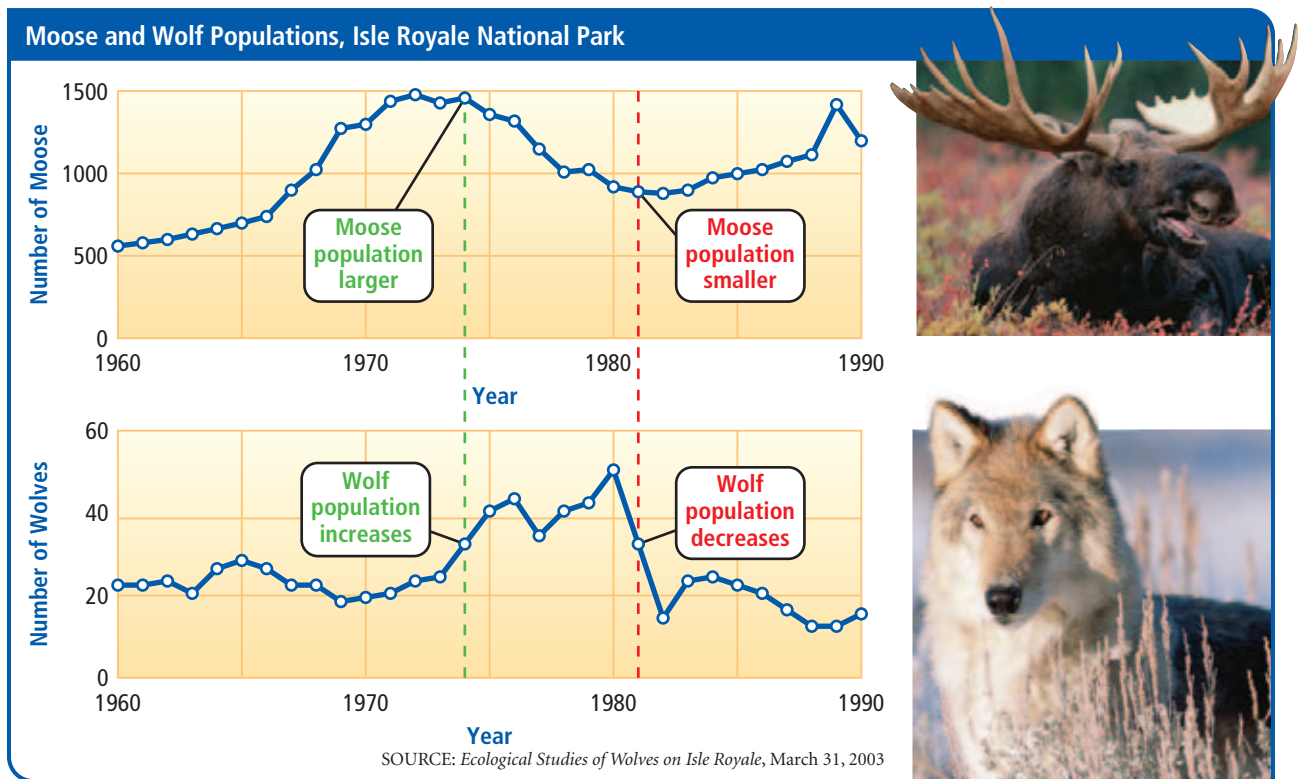
REMINDER

A *population* is a group of organisms of the same species that live together in the same habitat.

Population Growth and Decline

One factor that obviously affects population size is how often organisms reproduce. Birth rate is a measure of the number of births in an animal population. It can also be a measure of the stability of an ecosystem. For example, black bears reproduce once every two years. If there is not enough food available, however, the female bear's reproductive cycle is delayed, and the bear population does not grow.

Predator-prey interactions also affect population size. The graphs show how an increase in the moose population—the prey—in Isle Royale National Park was followed by an increase in the island's population of wolves—the predators. The wolves preyed upon the moose, the moose population decreased, then the wolf population decreased.



READING TIP

Note in the graphs above that it can take some time for the size of one population to affect the size of the other.

Any factor or condition that limits the growth of a population in an ecosystem is called a **limiting factor**. A large population of predators will limit the population of prey; a small population of prey will limit the population of predators. Too much or too little of any biotic or abiotic factor—like food, water, or light—makes an ecosystem unstable and brings about change.

A lack of nutrients in the soil is a limiting factor for plants. That is why farmers fertilize their crops. That same fertilizer, if it runs off into a lake, can increase the population of algae, another photosynthetic organism. A large population of algae can cover a lake with scum and use up oxygen needed by fish. This then limits the fish population.

INVESTIGATE Limiting Factors

What effect does spacing have upon a population of plants?

Using the materials listed, design an experiment to test this hypothesis: "If plants grow too close together, the health of the population will be affected because the individual plants do not get enough of the nutrients and water that they need."

DESIGN
— YOUR OWN —
EXPERIMENT

SKILL FOCUS
Designing experiments

MATERIALS

- paper cups
- potting soil
- radish seeds
- water
- pencil
- ruler

TIME
20 minutes



PROCEDURE

- 1 Decide how to use the seeds, cups, and soil to test the hypothesis.
- 2 Write up your experimental procedure. Include safety tips.

WHAT DO YOU THINK?

- What are the variables in your experiment?
- What evidence would you expect to see if your hypothesis is true?

CHALLENGE Conduct your experiment. Note that seeds must be planted near the top of the soil. A good measure for this is the tip of a pencil. Measure and record the growth of the seedlings. Allow the seedlings to grow for two weeks before drawing your conclusions.



Maintaining a Balance

Living things have certain minimum requirements for food, water, and living space. When a population reaches a state where it can no longer grow, the population has reached its **carrying capacity**, the maximum number of individuals that an ecosystem can support. You can see on page 64 that the graph for the moose population does appear to peak around 1500. Even if there were no wolves on the island of Isle Royale, the population of moose would still be limited because there is only so much food and space available.



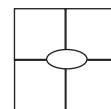
Explain the term *carrying capacity*.

An ecosystem's carrying capacity is different for each population. A meadow ecosystem will support many more bees and ants than bluebirds, for example. Isle Royale supports many more moose than wolves. The moose is a primary consumer of plants. It is at a lower level of the energy pyramid than the wolf, a secondary consumer.

Biotic factors can be limiting factors. These factors include the interactions between populations, such as competition, predation, and parasitism. Abiotic factors, such as temperature, availability of water or minerals, and exposure to wind, are also limiting.

VOCABULARY

Remember to make a four square diagram for *carrying capacity* in your notebook. Try to use *limiting factor* in your diagram.



Ecosystems change over time.

Take a walk in a New Hampshire woods and you may see the remains of old stone walls scattered about. A hundred years ago this land was mostly farmland. The farms were abandoned. And now, new trees have grown where farm animals once grazed.

Succession (suhk-SEHSH-uhn) is the gradual change in an ecosystem in which one biological community is replaced by another. The change from field to forest is an example of succession. Over time the grasses of open farmland are slowly replaced by small plants and shrubs, then trees.

Primary Succession

READING TIP

Succeed and *succession* come from the same Latin root word, *succedere*, meaning to go up or to follow after.

Very few places on Earth are without some form of life. Even when a lava flow covers an area or a glacier retreats and leaves behind an empty and barren environment, plants will move into the area and bring it back to life. These are examples of primary succession, the establishment of a new biological community.

Pioneer species are the first living things to move into a barren environment. In the illustration below, moss and lichen move in after a glacier retreats. There is little or no topsoil. Moss and lichen are common pioneers because they have tiny rootlike structures that can take hold on exposed rock.

Primary Succession

Primary succession can occur after a glacier retreats, when little topsoil is present.



1

Moss and lichen grow on rock with little or no soil. These pioneer species break apart the surface rock.



2

Over time, the rock breaks down further, forming soil. Larger plants take root. These support populations of animals.



3

Coniferous trees take root in a deep layer of soil. A diversity of plants and animals are supported in this habitat.

As the pioneers grow, they gradually weaken the rock surface. The rock breaks down and weathers over time. Decaying plant matter adds nutrients, forming soil. Now a variety of small plants and shrubs can take root. These plants, in turn, support insects, birds, and small rodents. Eventually there is enough soil to support coniferous trees. Forests grow, providing a stable habitat for larger animals.



Learn more about succession.

Secondary Succession

Secondary succession takes place after a major disturbance to the biological community in a stable ecosystem. Despite the disturbance, the soil remains. A community can be disturbed by a natural event, like fire or flood, or it can be disturbed by human activity. A forest cleared or farmland abandoned can lead to secondary succession.

The illustration below shows secondary succession following a forest fire. The damage, as bad as it is, is surface damage. Below the surface, seeds and plant roots survive. After a time, grasses and small shrubs grow up among the decaying remains of the original plants. Birds, insects, and rodents return. Alder trees take root—alders are trees that put nutrients into the soil. Over time, a variety of trees and plants grow, providing food for a variety of animals.

CHECK YOUR READING What is the difference between primary and secondary succession?

Secondary Succession

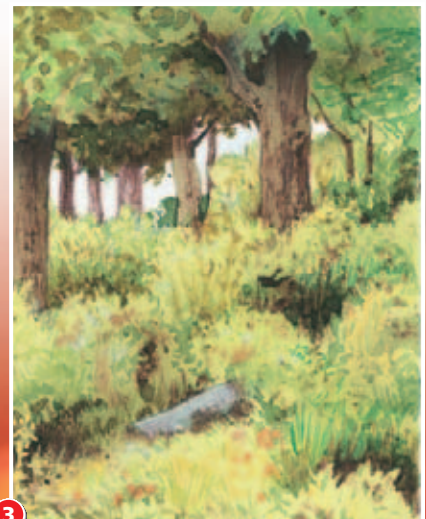
Secondary succession occurs if soil remains after a disturbance, such as a forest fire.



1 Plants at the surface are burned; however, below the surface seeds and some plant roots survive.



2 Grasses and small shrubs sprout among the charred trees and vegetation. Smaller animals return.



3 Deciduous trees like elm and maple grow and mature. A forest habitat is reestablished. More animals are supported.

Patterns of Change

All types of ecosystems go through succession. Succession can establish a forest community, a wetland community, a coastal community, or even an ocean community. Succession can happen over tens or hundreds of years. The pattern is the same, however. First a community of producers is established. These are followed by decomposers and consumers, then more producers, then more decomposers and consumers. Over time, a stable biological community develops.

In a way, the establishment of a biological community is like planting a garden. You first prepare the soil. Perhaps you add compost. This adds organic matter and nutrients to the soil, which helps the soil hold water. With the right preparation, your vegetables and flowers should grow well.

Pioneer species can function in one of two ways in an ecological succession. They can help other species to grow or they can prevent species from getting established.

- Some plant species function a bit like gardeners. Trees such as alders have nitrogen-fixing bacteria on their roots that improve the nutrient content of the soil and allow other tree seedlings to grow. Pioneering species may also stabilize the soil, shade the soil surface, or add nutrients to the soil when they die and decay.
- Other plant species produce conditions that keep out other plants. The plants may release chemicals that keep other plants from taking root. Or a new species may outcompete other species by using up resources or better resisting a disease.

Such interactions between living things help to determine succession in an ecosystem.

READING TIP

As you read about the two ways plant species function in succession, think in terms of cooperation and competition.

2.3 Review

KEY CONCEPTS

1. Describe three factors that could limit the size of a population in a habitat.
2. List two natural disturbances and two human-made disturbances that can lead to succession.
3. What role do pioneer species play in succession?

CRITICAL THINKING

4. **Infer** How and why would secondary succession in a tundra habitat differ from secondary succession in a rainforest habitat?
5. **Predict** Suppose you are clearing an area in your yard to construct a small pond. Sketch the stages of succession that would follow this disturbance.

CHALLENGE

6. **Synthesize** Imagine you are the wildlife manager for a forest preserve that supports both moose and wolves. What types of information should you collect to determine the carrying capacity for each species?