CHAPTER

1

Wolves in Yellowstone

Imagine you could travel back in time a thousand years. What differences would you notice in the animals and plants in the area where you live? What kind of animals might you see? Bears, wolves, and eagles used to live where New York City now stands. Today, coyotes, deer, and peregrine falcons can sometimes be found in the city. In many places in the world, the populations of plants and animals have changed as human populations have grown. In some places the changes haven't been as extreme. In Rocky Mountain National Park in Colorado there used to be wolves, black bears, and grizzly bears, but now there are only black bears. What do you think caused such changes? What effects do you think these changes have had on the other animals and the plants that live in the area? What do you think would happen if some animals, like bears, were brought back to live in these environments?

In this chapter you will focus on the relationships between living things and the nonliving things in the environment. You will investigate the effects of disruptions—events that change environments—caused by human populations and their actions. As you study scientific questions, you will engage in scientific practices—the things scientists do to understand and explain the world. For example, scientists analyze the data they collect to develop explanations for how things work. Scientists also construct arguments about which explanation makes the most sense. You will develop scientific explanations about relationships and changes in the environment. You will learn how to use your explanations to construct scientific arguments about the ways humans affect the environment, and whether people should try to reduce disruptions.

Engage: People and Animals Interacting

More than 305 million people visited national parks in 2015. One of those parks was Yellowstone National Park—the first national park in America. The park was created in 1872 by the federal government to preserve a large wilderness area. Yellowstone is home to many types of plants and animals, and the majority of the world's geysers.

Figure 1. Location of Yellowstone National Park. While 96% of the park is in the state of Wyoming, 3% is in Montana and 1% is in Idaho.

The animals in Yellowstone include bison, grizzly bears, moose, and wolves. These animals interact with plants and other animals and with non-living things including air, water, and soil. Scientists study the interactions between living and non-living parts of the environment. Over time, they can use this information to tell how disruptions—events that change environments—affect these interactions. In this unit, you will investigate how and why environments get disrupted.

A geyser in Yellowstone National Park. A geyser is a natural hot spring that ejects hot water or steam into the air.

Guiding Question

How do living things interact with living and non-living parts of the environment?

Materials

For each student:

- Handout 1.1-1, "Video Guide: Wolves in Yellowstone"

Process & Procedure

Part One: Your Local Ecosystem

1. Think of an environment with lots of nature, such as a park, field, or garden, near where you live or that you know well. Discuss the following with your group, and then with the class.

a. Brainstorm a list of living things in that area.

b. How do you think these living things interact with each other?

c. Brainstorm a list of non-living things in that area.

d. How do you think the living things interact with non-living things in the area?

e. How do you think this area has changed over time? What types of events (disruptions) may have caused these changes?

Part Two: Wolves in Yellowstone

2. Do wolves belong in Yellowstone? See what you think after watching the video clip and reading the information on the next page. Use Handout 1.1-1, "Video Guide: Wolves in Yellowstone," to guide your understanding.

3. Discuss each of the following questions with your partner, and then with the class.

a. What are some living and non-living parts of Yellowstone? How do living things interact with each other and with non-living things?

b. What types of events (disruptions) have caused Yellowstone to change in the past? What types of events do you think will cause it to change in the future?

c. Why do you think park officials thought it would be a good thing to reintroduce wolves to the park? How do you think this has changed interactions between living and non-living parts of Yellowstone?

d. How are each of the following groups likely to feel about the reintroduction of wolves in Yellowstone National Park?

- Tourists who visit the park
- Cattle ranchers (people who raise animals such as cows for meat)
- People who live near the park
- Park rangers (people whose job it is to protect the park)

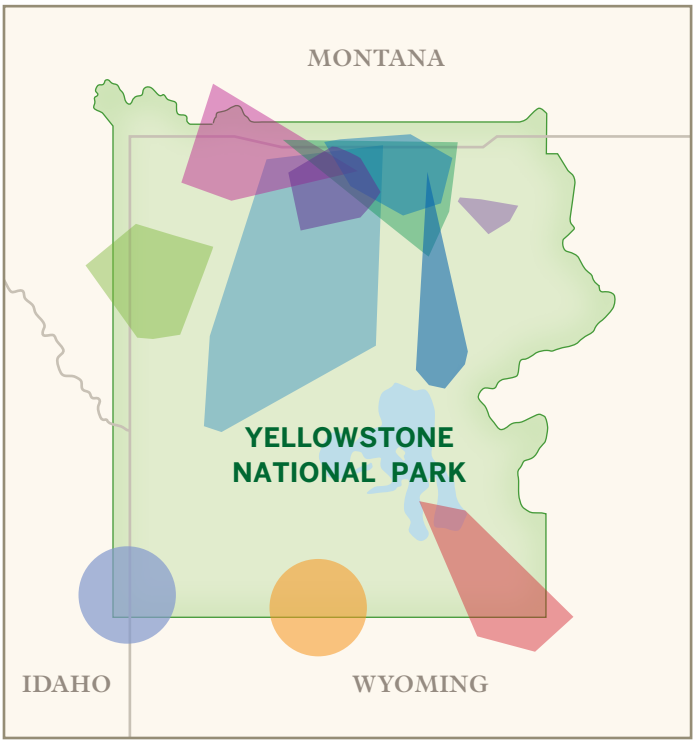
e. What is your opinion: do wolves belong in Yellowstone? Explain your reasoning.

Wolves in Yellowstone

When Yellowstone National Park was created in 1872, wolves were already living there. At the same time, the number of humans in the area and in the United States was increasing. Cattle ranches in Montana and Wyoming helped to meet the growing population's demand for meat. People killed large animals, such as wolves and bears, because they were worried about their effects on cattle, pets, other wildlife, and human safety. By 1930, there were no wolves left in Yellowstone National Park.

After the Endangered Species Act was passed in 1973, the gray wolf was listed as a protected species. This meant that wolves could no longer be killed. By the mid-1980s, there were packs of gray wolves in northwestern Montana, but none in Yellowstone National Park. Park officials decided to reintroduce the gray wolf into the park. They wanted to make the Yellowstone environment more like it was before large numbers of people arrived. They began with 14 wolves in 1995. These wolves had pups, and by the end of 1995 there were 21 wolves in the park. The number of wolves continued to increase, and today there are approximately 100 wolves in the park. They travel in packs that average four to nine wolves. These wolf packs move in and out of the park. They hunt small and large animals, including moose, deer, and bighorn sheep.

Figure 2.
Yellowstone National Park Wolf Packs and Their Ranges



Each colored shape on the map shows the range of one wolf pack.

Analysis

1. As you can see in Figure 2, "Yellowstone National Park Wolf Packs and Their Ranges," wolf packs can move and hunt outside the park.

a. List at least five animal species that can be found within the park. Are these animals likely to stay within the park boundaries? Explain your thinking.

b. How might the movement of animals into and out of the park affect how ranchers and other people in the area feel about wolves? Why?

2. What questions do you have about the interaction of animals and people in the Yellowstone environment? Share your ideas with your class. As a class, record these ideas on your KWL chart.

3. **a.** Do you think people should try to restore wild environments (like they have when reintroducing the wolf to Yellowstone)?

b. What scientific evidence supports your idea?

Extension

National parklands can be found all over the U.S. In Queens, New York, Jamaica Bay Wildlife Refuge is a part of the National Park Service where over 330 species of migrating birds have been seen. Other National Park sites include historic buildings, monuments, and battlefields. What National Park sites are located near where you live? Have these sites changed over time? How?

Explore: Ecological Interactions

After studying an environment, scientists may observe patterns in the way that living things interact. For example, they may observe that owls eat lots of mice and that mice eat seeds and insects. Scientists use diagrams to show the feeding relationships among the living things. You may know that these relationships can be shown as a single chain (Figure 1a) or as a web that provides a more complete picture (Figure 1b). Arrows point from the thing that is eaten to the thing that eats it. For example, in the chain in Figure 1a, the arrow from the grass to the grasshopper shows that the grasshopper eats the grass.

Figure 1a.
Food Chain

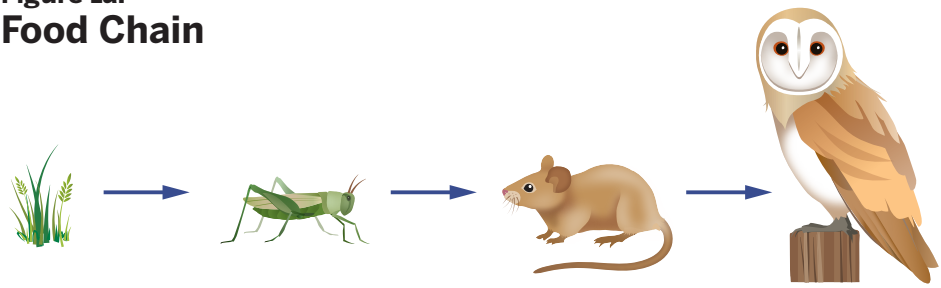
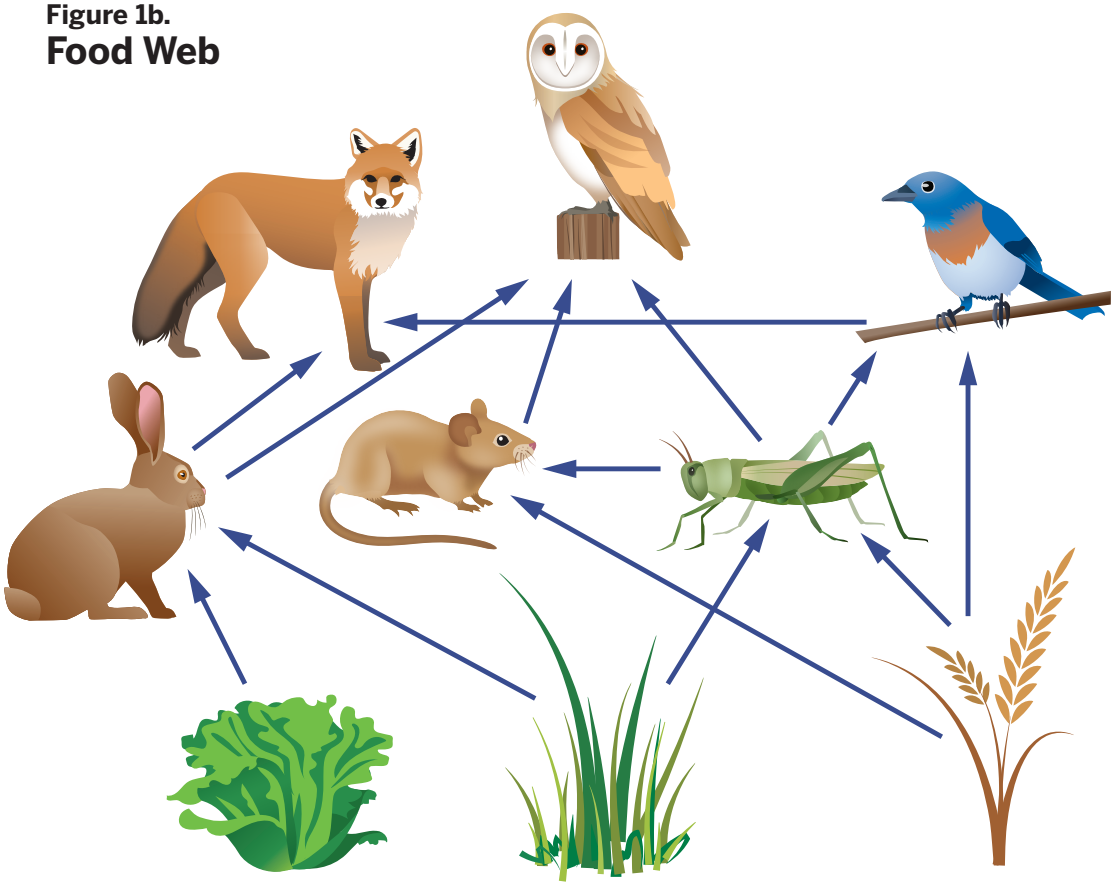


Figure 1b.
Food Web



Guiding Question

What effect did the reintroduction of wolves have on the food web in Yellowstone National Park?

Materials

For each group of four students:

- 1 set of 12 Yellowstone Food Web cards
- 1 additional Yellowstone Food Web card: Gray Wolf

For each student:

- Handout 1.2-1, "Yellowstone Food Web Data"

Process & Procedure

Part One: Investigating the Yellowstone Food Web in 1990

1. Work with your group to examine the 12 Yellowstone Food Web cards in your set. Consider which organisms (living things) are familiar to you and which are not.
2. Think about what the organisms on the Food Web cards might eat.
3. Work with your group to sort the cards into groups. Explain how you decided to group the cards.
4. As a group, choose three cards that make a simple food chain. Record your food chain in your science notebook.
5. Work with your group to create a food web using all of the cards in your set.
6. Record your food web. Use a full page of paper to draw your food web. Leave space around the name of each organism so that you have room to draw in arrows. Then draw arrows from the eaten organism to the animal that eats it.
7. Share and discuss your food web with another group of students. How similar or different are your ideas?

Hint

Put organisms with similar eating patterns on the same row of your food web to make it easy to understand (see sample food web in the introduction). If you are having difficulty with making the web, make several food chains and then work to combine them into a single food web.

8. Obtain a copy of Handout 1.2-1, "Yellowstone Food Web Data," from your teacher. Use the information on the handout to revise your food web.

9. Record your revised food web in your science notebook.

10. Discuss with your group the patterns of interaction among the organisms in your food web:

    - Which organisms play a similar role in the food web? Describe these roles.
    - What do you predict would happen to the food web if all of the plants died?

Part Two: Reintroducing the Gray Wolf in 1995

11. Your teacher will give you another Yellowstone Food Web card: the Gray Wolf.

12. Add the wolf to your revised food web.

13. Discuss with your group how the reintroduction of the wolf affected your food web.

14. Your teacher will introduce another organism into the food web: bacteria. With your class, discuss the role this organism plays in this environment and where to add it to the food web.

15. As a class, discuss what effect you think restoring wolves to the Yellowstone food web had on each of the following populations in the park. Explain your ideas.

    a. Elk

    b. Small animals

    c. Plants

Analysis

1. Describe the patterns of interaction among the organisms in your food web:

    a. Which animals eat other animals for food?

    b. Which animals compete for the same food source(s)?

    c. What role did the winter tick play in the food web?

d. What role did the bacteria play in the food web?

e. Look again at your food web and Handout 1.2-1. Find an example of a helpful relationship between two animals.

Hint

They do not have to be directly connected in your food web.

2. a. Add humans and cattle to your food web diagram.

b. Describe how humans and cattle change the food web.

3. People often think of grizzly bears as meat-eaters. Grizzlies eat everything, including plants, insects, and other animals. More than 80% of their diet comes from seeds, nuts, and other vegetation. Does a food web address the importance of different food sources in an organism's diet? Explain.

4. Review the list of organisms in a familiar environment that you developed for Part One of Activity 1.1.

a. Construct a food web for that area.

b. What similarities do you see between the food web you drew for question 5a and the Yellowstone food web? Share your ideas with your class. As a class, record these ideas on your KWL chart.

Explain: Patterns of Interaction Among Organisms

In an **ecosystem**, living organisms interact with each other and with non-living things in their environment. Ecosystems don't end at park borders. Yellowstone National Park is part of a larger area known as the Greater Yellowstone Ecosystem. The Greater Yellowstone Ecosystem refers to the park and nearby areas with similar plants and animals.

Figure 1. Map of Greater Yellowstone Ecosystem. How does the boundary of Yellowstone National Park compare to that of the Greater Yellowstone Ecosystem?

In an ecosystem, organisms interact in various ways. One type of organism may eat another, or may be eaten. Organisms can compete for resources such as food, space, or water. Organisms can also interact in other ways that may be helpful to one or both types of organism. In some cases, what is helpful to one can harm the other.

Elk and bison in Yellowstone. What interactions between living organisms do you observe in this photo?

Guiding Question

How do organisms interact with each other?

Materials

For each student:

- Handout 1.3-1, "Types of Interactions"

Process & Procedure

Part One: Types of Interactions

1. Watch and discuss three video clips describing patterns of interaction between types of organisms.
2. Work with your group to define these patterns of interaction and to provide an example of each from the video. Record your responses on Handout 1.3-1, "Types of Interactions," in the columns headed "My Group's Definition" and "Video Examples."
3. Share your definitions and examples with your class.

Part Two: Living Interactions in Ecosystems

4. Read the information on the next page about patterns of interaction between types of organisms.
5. Work with your group to revise your definition and add additional examples from the reading to the last two columns of Handout 1.3-1.

Types of Interactions

Predator-prey interactions, competition, and symbiosis are all interactions between living organisms. A **predator-prey** interaction involves a feeding relationship between two animals. The **predator** is the animal that kills and consumes another animal, called the **prey**. In the photo above the bear is the predator and the fish is the prey.

Competition can occur when two or more species require the same limited resources. Competition can cause one or both populations to go down. For example, in 1989 green crabs from Europe ended up in the San Francisco Bay. These crabs started eating up the clams in the Bay. Local yellow shore crabs now found it very hard to find clams to eat. Since 1989, the yellow shore crab population has gone down 90% in some areas.

Symbiosis includes mutualism, commensalism, and parasitism. These interactions are defined and illustrated below. Many symbiotic relationships have evolved over time. These established interactions do not usually change population sizes. However, if either population were to be affected by living or non-living factors, the other population might be affected in turn.

Type of Symbiosis

Mutualism helps both species involved.

The Nile crocodile allows the Egyptian plover to enter its open mouth. The plover benefits by eating small bits of food left on the crocodile's teeth. The crocodile benefits by having its mouth cleaned, reducing the chance of infection.

Commensalism helps one species, while neither helping nor harming the other.

Groundhogs (woodchucks) are the major hole-digging mammal of North America. Their abandoned burrows are used for shelter by foxes, opossums, raccoons, and skunks.

Parasitism benefits one species (the parasite), which lives in or on the other (the host). The host is usually harmed.

Tapeworms can live in the intestines of animals. They obtain nutrients from food passing through the intestines and harm the host by depriving them of needed nutrients.

Analysis

1. Identify each of the following as one of the five patterns of interaction being studied and explain your answers:

   a. Mountain lions eat deer

   b. Lice live on a person's head

   c. Hummingbirds feed on plant nectar

   d. Ladybugs eat aphids

   e. Deer and elk browse for shrubs in winter

   f. Vultures eat the remains of an animal killed by a mountain lion

   g. Roundworms live in the intestines of dogs

   h. Gophers dig tunnels and expose insects to nearby birds

   i. Bees gather nectar and pollinate flowers

2. Look back at the Yellowstone food web you developed in Activity 1.2, "Ecological Interactions." What patterns of interactions are in the food web? Copy the table below and provide an example of each pattern from this ecosystem.

Examples of Ecological Relationships in Yellowstone

Pattern of Interaction		Example
Predator-prey		
Competition		
Symbiosis	commensalism	
	mutualism	
	parasitism	

3. Give an example of how humans interact with another species in each of the following ways:

   a. Predator-prey

   b. Competition

   c. Mutualism

4. Explain the impact of humans on the food web in and near Yellowstone National Park during each of the following time periods. Use the scientific terms you have learned in this chapter (such as predator-prey, competition, symbiosis) to explain the interactions between humans and other organisms.

a. From the late 1800s to 1994 (Yellowstone was established in 1872)

b. From 1995 (when wolves were brought back to Yellowstone) to the present

Explain: Biotic and Abiotic Factors in Ecosystems

So far in this chapter, you have focused on the living organisms in an ecosystem and their interactions. Various factors can affect ecosystems. In some cases, living, or **biotic**, factors such as a predator or competition with another type of organism can affect population size. In other cases, non-living, or **abiotic**, factors, such as temperature, rainfall, or even the amount of pollution, can affect a population. The diagram below illustrates some biotic and abiotic factors in Yellowstone.

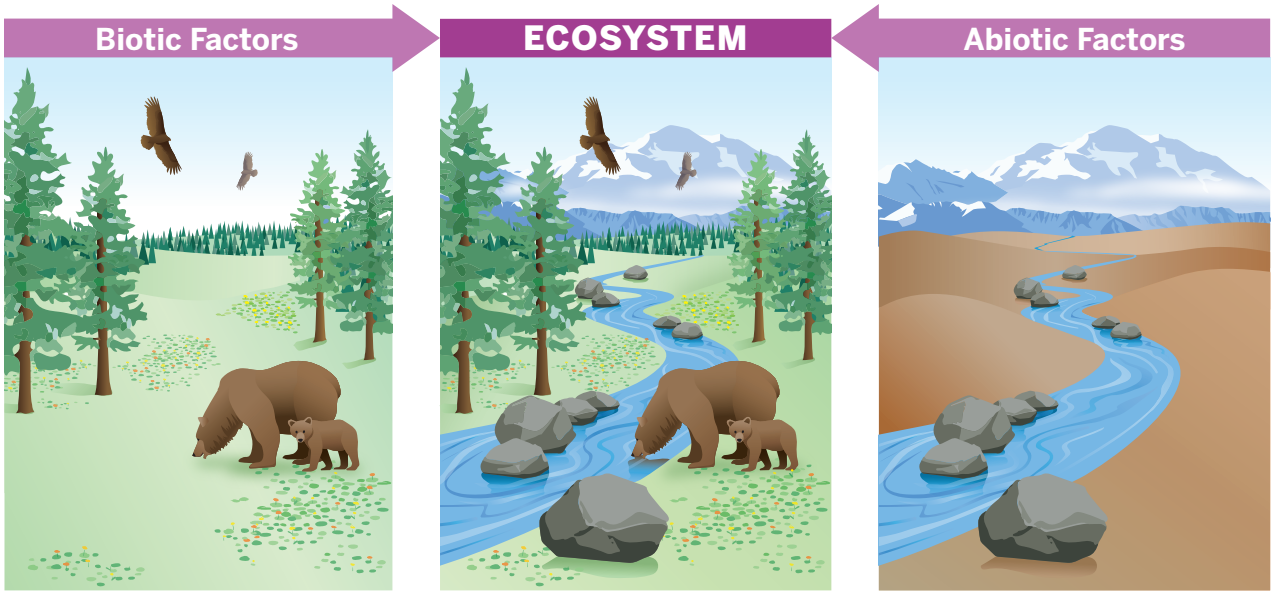
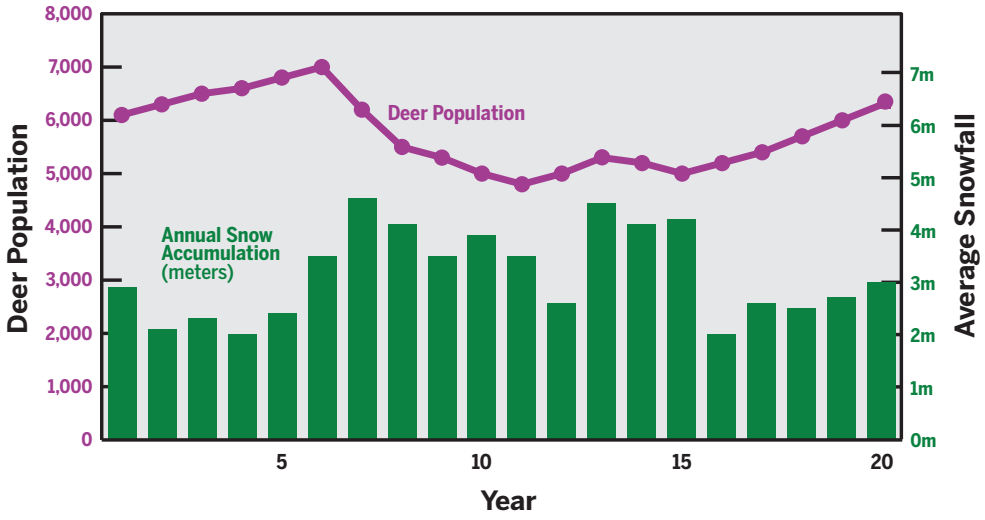


Figure 1. Biotic and Abiotic Factors in the Greater Yellowstone Ecosystem. What similarities and differences do you observe among the pictures? How does this help you understand biotic and abiotic factors?

Changes in the biotic and abiotic parts of an ecosystem often affect the populations of organisms that live there. For example, several years of heavy snow can weaken animals, or kill the plants they rely on for food. Graphing these measurements helps to reveal patterns. The graph on the next page shows a relationship between a deer population and average snowfall. After several years of very heavy snowfall during years 7-10, the deer population begins to decline.

Figure 2.
Deer Population and Average Snowfall



Guiding Question

What effects do biotic and abiotic factors have on populations?

Materials

For each student:

- Handout 1.4-1, "Predicting Predator-Prey Interactions"
- Handout 1.4-2, "Graphing Rainfall-Fawn Survival Data"
- 2 colored pencils

Process & Procedure

Part One: Biotic Factors Affecting a Population

1. Examine the graph of a predator population and the start of a graph for the prey population on Handout 1.4-1, "Predicting Predator-Prey Interactions." With your group, discuss the relationship between the population of predators and prey over time:

- What happens to the number of prey when the number of predators *increases*?
- What happens to the number of prey when the number of predators *decreases*?

2. **a.** On Handout 1.4-1, complete the pattern of the *predator* line.

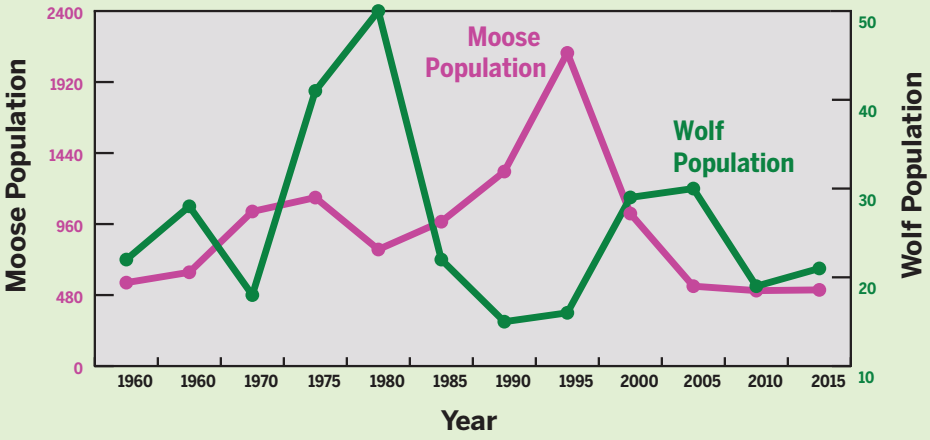
   b. Then predict what will happen to the prey population over time by drawing the rest of the *prey* population line.

3. Read about the wolves and moose on Isle Royale below.

Wolves and Moose on Isle Royale

One of the longest studies of predator-prey interactions is that of the wolves and moose on Isle Royale, Michigan. Isle Royale is an isolated island in Lake Superior. Wolves are the only large predators on the island. Moose eat plants. Isle Royale and smaller nearby islands are part of Isle Royale National Park.

Figure 3.
Wolf and Moose Populations in Isle Royale National Park 1960-2015



4. Discuss Figure 3, "Graph of Wolf and Moose Populations in Isle Royale National Park, 1960-2015," with your group, and then with your class:
   - What happens to the number of prey when the number of predators *increases*?
   - What happens to the number of prey when the number of predators *decreases*?
   - Does there appear to be a relationship between the populations of the predators and the prey?
   - What other factors could affect these predator and prey populations?
5. Figure 3 shows real data about a specific population of wolves and moose. Ecologists have used such information to create a graph showing the general pattern of interaction between predator and prey populations. Your teacher will help you record this predator-prey pattern on Handout 1.4-1.

Part Two: Abiotic Factors Affecting a Population

6. Read the information below about patterns of interaction between an organism and an abiotic factor.

Sonoran Pronghorn

One endangered species found in the Arizona desert ecosystem is the Sonoran pronghorn, the fastest land mammal in North America. They eat a variety of desert plants. Droughts have been increasingly frequent in the western United States, even in desert ecosystems. Young pronghorns, called fawns, are especially sensitive to drought conditions.

Table 1
Rainfall and Fawn Survival 1995-2002

Year	Rainfall (cm)	Fawns surviving to December (fawns per 100 females)
1995	11	12
1996	3	0
1997	4	0
1998	19	32
1999	6	0
2000	5	15
2001	15	78
2002	2	9

7. Work with your partner to use the data in Table 1, "Rainfall and Fawn Survival, 1995–2002," to construct graphs of fawn survival and rainfall. Use Handout 1.4-2, "Graphing Rainfall-Fawn Survival Data," to help you.

- Complete and label the scale on the x-axis.
- Complete and label the scales on the y-axes.
- Title your graph and create a key.
- Draw a bar graph for the rainfall data.
- Draw a line graph for the fawn data.

8. Discuss your graphs with your group:

- Describe how the amount of rain changed over time.
- Describe how the survival rate of fawns changed over time.
- Does there appear to be a relationship between rainfall and fawn survival? What is it?
- What effect could these changes have on the pronghorn population?
- What other factors could be affecting the survival rate of fawns?

Analysis

1. Describe the pattern the graph shows in the interaction between wolves and moose on Isle Royale, Michigan.

a. What do you think might cause this pattern?

b. What other living factors could affect the size of moose population?

c. What abiotic factors could affect the size of the moose population?

d. Looking at Figure 1, what do you predict will happen to the size of the wolf and moose populations over the next 10 years? Explain your reasoning.

2. Describe the pattern in the relationship between Sonoran pronghorn fawns and rainfall.

a. What do you think might cause this pattern?

b. What other abiotic factors could affect the survival rate of fawns?

c. What biotic factors could affect the survival rate of fawns?

d. What do you predict would happen to the survival rate of fawns if rainfall levels stayed high? Explain your reasoning.

3. What advantage(s) does the Isle Royale ecosystem provide to scientists studying predator-prey relationships that the Yellowstone ecosystem does not?

4. Pigeons are native to Europe, Asia, and northern Africa. They originally nested on cliffs and ledges. Their diet included seeds, grains, and some fruit and insects. Their predators included large birds, such as hawks, and mammals, such as raccoons and foxes. Pigeons are one of the few animals that are very successful in urban ecosystems with dense human populations.

Why are pigeons successful in urban ecosystems? Use what you know about biotic and abiotic factors in your answer.

Hint

Think about your Yellowstone food web.

Elaborate: Analyzing Patterns in Ecosystems

Organisms in an ecosystem interact with both biotic and abiotic factors. For example, squirrels in a city park are affected by biotic factors, such as the availability of food. Abiotic factors, such as water shortages could also affect the population size. Scientists observe and gather information about ecosystems. They use the information to create explanations. For example, an explanation of why a squirrel population in a park has decreased over time could include an increase in the predator population and the loss of parkland. Understanding such an explanation would require knowledge of predator-prey interactions and the role of abiotic factors in an ecosystem.

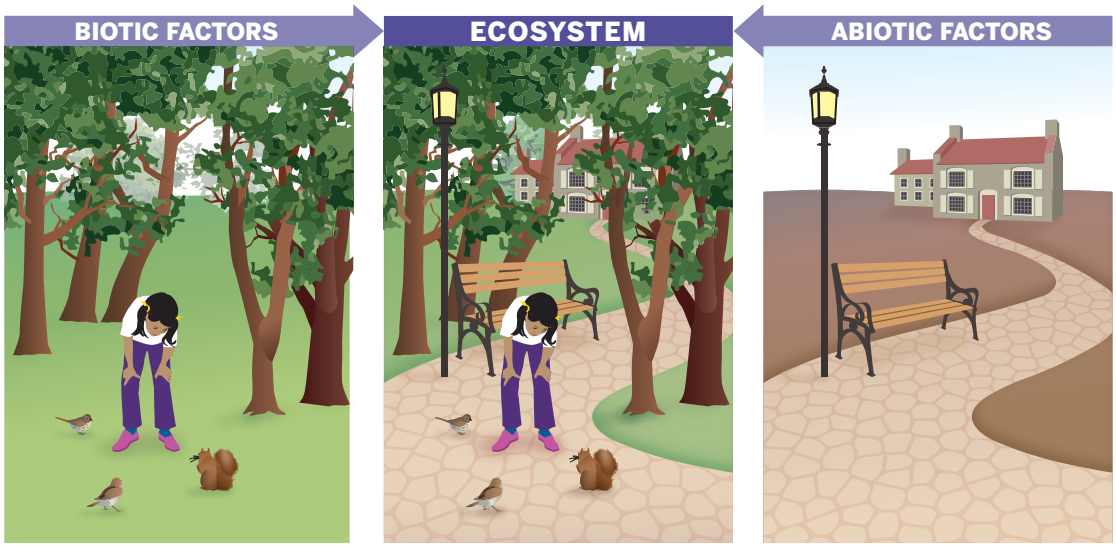


Figure 1. Biotic and abiotic factors in a local ecosystem. What similarities and differences do you observe among the pictures?

Guiding Question

How do biotic and abiotic factors affect patterns of interaction among organisms?

Materials

For each student:

- Handout 1.5-1, "Patterns of Interaction"
- 1 Handout: Explanation Tool

Process & Procedure

1. Read the six scenarios described below. Each one describes an interaction between a population and an abiotic or biotic factor.
2. Work with your group to examine the patterns of interaction

SCENARIO 1: Freshwater Lake Fish

Rainbow smelt are a freshwater fish that can survive in a wide range of lake environments. When rainbow smelt were introduced to Crystal Lake in northern Wisconsin, they quickly changed ecological interactions in the lake. For example, they ate up much of the food preferred by other fish. They have nearly eliminated the yellow perch, another type of fish.

SCENARIO 2: Marine Worms and Ocean Temperatures

A kind of scaleworm lives on sea stars in shallow ocean waters of the Pacific northwestern U.S. The population of the worms increases when water temperatures drop in winter, and then the population decreases as water temperatures rise through the summer.

SCENARIO 3: Insects in Fields and Orchards

Insects are a pest in crop fields, orchards, and other farmland. Evidence suggests that the introduction of a parasitic wasp can cause the populations of certain insect pests in farm fields to decline.

SCENARIO 4: Phosphorus and Algae Growth

Phosphorus is an abiotic substance needed by plants and algae to grow. When phosphorus levels in water rise due to sewage waste, the population of algae increases.

SCENARIO 5: Canadian Lynx and Snowshoe Hare

The Canada lynx is a member of the cat family, not much larger than a house cat. In northern Canada, the lynx prefers to eat snowshoe hare. When the snowshoe hare population decreases, the lynx kittens are often unable to survive.

SCENARIO 6: Oxygen and Fish Populations

Investigations of a fish population in a lake showed that it was able to survive some decrease in oxygen. But as oxygen levels continued to drop, the fish population decreased rapidly.

illustrated by the graphs on Handout 1.5-1, "Patterns of Interaction." Describe what is happening to each line on the graph and how it relates to the other line.

3. Work together to match each scenario to one or more graphs. Record the graph(s) that match the scenario.
4. If the interaction is biotic, discuss with your group what pattern of interaction may be occurring (predator-prey, competition, mutualism, commensalism, or parasitism). Record this information on Handout 1.5-1, making sure to explain your reasoning.
5. With your group, discuss what you think might happen to the organisms on each graph over time.
6. Your teacher will model the use of an Explanation Tool. This tool will help you construct a scientific explanation.
7. Your teacher will assign your group to focus on one of the six scenarios. Review why you think the graph you selected matches this scenario.
8. Using the Explanation Tool, construct a scientific explanation about the pattern of interaction in your scenario. Use the steps below to guide you as you use the Explanation Tool.

- **Question:** Record the question "Which graph best represents the pattern of interaction described in your scenario?"
- **Evidence:** Examine the data in the graph(s) that you matched with your scenario. What patterns do you notice? Describe these patterns to use them as evidence.
- **Science Concepts:** List any science concepts that are connected to the evidence and might help answer the question.
- **Scientific Reasoning:** Describe the scientific reasoning that connects the evidence and science concepts to the question you are trying to answer.
- **Claim:** Based on the evidence of patterns in the data and on your scientific reasoning, state your claim about the patterns of interaction in your scenario.

Analysis

1. **a.** What pattern of interaction was the reintroduction of wolves to Yellowstone?

   b. What do you think a graph showing Yellowstone wolves and elk populations over time would look like? Sketch out your ideas. Discuss your sketched graph with your class.

   c. Would a graph showing Yellowstone bears and elk populations over time look similar or different to the graph you created in Question 1(b)? Explain your reasoning.

2. What happens when humans disrupt ecosystems? Share your ideas with your class. As a class, record these ideas on your KWL chart.

Evaluate: Disrupting Ecosystems with Wolves

As you have seen, biotic and abiotic factors can affect an ecosystem in many ways. For example, the number of elk in the Greater Yellowstone ecosystem increased greatly after the wolves were gone. The reintroduction of wolves to Yellowstone contributed to a smaller elk population, as shown in Figure 1 below. Other factors, include disease, severe winter weather, drought, and hunting, also played a role in decreasing elk populations.

An explanation of why elk populations are smaller today than 20 years ago includes the reintroduction of a predator, disease, weather, and hunting. In many parts of the United States, white-tailed deer populations are at very high levels. Is it time to reintroduce a predator such as the wolf?

Figure 1.
Wolf and Elk Populations, 1994–2014

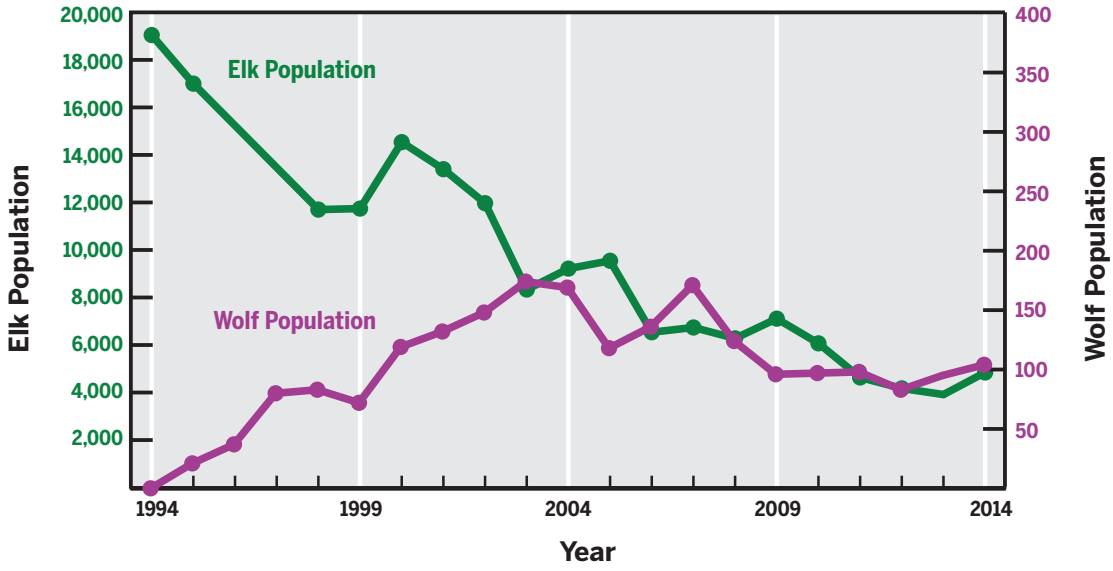


Figure 1. Wolves were reintroduced into Yellowstone in 1995, and they have been counted every year since. Elk counts were made in and near the northern border of the park during the winter. There are no elk data for 1996 and 1997 because of weather.

Guiding Question

Should wolves be reintroduced into the northeastern United States?

Materials

For each student:

- 1 Handout 1.6-1, "DART: Reading Support for Activity 1.6"
- 1 Handout: Explanation Tool

Process & Procedure

Part One: Interactions between Deer and Wolves

1. Use Handout 1.6-1, "DART: Reading Support for Activity 1.6," with the reading on the following pages.

Part Two: Developing an Explanation

2. Use information from the reading and the Handout: Explanation Tool to construct a scientific explanation answering the question "What effect does a large population of deer have on an ecosystem?" Use the steps below to guide you as you use the Explanation Tool.

- **Question:** Record the question "What effect does a large population of deer have on an ecosystem?"
- **Evidence:** Examine information and data from the reading.
- **Science Concepts:** List any science concepts that are connected to the evidence and might help answer the question.
- **Scientific Reasoning:** Describe the scientific reasoning that connects the evidence and science concepts to the question you are trying to answer.
- **Claim:** Based on the evidence of patterns in the data and on your scientific reasoning, state your claim about the effect of a large population of deer on an ecosystem.

Part Three: Using Evidence

3. Use information from the reading, what you have learned in this chapter, and your Explanation Tool to decide:
    - Should wolves be reintroduced into the northeastern U.S. Adirondack ecosystem? Why or why not?
4. Participate in a walking debate with your class to see what others think about this issue. Discuss your points of view, supporting your ideas with scientific evidence from this unit. You may also want to add ideas to your class KWL chart.

Populations of Deer

In this chapter, you have closely examined the Greater Yellowstone ecosystem. People often think of the animals in this ecosystem as living only in the western U.S. At one time, many of these animals existed in large numbers in other parts of the U.S. For example, bears, wolves, elk, and moose were found across the northern states. Today, black bears and moose can still be found in upstate New York and other northeastern states.

One species that thrives in much of the U.S. is deer. White-tailed deer in particular have been successful in the absence of predators. You may have heard of white-tailed deer because it is a host animal for the blacklegged tick, also known as the deer tick. This tick sometimes carries Lyme disease, which can be transmitted to humans when they are bitten by an infected tick. Lyme disease is a growing problem, especially in the Northeast and upper Midwest.

The white-tailed deer population was estimated to be over 30 million a few hundred years ago. Deer, as well as the wolves that ate them, were hunted almost to extinction in the early part of the 20th century. Deer populations recovered when wildlife protections were put into place and predator populations remained low. Today, large deer populations mean that hunters can apply for licenses to kill deer during certain times of the year.

Figure 2.
Number of Deer Intentionally Killed by People, 2000-2013

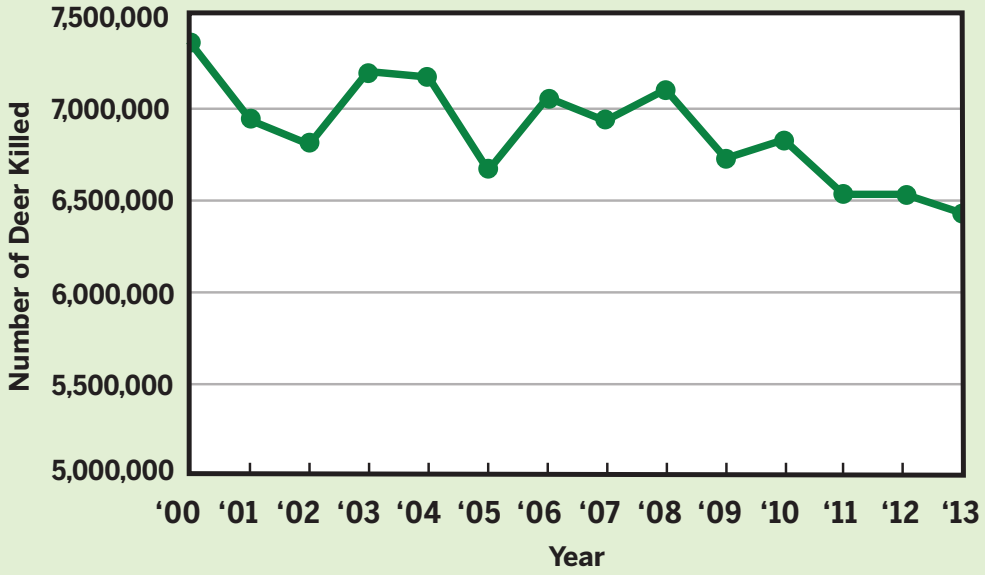


Figure 2 shows that the number of deer killed in 2000 was over 7 million, which dropped to just under 6.5 million in 2013. This represents a 12.6% drop in killed deer.

Deer Within an Ecosystem

Today, white-tailed deer are found throughout North America, from Canada to Mexico. In the northeast, bobcats, coyotes, and black bears eat deer, usually scavenging dead deer. Bobcats and coyotes also hunt them in the winter when the deer are tired and slowed by deep snow. However, these interactions are not enough to reduce deer populations.

White-tailed deer usually live at the forest edge, and are often found in fields and grasslands during summer months. They eat

Trillium

plant leaves, twigs, buds, nuts, and fruits and vegetables. They do not eat grass. The deer scatter seeds in their droppings, spreading certain plant species like *Trillium* (at left) up to 3 kilometers from their original site.

White-tailed deer eat about 3% of their body weight per day, which can be 1–5 kilograms (2–10 pounds) of plant material a day. When large numbers of deer are concentrated in an area, their feeding can affect the local ecosystem, reducing the diversity of plants and small animals. As you can see in the photos below the healthy forest (on the left) has new plant growth on the forest floor as well as on the lower layers of the forest. The forest on the right shows signs of overgrazing. Numerous studies have shown that this can occur when large numbers of herbivores such as deer are feeding in one area.

The healthy forest at left has typical plant life on the forest floor. The overgrazed forest at right lacks young trees, shrub, and other plants typical of a healthy forest.

Deer can also affect the number of songbirds in a forest. Some songbird populations eat or nest in the same trees and shrubs that are consumed by deer. One study found that bird counts across the U.S. showed that high populations of deer correlated with declining populations of these songbird species.

People and Deer

Hungry deer are not restricted to wild ecosystems. Urban and sub- urban areas with high deer populations routinely have problems with deer eating flowers, vegetables, shrubs, and other neighborhood plants. It is estimated that they cause about $250 million in damage to these environments, as well as another $100 million in damage to cropland.

By far the greatest damage results from collisions between deer and cars. On average, over one million such collisions occur each year. This can sometimes result in human injury or death as well as the death of the deer. Damage to cars involved in deer collisions is estimated to be 1-4 billion dollars a year.

Controlling Deer Populations

Hunting is one way to control deer populations. White-tailed deer are one of the most commonly hunted species in the U.S., with approximately six million deer killed each year. In most cases, the dead animals are used for food.

In addition to hunting to reduce deer populations, some people have proposed reintroducing wolves into areas such as

the Adirondacks in upstate New York. The Adirondacks are a mountainous area inside Adirondack Park, the largest preserve in the lower 48 states and considerably larger than Yellowstone National Park.

The park contains mountains, lakes, rivers, forests, and many types of plants and animals. The park covers about 6 million acres, of which 45% is protected public land. Much of the private land is used for agriculture, forestry, and open space. There are 105 towns and villages within the park, and over 60 million people live within a day's drive of the park.

Analysis

1. In this activity, you investigated the question, "Should wolves be reintroduced into the northeastern U.S. Adirondack ecosystem?" Some students may have argued that wolves should be reintroduced, while other students may have argued that wolves should not be reintroduced. As a class, discuss:

   a. What scientific evidence supports each side of this debate?

   b. Discuss the quality and strength of the evidence that supports each side.