

## Topic 1.4

# What natural factors limit the growth of ecosystems?

### Key Concepts

- Ecosystem growth is limited by the availability of resources.
- Abiotic and biotic factors limit populations in ecosystems.

### Key Skills

Inquiry

### Key Terms

population  
carrying capacity  
limiting factor

In the year 1955, film star James Dean died in a car accident. Ford rolled out the Thunderbird. And Rosa Parks changed the course of history for African-Americans and African-Canadians. If you had been alive at that time, you would have shared the world with 2.8 billion people.

If that sounds like a lot, fast-forward to 1985. In that year, athlete Rick Hansen began his wheelchair trek around the world. The first Blockbuster video store opened. And 41 tornadoes tore a devastating path through Ohio, Pennsylvania, and Ontario. If you had been alive in 1955, you would have shared the world with 4.8 billion people.

Time-jump once more to today. Today, you are walking on Earth alongside about 7 billion other people. These numbers, and the graph on the right, show that Earth's human population has grown, and continues to grow, at a very fast rate.

1900 1910 1920 1930 1940 1950

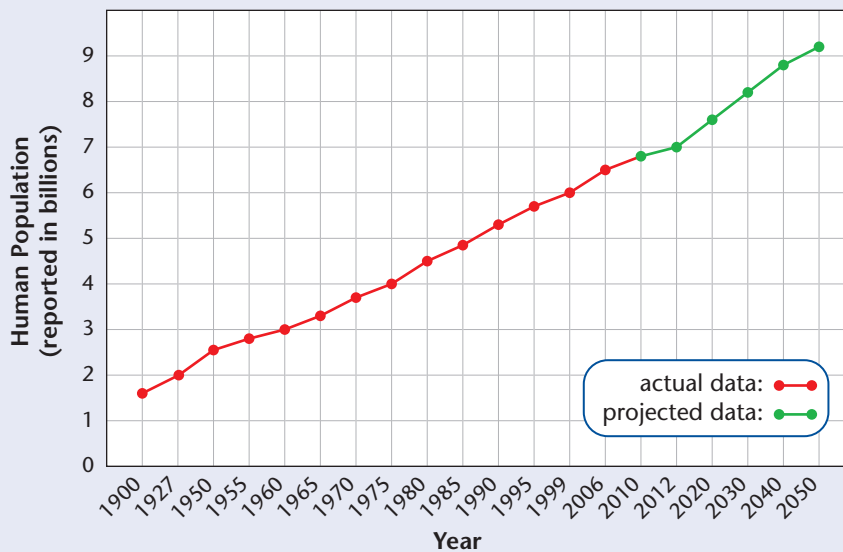
Rosa Parks



## Starting Point Activity

1. Name three resources that humans need to survive.
2. As our human population keeps growing in size, what could happen to our access to the resources we need?
3. As our population grows, what could happen to other living things that depend on many of the same resources that we do?
4. Do you think there is a limit to the size that our population can grow? Explain why.

### Changes in Global Population from 1900–2050



1960 1970 1980 1990 2000 2010 2020 2030 2040 2050

Rick Hansen



A fellow human



# Ecosystem growth is limited by the availability of resources.

## Inquiry Focus

### Activity 1.10

#### UP FOR THE COUNT

It's noon, and a single-celled bacterium—a germ—has invaded your body. The warm, wet environment of your body provides this germ with lots of food and plenty of living space. And so the germ begins to divide (reproduce). In 20 min, the 1 germ divides to become 2 germs. After another 20 min, each of the 2 germs divides to become 4 germs. And 20 min after that, each of the 4 germs divides to become 8 germs. As this pattern continues, the germ population keeps growing in size.

**Make a prediction:** Predict how long this germ population will be able to keep growing in size. Give reasons to support your prediction.

One day you walk into your science class and find that the number of students has doubled. Your classmates are sitting on desks and on the floor, because there are not enough chairs. You find a seat, but you can't see the board. You have to share a textbook with four other students. Your once-efficient classroom environment is not working anymore. There are not enough resources to support and sustain the number of students in it.

## Carrying Capacity and Limiting Factors

Any ecosystem has a limited amount of resources. So it can only sustain a **population** of a certain size. The largest population size that an ecosystem can sustain is called its **carrying capacity**.

Carrying capacity is always limited by the resources that are available to a population. These resources are called **limiting factors**, because they limit the size to which the population can grow. In your classroom, limiting factors include the size of the room, the number of desks and chairs, and the number of textbooks. In a natural ecosystem, population growth is limited by factors such as the amount of living space, food, sunlight, and water.

In any ecosystem, a population can keep growing only if it has an endless supply of the resources that it needs. Without these resources, fewer new members of the population will be born, and more members of the population will die. So, limiting factors control the carrying capacity of an ecosystem and, therefore, the size of its populations.

**population:** all the individuals of a species that live in a certain place at a certain time

**carrying capacity:** the largest population size that an ecosystem can sustain

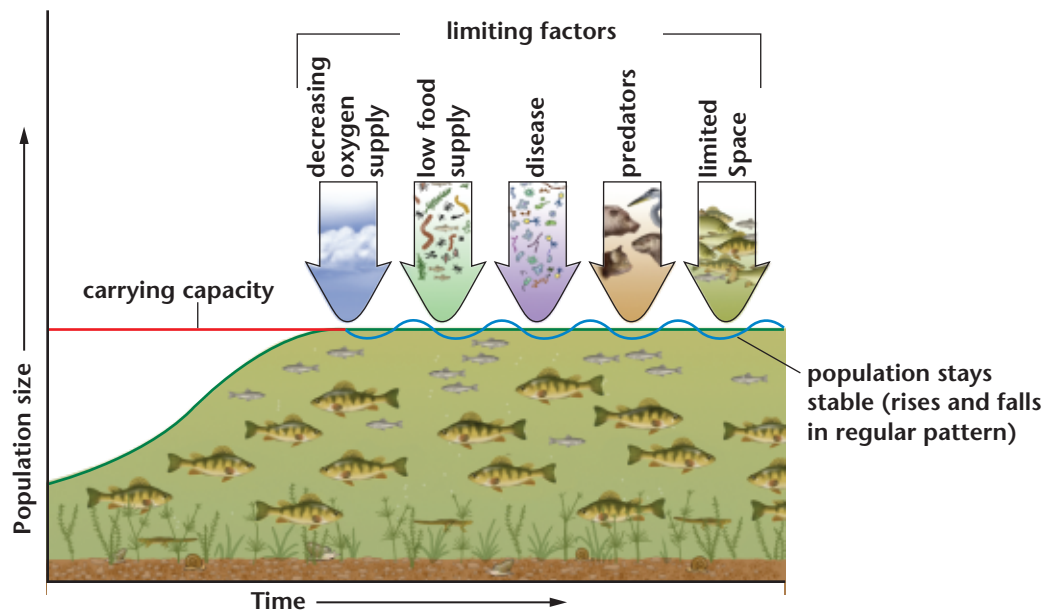
**limiting factors:** any resources that limit the size to which a population can grow

## Limiting Factors Can Play Different Roles in Different Ecosystems

Most ecosystems are affected by the same limiting factors. However, a limiting factor might play a bigger role in one ecosystem than in another. For instance, look at the lake picture and the graph in [Figure 1.9](#). In aquatic ecosystems such as this one, the amount of oxygen is a limiting factor. In terrestrial ecosystems, on the other hand, oxygen is always in the air. So it rarely affects carrying capacity. However, population growth in terrestrial ecosystems is often limited by something that is abundant in aquatic ecosystems—water!

### LEARNING CHECK

1. Use pictures and words to explain “carrying capacity.”
2. What are some examples of limiting factors in ecosystems?
3. Use [Figure 1.9](#) to explain how the limiting factors in an aquatic ecosystem can affect its carrying capacity.
4. Do you think that limiting factors also affect the human population? Explain why.



▲ **Figure 1.9** This picture shows how limiting factors control carrying capacity. Be sure you see the five limiting factors. Then look at the blue graph line. See how the limiting factors keep the size of a population from growing too big. Look also at the red line that is labelled “carrying capacity.” This red line and the blue graph line show you the link between limiting factors and carrying capacity.

# Abiotic and biotic factors limit populations in ecosystems.

## INVESTIGATION LINK

Investigation 1B, on page 46

The factors that affect the carrying capacity of an ecosystem can be non-living and living. In other words, abiotic and biotic factors limit the size of populations in ecosystems. Abiotic factors that limit the size of populations include water, living space, nutrients, shelter, sunlight, and weather. Biotic factors that limit the size of populations include those described in the text boxes in **Figure 1.10**.

**Figure 1.10** Biotic factors that limit the size of populations include those shown in this forest ecosystem. This is an ecosystem that might be found in Northwestern Ontario.

### Parasites

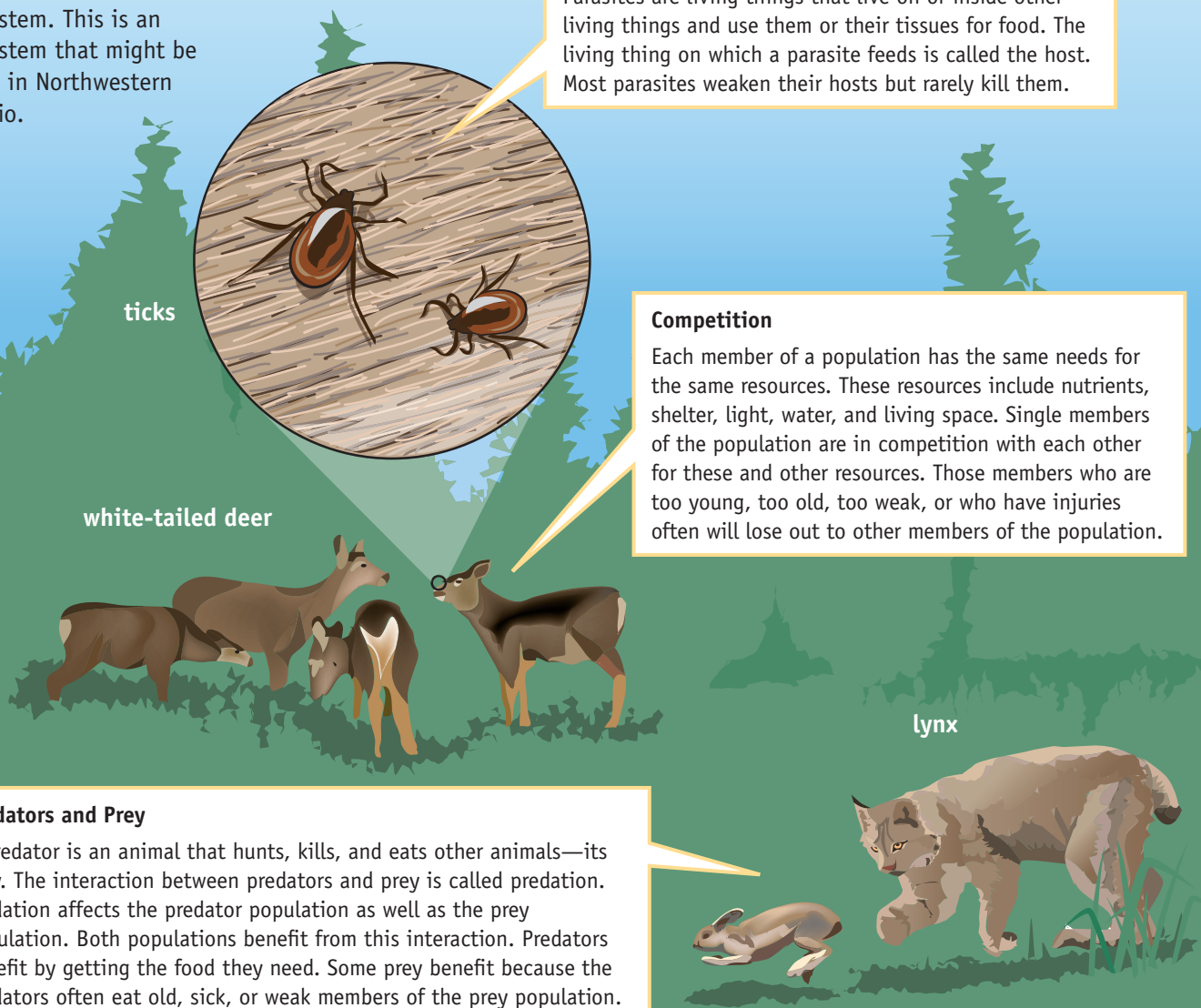
Parasites are living things that live on or inside other living things and use them or their tissues for food. The living thing on which a parasite feeds is called the host. Most parasites weaken their hosts but rarely kill them.

### Competition

Each member of a population has the same needs for the same resources. These resources include nutrients, shelter, light, water, and living space. Single members of the population are in competition with each other for these and other resources. Those members who are too young, too old, too weak, or who have injuries often will lose out to other members of the population.

### Predators and Prey

A predator is an animal that hunts, kills, and eats other animals—its prey. The interaction between predators and prey is called predation. Predation affects the predator population as well as the prey population. Both populations benefit from this interaction. Predators benefit by getting the food they need. Some prey benefit because the predators often eat old, sick, or weak members of the prey population. The benefit is less competition among the prey population.



## Activity 1.11

### WHAT'S THE LINK?

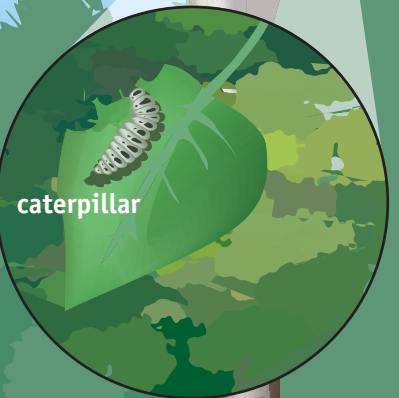
Share your ideas as you discuss these questions.

1. Why do palm trees grow in Florida but not in Ontario?
2. How could the number of foxes in a meadow affect the number of rabbits that also live there?
3. How could a severe drought affect the populations that live in and around a pond?
4. How is nitrogen a limiting factor in a lake ecosystem?

### LEARNING CHECK

1. Refer to **Figure 1.10**. List three abiotic factors that limit the size of a population of deer.
2. Use pictures or words to explain the different ways in which competition can limit populations.
3. What kinds of resources might plant populations compete for?

yellow warbler



caterpillar

aspen

### Different Populations Compete

Individual animals from different populations also compete for resources. For example, snowshoe hares eat many of the same foods that deer do. They may share some of the same predators. For instance, wolves eat deer and snowshoe hares. Bobcats and lynx prefer hares, but they will sometimes take a deer if it is too old, young, or sick.

### Plant Competitors

Animals are not the only living things that compete. Plants also compete for the resources they need. Members from the same plant population compete with each other. They also compete with members of different plant populations.

snowshoe hare



## Skill Check

- ✓ Initiating and Planning
- ✓ Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communicating

## Safety Precautions



## What You Need

5 Erlenmeyer flasks or beakers  
fertilizer solutions (five different concentrations)  
dropper  
well-lit space or grow light  
algae  
graph paper

## Investigating Limiting Factors for Algae Growth

Algae are microscopic plant-like organisms commonly found in aquatic ecosystems. As is the case with all living things, the growth of an algae population is limited by abiotic and biotic factors. In this investigation, you will plan and conduct an experiment to explore how fertilizer affects the size of an algae population.

### What To Do

1. Design a procedure to determine how different concentrations of fertilizer solutions affect the growth of algae. Use this checklist to help you plan your procedure.
  - ✓ Because algae are producers, they need light for photosynthesis. Ensure that the algae have enough light.
  - ✓ You will need to design a way to describe and compare the amount of algae growth in each test tube.
  - ✓ Be sure to consider safety precautions and proper clean-up and disposal in your procedure. Why must you not pour the material in your flasks down the sink?
  - ✓ Ensure that you design an experiment to test only one variable. The variable that you choose to test is called the independent variable. It is the variable that you make changes to. The variable that responds to the changes you make is the responding, or dependent, variable. All of the other variables that you are not testing are called controlled variables. You keep all the controlled variables the same. Turn to Science Skills Toolkit 2: Scientific Inquiry at the back of the book to review variables and how to conduct an experiment.
  - ✓ Ask yourself:
    - What is the independent variable (the one you are changing) in this experiment?
    - What is the dependent variable (the one that changes as a result)?
    - What are the controlled variables (the ones that must be kept the same)? Hint: Consider any factors that might affect the outcome of the experiment. Examples include air temperature, water temperature, amount of light, and volume of pond water.)
2. Create a table to record your observations. Give your table a suitable title.
3. Ask your teacher to approve your procedure. Then carry it out.

4. When you have finished your observations, make a graph that compares the concentration of fertilizer solution to algae growth. Give your graph a suitable title. Turn to Numeracy Skills Toolkit 4: Organizing and Communicating Scientific Results with Graphs, to help you decide which of your variables goes on the  $x$ -axis and which goes on the  $y$ -axis.

### What Did You Find Out?

1. What was the limiting factor that you investigated? Was it biotic or abiotic? Explain.
2. Explain how you controlled your experiment. As part of your answer, state your independent variable and your dependent variable. Also state the variables that you controlled.
3. If you were able to design your experiment again, what would you do differently? Why?
4. Using your graph, what can you conclude about the effect that different concentrations of fertilizer solution have on algae growth?
5. If algae have access to unlimited nutrients for growth, will an algae population keep growing forever? What other abiotic and biotic factors might limit the growth of the population?
6. Human activity can cause more nutrients than usual to enter aquatic ecosystems. For instance, farmers and gardeners often use nutrient-rich fertilizers to enhance plant growth. But not all the nutrients are used by the plants. Some stay behind in the soil. These excess nutrients are then carried into lakes, ponds, and other aquatic ecosystems by rain or run-off from watering. The excess nutrients can cause an overgrowth of algae called an algal bloom. How do you think an algal bloom might affect other living things in an aquatic ecosystem? How might it affect the ecosystem as a whole? Give reasons for your opinions.

### Inquire Further

7. Many people believe that organic fertilizers such as manure and compost are better for the environment than synthetic (human-made) fertilizers. Is there less risk of an algal bloom if farmers and gardeners use organic fertilizers instead of synthetic fertilizers? Use print or electronic resources to find an answer.



# STRANGE TALES OF SCIENCE

Limiting factors limit the size to which a population can grow. Consider a population of bacteria, known as a colony. Bacteria grow by doubling: one bacterium becomes two, two become four, four become eight, and so on. If there were no limiting factors to keep its growth in check, a bacterial population could get very large, very quickly. How large? How quickly? *E. coli* bacteria divide once every 20 minutes. Without limiting factors, it would take a single *E. coli* bacterium (one cell) exactly 24 hours to create a super colony with the same mass as planet Earth!

## BACTERIA TAKE OVER THE WORLD



*Mwahahaha!*

00:00

21:00

23:40

*My plan for global domination is complete.*

24:00

*And I still have time for lunch!*



So... What do you think?

1. Is it true that *E. coli* could divide to create a super colony with the same mass as Earth in 24 hours?
2. Find out what limiting factors keep bacteria from taking over our planet.
3. The bacterium in this feature is an evil character, but bacteria also play beneficial roles in ecosystems. What would happen to ecosystems if there were no bacteria?

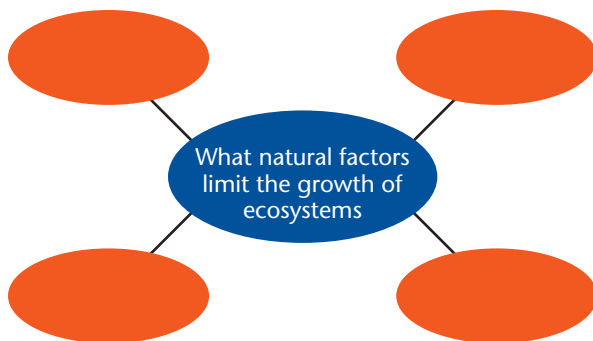
# Topic 1.4 Review

## Key Concepts Summary

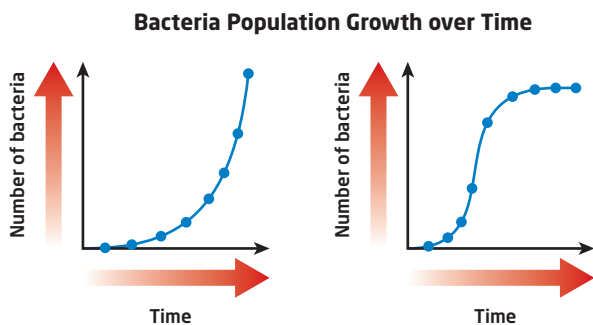
- Ecosystem growth is limited by the availability of resources.
- Abiotic and biotic factors limit populations in ecosystems.

## Review the Key Concepts

1. **K/U** Answer the question that is the title of this topic. Copy and complete the graphic organizer below in your notebook. Fill in four examples from the topic using key terms as well as your own words.



2. **K/U** Use a Venn diagram or other graphic organizer to compare the limiting factors in terrestrial and aquatic ecosystems.
3. **T/I** The two bacterial-population graphs below shows the growth patterns for two different populations of bacteria over a period of time.
  - a) Describe, in words, what is happening to each of the bacteria populations.
  - b) Has either of these populations reached its carrying capacity? Explain your answer.



4. **C** List some examples of limiting factors on human populations. Then answer the questions below.
  - a) Why would a government restrict the number of children that urban couples may have?
  - b) Should governments be allowed to do this?
  - c) Construct a list of pros and cons concerning government restrictions on the number of children that couples may have.
  - d) Summarize your points in several paragraphs that support your opinion.
5. **A** How might the removal of dead timber from an area affect the carrying capacity of flying squirrels?
6. **K/U** Use a spider map to represent either the biotic factors or the abiotic factors that limit the size of populations in a forest ecosystem.
7. **T/I** The water-flea graph below shows how a population of water fleas changed during a laboratory experiment. Use the terms “carrying capacity” and “limiting factors” to explain how the population changed.

