# Walch Science Literacy Series
# Biology

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WALCH PUBLISHING

# Contents

# Contents

# To the Teacher

As teachers, what do any of us want for students? In addition to wishing them healthy and fruitful lives, we want them to be able to think. We want them to be literate in the fields we teach year after year. We want them to develop the thinking skills that will allow them to be respected and productive. We hope that they will be critical of false claims and weak arguments. We urge them to study so that they may possess that special body of knowledge that will help them to do their jobs better. In addition, we want them to develop habits of mind that characterize good thinkers. In this program we have developed a tool that will help you direct your efforts to a very worthwhile end, namely teaching science literacy.

## *What Is Science Literacy?*

Project 2061, sponsored by the American Association for the Advancement of Science (AAAS), seeks to promote literacy in science in order to help people live interesting, responsible, and productive lives in a society in which science, mathematics, and technology are central.

In the book *Science for All Americans,* Project 2061 defines science literacy as "what every high school graduate should understand about science, mathematics and technology." It recommends that scientific literacy include:

- Being familiar with the natural world and recognizing both its diversity and its unity
- Understanding key concepts and principles of science
- Being aware of some of the important ways in which science, mathematics, and technology depend on one another
- Knowing that science, mathematics, and technology are human enterprises, and knowing what that implies about their strengths and limitations
- Having a capacity for scientific ways of thinking
- Using scientific knowledge and ways of thinking for individual and social purposes

## *What Are Habits of Mind?*

Science literacy requires ways of understanding and habits of mind that allow people to grasp what science and technology are about, to make some sense of how the natural and designed worlds work, to think critically and independently, and to recognize and weigh alternative explanations of events.

Habits of mind refer to thinking skills, values, and attitudes that, taken together, relate directly to a person's outlook on knowledge and ways of thinking and acting. Habits of mind need to be learned in the context of all scientific content areas. Students need not only to acquire these skills but also to be able to use them in new situations, both in and out of school.

Habits of mind include values and attitudes, computation and estimation skills, manipulation and observation skills, communication skills, and critical response skills.

The *Walch Science Literacy Series* uses a variety of content areas to help students develop the necessary habits of mind needed by a scientifically literate person. The following list of habits of mind describes the science literacy skills included in the series.

## *Values and Attitudes*

- Raise questions and seek answers.
- Make hypotheses.
- Make careful observations.
- Keep honest, clear, accurate records.
- Offer reasons for findings.
- Understand that different explanations can be offered and that it isn't always possible to tell which is correct.
- Value and exhibit curiosity, honesty, openness, and skepticism.
- View science and technology thoughtfully.

## *Computation and Estimation Skills*

- Manipulate numbers mentally.
- Translate from common fractions to decimals.
- Estimate measurements and computations.
- Judge whether measurements and computations are reasonable.
- Understand the purpose of each step in a calculation.
- Determine the units in which an answer should be expressed.
- Estimate probabilities of outcomes.

## *Manipulation and Observation Skills*

- Use common tools.
- Operate common audio equipment.
- Make simple models and equipment.
- Repair things.

- Keep a notebook that describes observations and distinguishes these from speculations.
- Calculate and compare areas and volumes.
- Read analog and digital meters on instruments.
- Disassemble and reassemble simple mechanical devices.
- Understand the purposes of the parts of simple mechanical devices.

## Communication Skills

- Describe and compare things in terms of number, shape, texture, size, weight, color, or motion.
- Draw pictures that correctly portray observations.
- Write and illustrate instructions to carry out a procedure.
- Use numerical data in descriptions.
- Organize information in simple tables and graphs.
- Read tables and graphs of all kinds.
- Locate information in reference books, newspapers, magazines, on CDs, on databases, and on the Internet.
- Make and interpret scale drawings.

## Critical Response Skills

- Support statements with facts from books or other sources, and identify the sources.
- Recognize faulty comparisons.
- Seek evidence for believing something, and discount reasons based on hearsay or speculation.
- Question claims built on vague attributions.
- Compare consumer products.
- Be skeptical of arguments based on very small samples of data, biased samples, or samples not matched with controls.
- Notice and criticize the reasoning of faulty arguments.
- Check graphs to see that they do not misrepresent data.
- Compare probabilities with chance.
- Insist that critical assumptions behind an argument be made explicit.
- Recognize arguments based on selected data.
- Suggest alternative ways of explaining data.

The foregoing list, while long, does not cover every conceivable habit of mind, but it does provide you with the insight and understanding necessary to be able to successfully teach a set of identified and organized thinking skills to your students.

# To the Student

How would you like to be one of the best thinkers in your school? Would you like to be able to put pieces of a problem together quickly and thoroughly in order to find a solution? Do you want to be able to spot flaws in weak arguments? Can you develop a strategy for setting up an experiment that will work to give you an answer to a problem?

Most students would like to be able to do all these things. But some of them are not as successful as they could be because they have not developed the skills—the "habits of mind"—of really good thinkers. In this program, you will learn some new thinking skills, and you will know when you are using them. You will become a more effective thinker and problem solver as you work through the science situations in this book.

Our best wishes for good thinking.

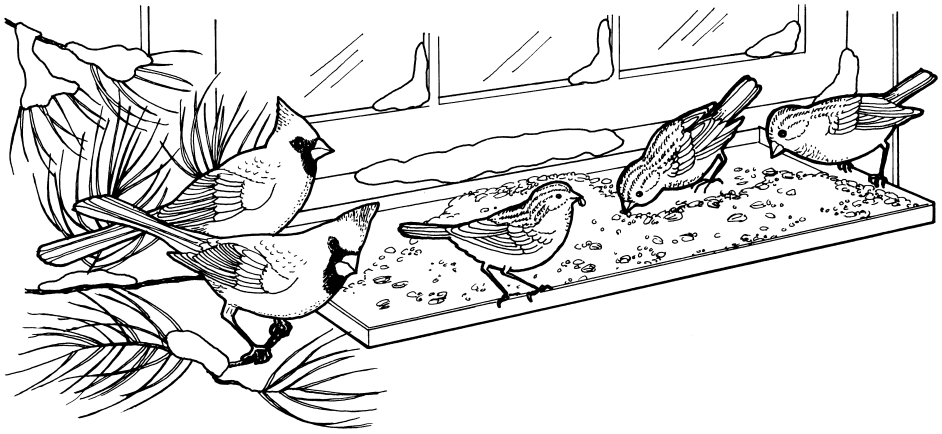
**Activity 1**

# Bird Visitors



The morning was crisp and cold. The sun shone on the drifted snow. The snow clung to tree branches. Jeff knew that the birds that lived around his house would not be able to find food in the snow. As he put seed in the feeder outside the window, the birds gathered in the trees near his house. The first visitor was a chickadee, landing on the platform with a "Dee-dee-dee-dee-deeee." It ate a seed and took another in its beak before flying off. Five sparrows landed within seconds of one another. They pecked and ate and pecked and ate. As they fed, the chickadee came back. It ate a seed and flew off with another. Two finches joined the sparrows and then a large mourning dove swooped down. The smaller birds scattered as the dove began eating. The sparrows returned within a few minutes.

For a while the feeder was quiet. Then there was a loud "Teearr!" The other birds quickly flew away from the feeder. A blue jay landed with a thump on the platform. It stomped around the feeder, scattering seeds everywhere. It ate a few seeds and then called again. Two other jays joined the first, but no other birds visited while the blue jays were there.

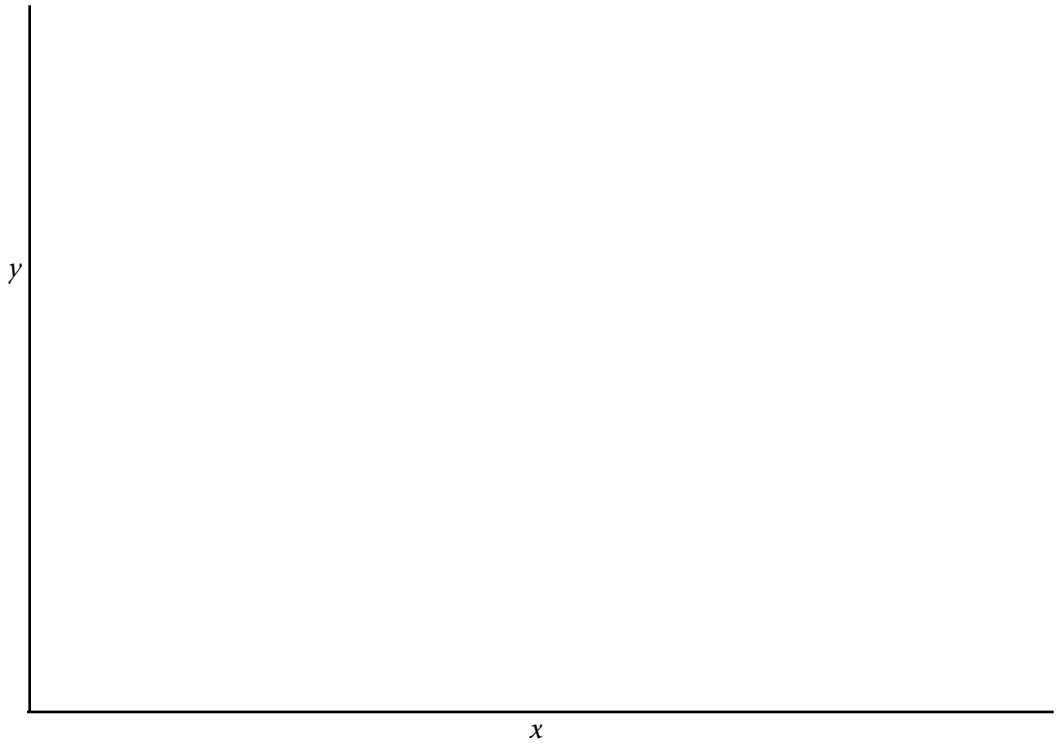


When the jays left, other birds came to feed. A bullet-shaped nuthatch flitted in and out, barely stopping as it grabbed a seed. A pair of cardinals came to a protected corner of the feeder. They looked all around before they ate. Then they flew back to the trees.

Jeff watched as the birds fed. He was curious about how often each kind of bird visited his feeder. Each Saturday he made a tally of the visits. The tally he made one Saturday is shown below.

| **Bird** | **Number of Visits** |
|---|---|
| Chickadee | IIII IIII III |
| Nuthatch | III |
| Cardinal | IIII I |
| Sparrow | IIII IIII |
| Blue jay | III |
| Mourning dove | I |
| Finch | III |

Help Jeff look at the data he collected in another way. Make a bar graph in the space below. Then write answers to the questions that follow, using a separate sheet of paper if needed.



1. Jeff's sister Nancy looked at the graph and stated, "Oh, the chickadee ate the most." Is Nancy's statement correct? Explain why or why not?

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   _____

   _____

2. Jeff was collecting data to answer the question, "How many times does each kind of bird come to the feeder?" What other questions could he have asked? List three.

   _____

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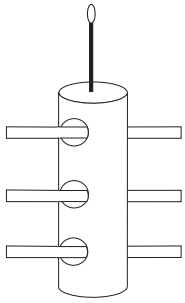
   _____

3. Jeff used a platform feeder, which is good for birds that normally feed on the ground. How might his results have been different if he had used a perch feeder like the one shown?



   _____

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4. Jeff used mixed seeds to feed the birds. What might have happened if he had put out just one kind of seed?

   _____

   _____

   _____

5. Describe how you would go about designing an experiment to attract a specific kind of bird that lives in your area. Write the plan for your experiment.

   _____

   _____

# *Who Eats What?*

**GOAL**

To determine if birds have food preferences

**MATERIALS**

You will need sunflower hearts, whole peanuts, small pieces of bread, 3 pieces of 12" 12" cardboard, and field guides to birds.

## PROCEDURE

Label the pieces of cardboard A, B, and C. Place them on the ground about one foot apart. Place sunflower hearts on A, peanuts on B, and bread pieces on C. Observe the feeding stations for 30 minutes a day for 5 days. Work with a partner to make it easier to keep track of the birds. List the number and kinds of birds that eat each kind of food. *Hint:* Try to identify a time and place that birds normally feed.

| | Sunflower Hearts | Peanuts | Bread |
|---|---|---|---|
| **Day 1** | | | |
| **Day 2** | | | |
| **Day 3** | | | |
| **Day 4** | | | |
| **Day 5** | | | |

**RECORD KEEPING:** Record your observations in a chart like the one above.

**CONCLUSIONS:** Based on your observations, what conclusions can you make about which foods are preferred by different kinds of birds? Write them out in a paragraph.

**APPLICATION:** Some kinds of birds are enjoyable to have as visitors and some are not. Using what you have learned, how might you encourage some visitors and discourage others?

# *What Should I Put in My Birdfeeder?*

To answer the above question, use the chart below. It shows the relative attractiveness of certain foods to 14 different kinds of birds. The higher the number, the more often the bird chose the food. Use the information in the chart to answer the questions that follow.

**Relative Attractiveness of Bird Feeds for Some Common Birds**

| | Cracked corn | Red proso millet | White proso millet | Niger | Peanut kernels | Rice | Black-oil sunflower | Black-striped sunflower |
|---|---|---|---|---|---|---|---|---|
| Blue jay | 0.2 | 0.0 | 0.1 | 0.0 | 1.6 | 0.0 | 0.2 | 1.0 |
| Cardinal | 0.0 | 0.1 | 0.2 | 0.0 | 0.1 | 0.0 | 1.1 | 1.0 |
| Chickadee | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 2.4 | 1.0 |
| Brown-headed cowbird | 0.1 | 0.7 | 1.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 |
| Evening grosbeak | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 1.0 |
| Common grackle | 0.5 | 0.1 | 0.1 | 0.1 | 0.4 | 0.0 | 0.6 | 1.0 |
| American goldfinch | 0.0 | 0.0 | 0.0 | 7.9 | 0.0 | 0.0 | 5.3 | 1.0 |
| House finch | 0.1 | 0.1 | 0.4 | 1.1 | 0.2 | 0.0 | 2.5 | 1.0 |
| House sparrow | 0.2 | 0.4 | 1.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 |
| Mourning dove | 0.4 | 1.0 | 1.0 | 0.2 | 0.1 | 0.1 | 1.0 | 0.4 |
| Purple finch | 0.0 | 0.1 | 0.0 | 0.2 | 0.0 | 0.0 | 3.3 | 1.1 |
| Tufted titmouse | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 | 0.0 | 0.6 | 1.0 |
| White-crowned sparrow | 0.2 | 0.6 | 1.0 | 0.0 | 1.3 | 0.1 | 0.0 | 0.6 |
| White-throated sparrow | 0.6 | 0.7 | 1.0 | 0.1 | 1.2 | 0.0 | 0.7 | 0.8 |

1. Which two kinds of birds show extremely strong preferences for certain feed? What are those feeds?
2. Brown-headed cowbirds are parasitic birds that lay their eggs in the nests of other birds. Cowbird young in a nest crowd out the other young, who often do not survive. What feed(s) should you avoid putting in your backyard feeder to make it less likely to attract cowbirds? Why?
3. You can make a mixture of up to four types of feed for your feeder. What would you choose to attract the most birds to your yard? Explain the reasons for your choices.

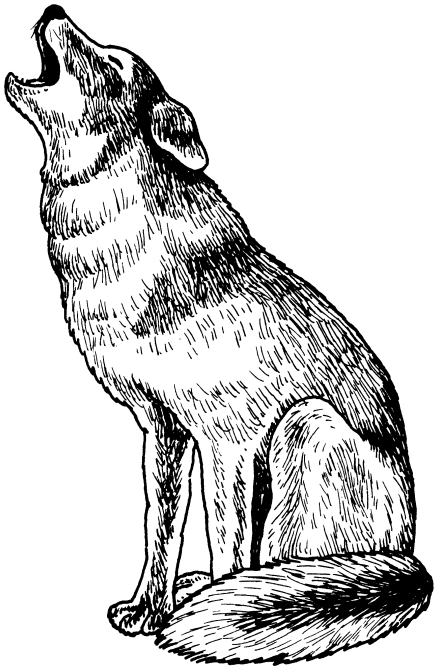
## Activity 1

# Going, Going, Gone!

Would you like to be able to visit dinosaurs in a zoo? or even have a pet dinosaur? Of course, you know that's not possible. There are no more living dinosaurs. The last of their kind disappeared from the earth, or became extinct, about 65 million years ago. At the same time dinosaurs became extinct, so did many other animals. In fact, almost all other land and sea animals larger than a small dog became extinct. An event like the one that happened 65 million years ago, when large numbers of organisms became extinct, is known as a **mass extinction.** During the history of life on the earth, mass extinctions have occurred five times. The first occurred about 440 million years ago; the last occurred 65 million years ago.

But did you know that during your lifetime more plants and animals are expected to become extinct than at any time during the last several hundred million years? Even more organisms will disappear during your lifetime than during the great extinction when the dinosaurs disappeared.

Human activities have accelerated the extinction of species dramatically. People have caused the extinction of many species, especially during the last 100 years. As human populations increase, more food, water, shelter, and other resources are needed. To provide food and space for people to live, much of the grasslands and forests have been cleared. The species that live in these areas may not survive. So, the rapid changes people make in the environment can cause many species to become extinct.



Mexican gray wolf

Some plants and animals aren't extinct, yet. But they are in danger of becoming extinct because the species population is low. These organisms are **endangered species.** Over 700 endangered plants and animals live in the United States alone. Many more live in other places around the world. The U.S. Fish and Wildlife Service keeps a list of endangered species. In 2004, there were 1,823 plants and animals on the list. The Mexican gray wolf is

one of the animals on that list. It has been on the list since 1976. At the beginning of 1997, only 148 Mexican gray wolves existed. None of them lived in their natural habitat in Mexico and the southwestern United States. They were all in captivity. In 1998, efforts began to reintroduce them into the wild.

Many people think we should do everything we can to protect endangered species. Other people point out that **extinction** is a natural process in which people shouldn't interfere. What do you think?

Use reference sources, such as library books and magazines or the Internet, to find information to help you answer the following questions.

1. What are some reasons that people give for wanting to save endangered species?

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2. What are some reasons that people give for not interfering and allowing some organisms to become extinct?

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3. If an organism becomes extinct, how might that affect other life on earth? How might its extinction affect other plants and animals that live in the same area? Could its extinction affect humans? If so, how?

4. Do you think that you contribute to the extinction problem? Explain your answer.

5. Should you care if some plant or animal becomes extinct? Why or why not?

# *Endangered Species*

**GOAL**

To research an endangered species

**MATERIALS**

You will need reference materials on endangered species, a piece of poster board, and colored pencils or markers.

## PROCEDURE

An **endangered species** is one that is in danger of becoming extinct. Choose one of the endangered species listed below, or select another endangered species. Find out all you can about the organism—where it lives, why it is endangered, what is being done to save it, and what you think should be done to save it. Make a poster showing the organism in its habitat. Then use the poster and the information you have gathered to present an oral report to the class. Be prepared to answer questions from your classmates.

### Endangered Animals

| | | |
|---|---|---|
| Bactrian camel | Queen Alexandria's birdwing butterfly | Key deer |
| California condor | Leatherback sea turtle | Wood bison |
| Snow leopard | Gray whale | Chinese river dolphin |
| Cheetah | Ivory-billed woodpecker | Asian elephant |
| Whooping crane | Galapagos tortoise | Hawaiian hawk |
| Black-footed ferret | Northern white rhinoceros | Ocelot |
| West Indian manatee | Woodland caribou | Golden parakeet |
| Gray bat | Peregrine falcon | Tiger |
| Giant panda | Pygmy chimpanzee | Mountain zebra |
| Giant armadillo | Japanese giant salamander | Gorilla |
| Indian python | | |

**RECORD KEEPING:** List the organism you chose to research in the following space.

_____

Record all the information you gather about the organism in a notebook. You might want to make note cards to use in your oral report.

**CONCLUSIONS:** Based on the information you collected, why is the organism you researched endangered? What are your predictions for its future? Will it become extinct? Why or why not? Write your conclusions in your notebook.

**APPLICATION:** Suppose your town wanted to build a new middle school. The site they have chosen is the only field in your area where plants needed by an endangered butterfly grow. It is also the only field close enough to town so most students could walk to school. Should the school be built there? Why or why not?

# *Should the Forest Be Cut?*

A logging company wants to cut down a large forest near your town. A lot of people in your town work as loggers and others are employed by the local sawmill that processes the cut trees. Several endangered animals live in the forest and some rare plants grow there, too.

1. What are some reasons people in your town might support the idea of logging the forest?

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2. What are some reasons other people might oppose the idea of logging the forest?

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3. Why isn't it always easy to decide which side to take?

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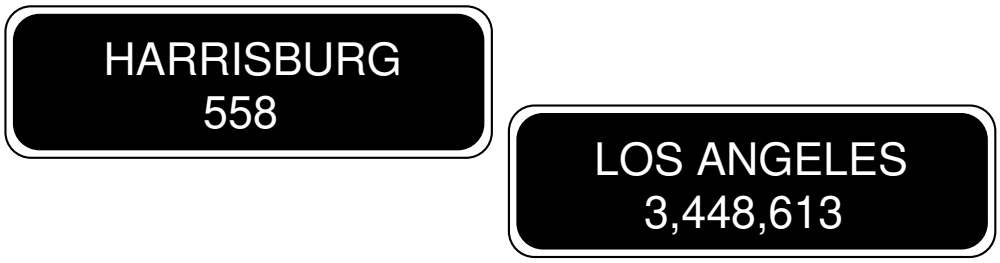
**Activity 1**

# Going Up or Going Down?

Do you know how many people live in your city or town? Many towns have signs as you enter them that list the population of the town. A small town might have only a few hundred people. A large city might have several million people.




The study of human **population** size has been going on for more than 2000 years. Ancient Romans and Chinese took censuses, or counts of the number of people living in their empires. They did this primarily for the purpose of collecting taxes from their citizens.

When talking scientifically about a population, you need to identify the kind of organism and its limits in time and space. Therefore you could talk about the human population in the Wisconsin town of Argyle in January of 1997. Or you could refer to the population of maple trees in Argyle Park during the summer of 1995. Usually, you are concerned with numbers when you talk about populations. So, you could say the human population of Argyle in January of 1997 was 743 or the maple tree population in Argyle Park in 1995 was 87.

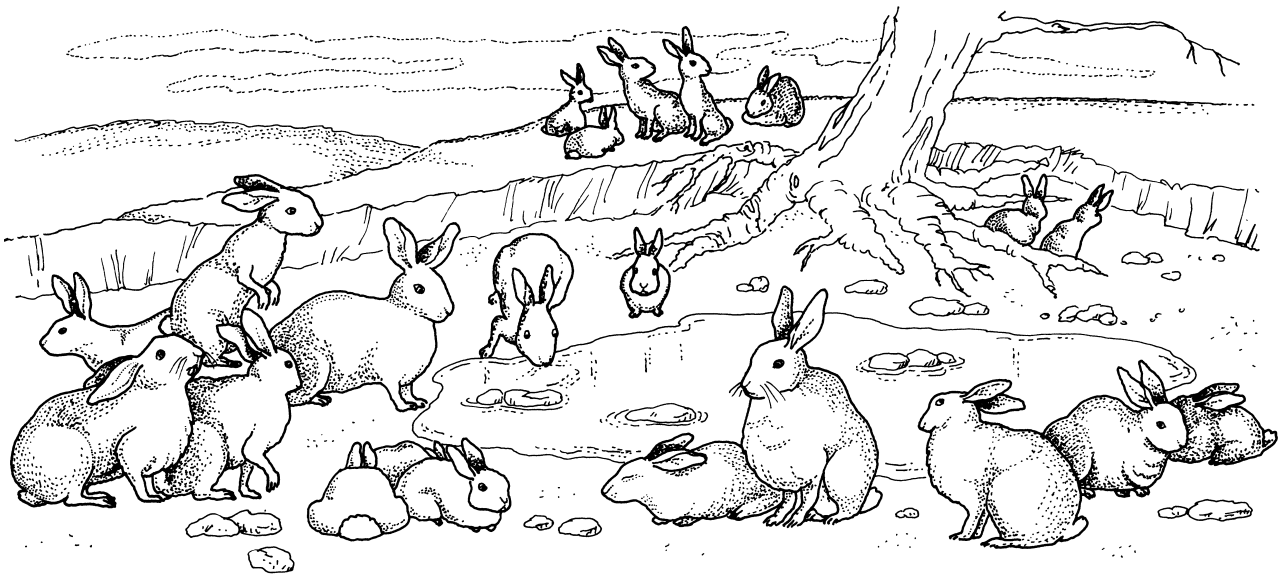
The size of any population changes constantly. In the case of the human population of Argyle, the population will increase if more people move into town or decrease if people move out of town. The population will also increase if new babies are born and decrease if people die.

In the case of the maple tree population, maple trees cannot move about. If the population of trees decreases, some of the trees must have died or been cut down. If the population increases, new trees must have grown from seeds or been planted.

What factors cause population changes? Consider, for example, two pairs of rabbits on a small island with no other animals. One female rabbit can have as many as nine young at a time. She can produce another litter of young in just 30 days. Each of her female young can mate and have a litter when it is only about six months old. In a single year, a population of four rabbits could grow into a population of hundreds of rabbits.

If all these rabbits lived, what might happen? The members of the population compete with each other for space, food, water, and mates. As the population grows, this competition becomes greater. If the population grows to such a size that there is not enough food, water, or space, not all the rabbits will live. The **death rate**—the number of rabbits that die over a period of time—rises. The **birth rate**—the number of new rabbits born over a period of time—will decrease. This is one way the size of the rabbit population on the island would be controlled naturally.

Populations also increase or decrease with changes in the environment. Suppose the island where the rabbits live experiences a drought. Very little rain falls, springs and ponds dry up and plants die. Fewer rabbits would survive and the population would decrease. If, the following year, there was plenty of rain and many plants for the rabbits to eat, the population would increase.



1. Assume you have a pair of rabbits. Every 30 days, the female rabbit produces eight young. The young cannot reproduce for six months. At the end of six months, what would the size of the rabbit population be? Show your calculations.

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2. How do you think the rabbit population on the island would change if a pair of foxes were brought to the island? Explain your answer.

   _____

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   _____

3. What might happen to the rabbit population on the island if the foxes produced a litter of four young each year?

   _____

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4. A biologist studied the population of box turtles in an Indiana woodlot for a period of five years. He determined that the birth rate was 40 per year and the death rate was 30 per year. He also found that three turtles from other areas entered the woodlot each year, and eight turtles from the woodlot left for other areas each year. Was the population of the woodlot increasing or decreasing? If the turtle population at the beginning of the study was 15, predict what the population would be at the end of 15 years.

   _____

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   _____

# *Seasonal Changes in Populations*

**GOAL**

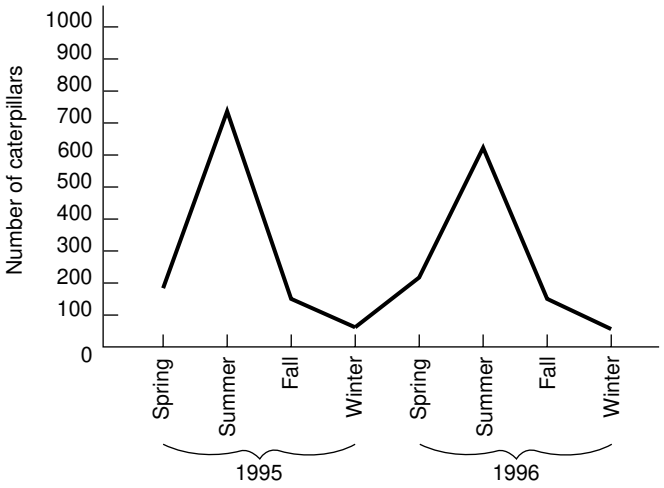
To examine how changing seasons affect populations

**MATERIALS**

You will need two sheets of graph paper.

## PROCEDURE

Some **populations** change size with the seasons. The graph below shows the number of tent caterpillars that lived on one wild cherry tree over a two-year period. Look at the graph and then answer the questions that follow.




1. When was the population the highest? The lowest? Was this true in both years?

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   _____

2. In what season did the population change the most from the season before?

   _____

   _____

3. When did the greatest drop in population occur?

   _____

   _____

4. Predict what you think the tent caterpillar population would be at the end of the summer of the third year.

   _____

   _____

*(continued)*

## *Seasonal Changes in Populations* (continued)

The table below contains data on the seasonal **populations** of pheasants on an island off the coast of Washington. Use the data to construct a graph showing how the pheasant population changes over the seasons.

| | Season | Pheasant Population |
|---|---|---|
| Year 1 | Spring<br>Fall | 8<br>40 |
| Year 2 | Spring<br>Fall | 30<br>100 |
| Year 3 | Spring<br>Fall | 90<br>425 |
| Year 4 | Spring<br>Fall | 300<br>825 |

**RECORD KEEPING:** Record the answers to the questions about the caterpillar population in a notebook, based on notes you make in the space provided. Draw your graph of the pheasant population on graph paper.

**CONCLUSIONS:** How do seasonal changes affect the tent caterpillar population? Why do you think this is so? What does your graph tell you about how seasonal changes affect the pheasant population? Why do you think this is so? Write your conclusions in your notebook.

**APPLICATION:** If spring counts had been made of the pheasant population in the spring of year 5, what do you think they would have shown? Why?

# *Examining Population Changes*

A biologist studied the **population** of western box turtles in a section of prairie in southern Nebraska for a period of six years. At the beginning of her study, the population of turtles was 20. She determined that the birth rate was 27 per year and the death rate was 18 per year. She also found that five turtles from her study section left for other areas each year and two turtles entered the section each year.

1. Use the grid to the right to make a line graph that shows the turtle population over the six years of the biologist's study. Be sure to label your graph. Show the calculations you made to prepare your graph in the space below.

   _____

   _____

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2. From looking at your graph, was the turtle population increasing or decreasing in the biologist's study area? How do you know?

   _____

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3. Use your graph to predict what the turtle population of the study area would be at the end of 10 years.

   _____

   _____

   _____

   _____