PRAIRIE DOG DAYS

How Fleas Transmit the Plague and its Effects on Gunnison's Prairie Dog

Meet the Scientists!

Dr. Megan Friggens, ecologist

My first favorite science experience was taking a 10-day field trip to Belize (bə **lēz**) as part of a college tropical biology class. Belize is in Central America. This trip was my first opportunity to travel to and live in a tropical jungle. I also explored Belize's **cays** and **reefs**. I saw animals in the wild, such as howler monkeys and barracudas. I did a field study on a plant that eats insects. I also learned a lot about the local human populations. These people were often leading the efforts to **conserve** wild **habitats** and animal **species**. During this time I slept in a hammock, was attacked by tiny biting flies, and swam in crocodile-infested waters (the crocodiles were too small to hurt me). By the end of it all, I knew that I was going to be an ecologist.

Dr. Bob Parmenter, chief scientist, biologist, and ecologist

My favorite science experience was (and still is) tracking the recovery of the plants, fish, and wildlife following the very large Las Conchas wildfire. This wildfire burned through northern New Mexico in the summer of 2011. I monitor the populations of bears, mountain lions, elk, deer, squirrels, mice, birds, salamanders, and fish. I also monitor invertebrates, including grasshoppers, beetles, spiders, ants, wasps, butterflies, and moths. It's fascinating to see how all these species respond to large forest fires in New Mexico.

Dr. Paulette Ford,
ecologist

My favorite science experiences are when I am outside at my experimental research sites. I love to be outside studying plants and animals! As a scientist, I also get to travel around the world to talk about my research and to explore different ecosystems. I've been to grasslands, forests, jungles, deserts, mountains, oceans, rivers, and swamps all over the world. I never stop learning, and that is big fun!

Dr. Kenneth Gage,
medical entomologist and zoologist

My favorite science experience happened while working at the Centers for Disease Control and Prevention. I was traveling to a remote village in the Andes Mountains of Peru. An outbreak of plague was occurring in the village. Plague is a rare but dangerous disease that can be fatal if not quickly treated with the right medicines. Humans can get the disease when they are bitten by infected fleas or handle infected animals.

In the village, some people had become sick after handling infected animals. Others had become ill after being bitten by infected fleas found in their homes or fields. The village could not be reached by road. My Peruvian colleagues and I had to ride mules up a very narrow trail that often passed by steep slopes and cliffs. In addition to riding mules, we also used seven small donkeys to carry the equipment and supplies needed to control the outbreak.

At one point, a rope used to tie some of the equipment to one of the donkeys broke. This caused the donkey to begin kicking. As it kicked, the equipment bounced up and down, making loud noises that frightened the mules and donkeys and caused them to begin braying loudly. At the same time, my mule started to buck, causing the stirrup on my saddle to break off. At that point, I was barely holding on and thought I was going to be bucked off my mule and over a cliff. Fortunately, I was able to hang on and made it safely to the village. The people there treated us kindly and greatly supported our work, making this trip a memorable and rewarding experience.

In this photo, I am investigating a case of human plague.

What Kind of Scientist Did This Research?

ecologist: This scientist studies the relationship of living things with each other and with the nonliving environment.

chief scientist: This scientist leads other scientists in a particular research area.

biologist: This scientist studies living organisms and systems.

medical entomologist: This scientist studies medically important arthropods, such as fleas, ticks, and mosquitoes.

zoologist: This scientist studies animals and animal life.

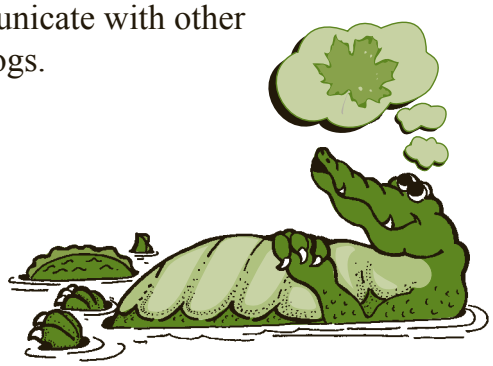
Thinking About Science

When scientists start a research project, they must do several things. First, they identify the problem they are interested in researching. Second, scientists develop a research question. Next, they design a study that helps them answer their research question.

It is not easy to design a study to answer a research question. To design a study, scientists must read a lot about the topic of interest. Scientists also need to find out if other research has been done on this topic. If other research has been done, scientists learn about what the other scientists did and how it applies to their new study. After scientists have done this reading and research, they design their study. In this article, scientists designed a research study to learn more about how **plague** affects prairie dogs and their environment. Plague is a disease that is easily spread to other animals.

Thinking About the Environment

A prairie dog is not really a dog! It is a large ground squirrel, a type of **rodent**, which lives on the **prairie** **(figures 1a, 1b, and 2)**. Prairie dogs get their name from where they live and the "barking" sound they make. Prairie dogs make this sound to communicate with other prairie dogs.



Figures 1a and 1b. Prairies are wide open spaces with grasslands and very few trees. Photos courtesy of U.S. Fish and Wildlife Service.

Figure 2. A white-tailed prairie dog standing guard. Photo courtesy of U.S. Fish and Wildlife Service.

Prairie dogs are social animals that live in large underground **burrows** **(figure 3)**. These underground burrows are called towns. Prairie dog towns are built by prairie dogs. The burrows have many long tunnels and rooms. The burrows have rooms used as nurseries, sleeping areas, and even bathrooms! When a female prairie dog is ready to have a baby, she goes into the nursery and gives birth to her baby. A baby prairie dog is called a "pup." Pups are hairless and don't open their eyes until they are about 6 weeks old.

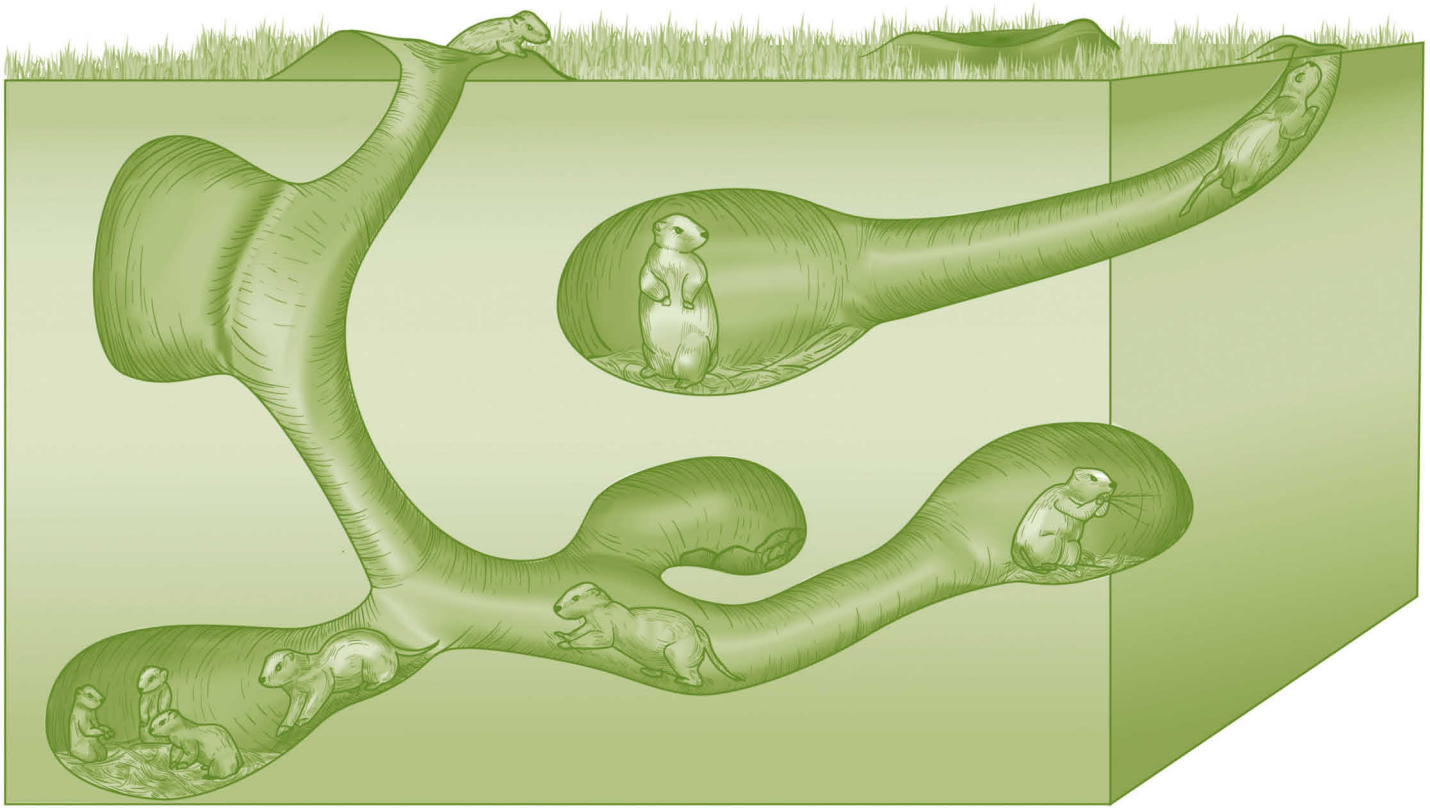


Figure 3. Prairie dog towns have many tunnels and "rooms."
Illustration by Samantha Bond.

Prairie dogs feed on grasses, roots, and seeds. In the past, ranchers thought prairie dogs were bad for ranch land because they would eat the grasses and dig holes in the soil **(figure 4)**. Cows and horses might accidentally step into the holes and hurt their legs. Because some ranchers thought prairie dogs were a problem, some people worked to get rid of prairie dogs. Scientists believe the prairie dog population has declined to a small percentage of what it was. An effort to get rid of prairie dogs, however, is not the only reason the prairie dog population is declining. In this article, you will learn about another problem prairie dogs are facing.

Figure 4. Two prairie dogs sitting near the entrance of their burrow. These holes are potential problems for horses and cows because they may accidentally step into them. Photo courtesy of the National Park Service.

WHY ARE PRAIRIE DOGS IMPORTANT?

Some efforts are underway to increase the populations of prairie dogs. A number of experts argue that prairie dogs are good for the ecosystem because they help **aerate** the soil. Aerating the soil helps more water get into the soil. Additionally, prairie dog scat or "poop" is high in nitrogen, which is good for the soil. Nitrogen is a **nutrient** used by plants and soil **bacteria**. Several predators, such as snakes and ferrets, rely on prairie dogs for food.

Introduction

Fleas present a problem for prairie dogs. Fleas are tiny, wingless insects that feed on the blood of other animals **(figure 5)**. Fleas can **transmit** diseases to other animals. Fleas transmit diseases by biting a diseased animal and carrying the disease to the next animal they bite. Plague is an **infectious** disease that is transmitted to other **mammals** by fleas. Prairie dogs are particularly **susceptible** to plague.

Prairie dogs are susceptible to plague for two reasons. First, prairie dogs have no natural **immunity** to plague. Second, prairie dogs live in large colonies with complex burrow systems. Burrows, and the large number of animals in a small area, are good conditions for fleas to survive and reproduce. More fleas in burrows greatly increase the chances of prairie dogs getting plague.

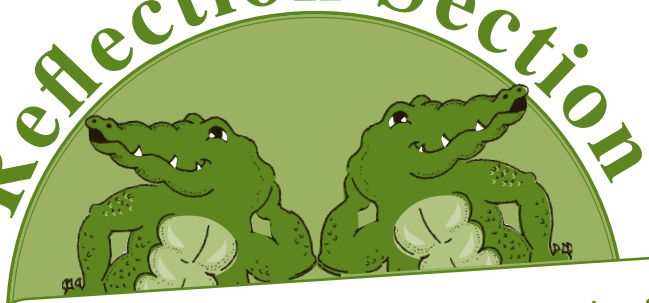
Plague is dangerous to all mammals. About 95 percent of the prairie dogs living in a colony may die from plague if exposed to it. The high death rate of prairie dogs exposed to plague also affects animals that depend on prairie dogs for food. An example of an animal that depends on prairie dogs is the black-footed ferret **(figures 6a and 6b)**. The scientists in this study were interested in figuring out which flea **species** transmit plague within a population of prairie dogs. The scientists also wanted to know if the burrows played a part in the plague outbreaks.

Figure 5. Fleas can transmit diseases to mammals such as prairie dogs. Photo courtesy of Thinkstock.com.

Figure 6a. A black-footed ferret looks over his shoulder. Photo courtesy of U.S. Fish and Wildlife Service.

Figure 6b. A black-footed ferret peeks out of a prairie dog hole. Photo courtesy of U.S. Fish and Wildlife Service.

Reflection Section



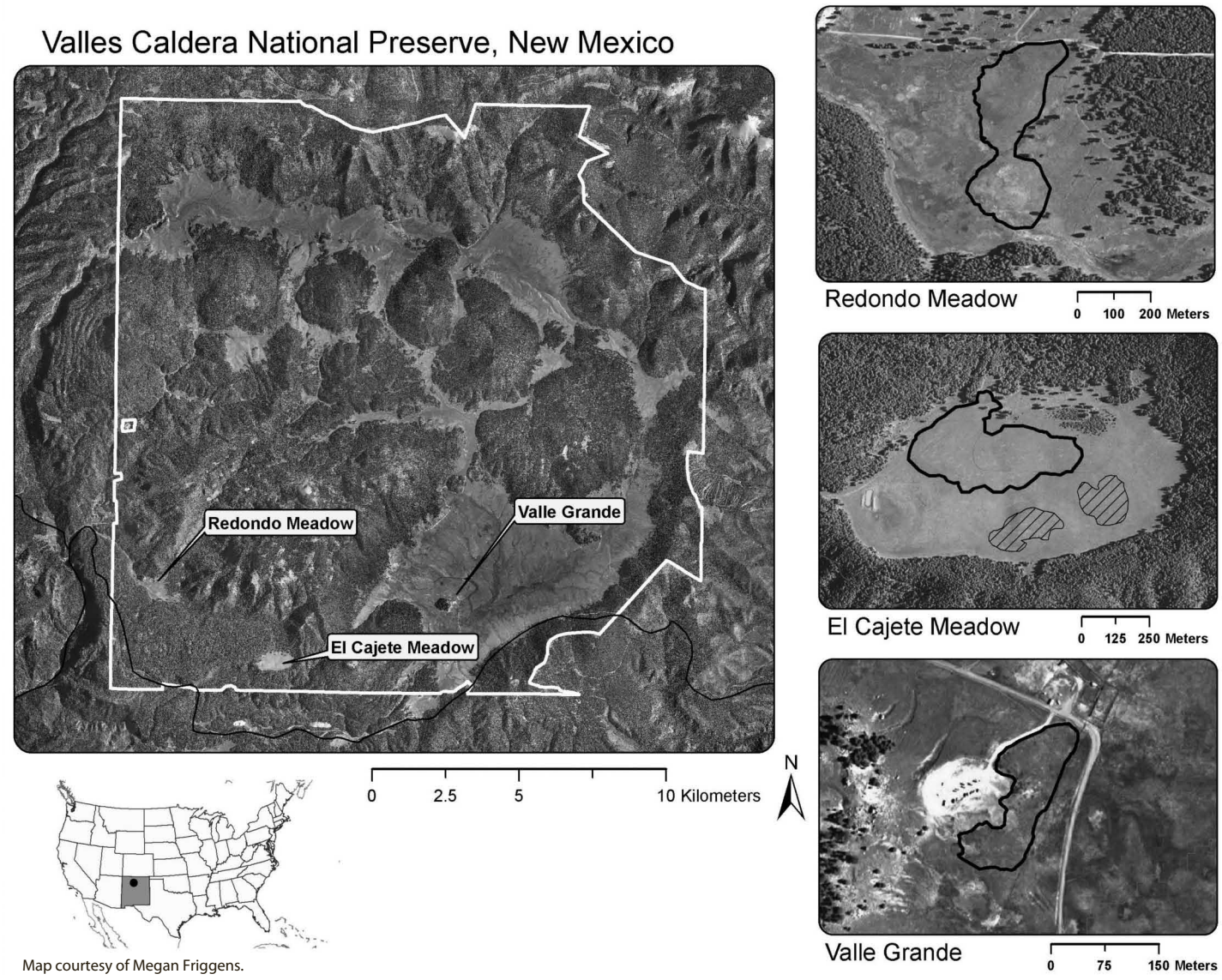
- What are the questions the scientists want to answer?
- Prairie dogs have no natural immunity to the plague. Think about some things to which humans are not immune. Why do you think a strong immune system is helpful? What are some ways you can help protect yourself from illness?

Number Crunch

Ninety-five percent of the prairie dogs in a colony may die from being exposed to plague. If 100 prairie dogs are exposed to the plague, how many would probably survive?

Methods

The scientists conducted their study in Valles Caldera National Preserve in New Mexico **(figure 7)**. The scientists specifically studied the Gunnison's prairie dog **(figures 8 and 9)**. The study was completed over 3 years from 2004-2006. The study areas were located in **montane** grassland habitats. Montane grasslands are grasslands located in high elevations. Three grassland habitats were selected: 1) Redondo Meadow, 2) El Cajete, and 3) Valle Grande **(figures 10a and 10b)**.



Map courtesy of Megan Friggens.

Figure 7. Valles Caldera National Preserve is located in New Mexico.

Figures 8 and 9. Gunnison's prairie dogs. What do you notice about prairie dogs that may be useful for where they live? Photos by Lisa Lynch, National Park Service.

Figure 10a.
El Cajete is a montane grassland. Montane grasslands are located at high elevations. Photo courtesy of www.vallescaldera.gov.

Figure 10b. Valle Grande is the largest grassland in the Valles Caldera National Preserve. Only one road goes through this grassland. Look closely and you may be able to see the road in this photo. Photo courtesy of www.vallescaldera.gov.

WHAT IS ELEVATION?

Elevation is the distance above a reference point. When we talk about the elevation of land, the reference point is the level of the sea **(figure 11)**. The areas in this study were between 2,460 and 2,640 meters above sea level. Compare this to one of the highest points of elevation in the world, Mount Everest, which is 8,848 meters above sea level. One of the lowest land elevations in the world is the area where the Dead Sea is located. The Dead Sea is located in the Middle East. The Dead Sea area is over 400 meters (over 1,300 feet) below sea level. The lowest land elevation in the United States is in Death Valley, California. The elevation in Death Valley is 86 meters (282 feet) below sea level. Do research about areas around where you live and see how their elevations compare!

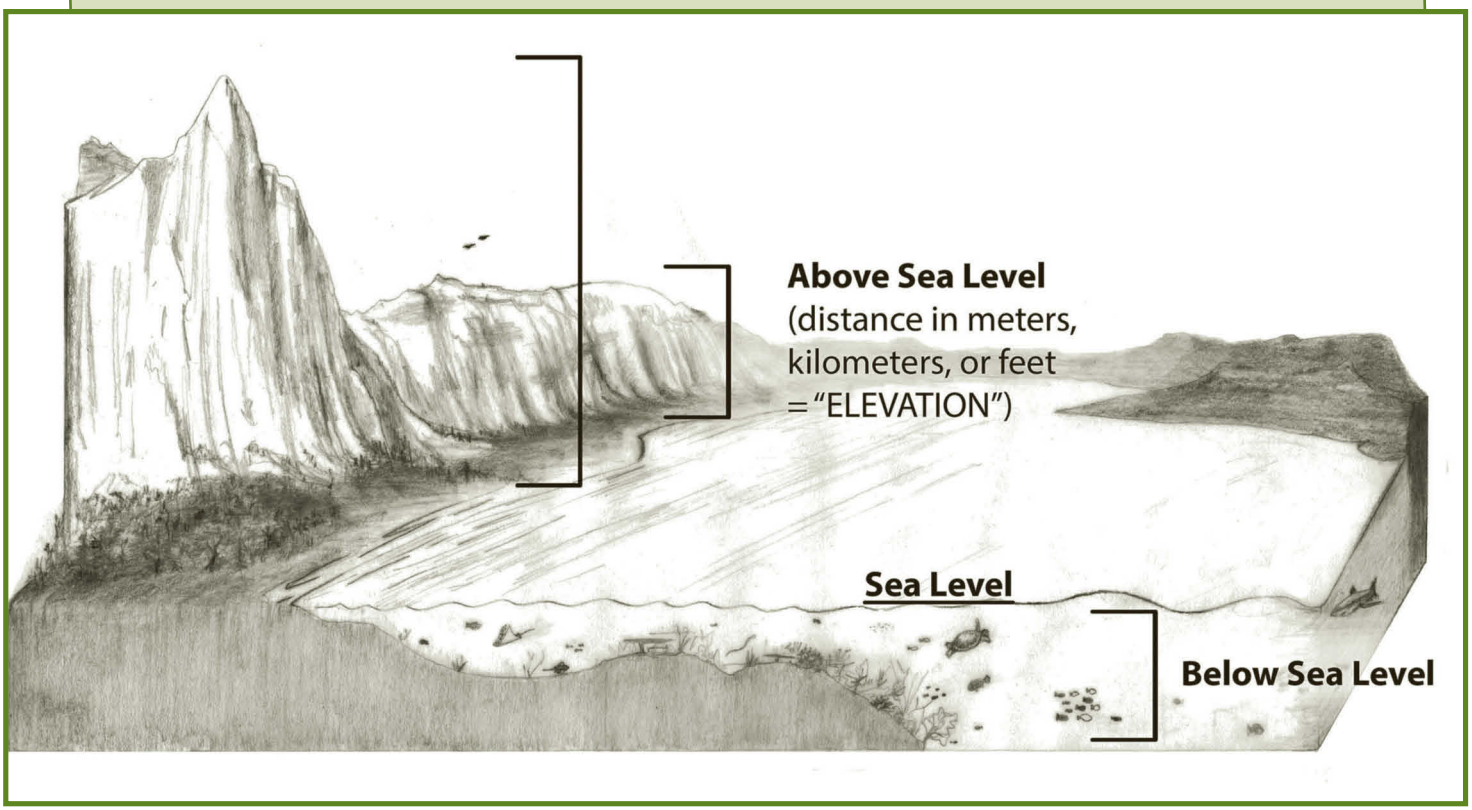


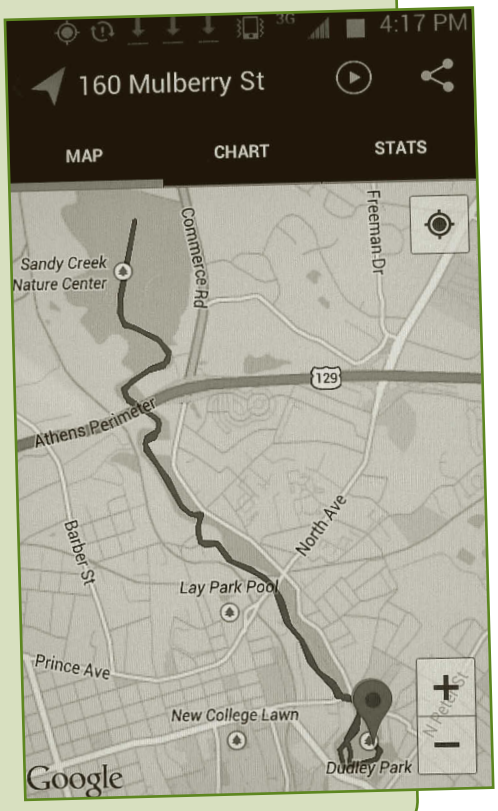
Figure 11. Elevation is the distance above or below the level of the sea.
Illustration by Stephanie Pfeiffer.

The scientists examined each colony. During their study of the colonies, the scientists did several things. They live-trapped prairie dogs **(figure 12)**. Live-trapping is a technique where animals are trapped for science research. They are not harmed and they are released back to their environment. The scientists did this in the spring and summer each year. During the first trapping session, the scientists marked and took global positioning system (GPS) **coordinates** of active burrows. GPS coordinates help scientists specifically locate and map areas such as prairie dog burrows.

Figure 12. Scientists captured this Gunnison's prairie dog for their study. The prairie dog is caught in a live-trap. This trap does not hurt the prairie dogs and when the scientists are finished working with the animals, the animals are released back into their habitat. Photo courtesy of Megan Friggens.

WHAT IS A GLOBAL POSITIONING SYSTEM (GPS)?

A GPS is a navigation system. GPS stands for Global Positioning System. A GPS can tell the exact coordinates of where you are located on Earth. A GPS works by using satellites orbiting Earth to send information to GPS receivers. At any time, at least three satellites are able to send signals to any receiver on Earth. GPS was designed in 1973 by the United States military. The military designed GPS to help soldiers and military vehicles find their exact location anywhere in the world. Today, GPS units are used in a wide variety of ways. Often, cell phones have GPS receivers and you may even have a GPS device in your car that tells you directions!



The scientists identified an active burrow by looking for scat (or "poop"), scratch marks on the ground near burrow entrances, or the presence of a lot of flies at each burrow entrance. If a burrow appeared abandoned, then the scientists made a note of this and chose a new burrow close by.

The burrows and prairie dogs were examined for the presence of fleas. When prairie dogs were captured, the scientists held them over a plastic bin containing a felt cloth. They brushed the fur with a flea comb or toothbrush. After brushing, the fleas fell into the plastic container and onto the cloth. They were then collected by the scientists.

The scientists collected fleas from the burrows. The burrows were swabbed by attaching a white flannel cloth to the end of a plumber's snake **(figure 13)**. The scientists pushed the plumber's snake down into the tunnels. The scientists extended the plumber's snake at least 1 meter (3.281 feet) into the burrow and held it there for 30 seconds. The scientists wiggled the flannel while down in the hole to imitate an animal. Sometimes the scientists blew on the flannel to attract fleas since fleas are also drawn to carbon dioxide.

The scientists took the plumber's snake out and then placed the flannel cloth into a plastic bag so the fleas could be collected. The scientists identified and examined the fleas using a dissecting microscope **(figure 14)**. Blood samples were taken from the fleas to test for plague.

Figure 13. The scientists used a plumber's snake and other equipment to collect fleas. Photo courtesy of Megan Friggens.

Figure 14. A dissecting microscope is useful for examining very small animals or objects. In this study, the scientists used the dissecting microscope to identify what type of flea they had found. A dissecting microscope enables scientists to see the sample in 3-D. Photo by Jessica Nickelsen.

The scientists used flannel cloth to capture fleas. Why do you think they used this kind of material? Do you think a slick surface would have been as effective at capturing the fleas? Why or why not?

The scientists used a dissecting microscope to identify the fleas. Why do you think the microscope was used instead of just looking at the fleas with the naked eye to figure out what species they were?

Findings

The scientists examined 130 prairie dogs. The scientists collected 633 fleas from prairie dogs and 167 fleas from burrows **(figure 15)**.

Where the fleas were found	Flea species	Spring	Summer	Total
Burrows	*Catallagia decipiens*	1	1	2
	Oropsylla hirsuta	85	47	132
	Oropsylla idahoensis	16	4	20
	Oropsylla tuberculata cynomuris	7	1	8
	Oropsylla tuberculata tuberculata	5	0	5
Gunnison's prairie dogs	*Oropsylla hirsuta*	79	507	586
	Oropsylla idahoensis	5	23	28
	Oropsylla tuberculata cynomuris	14	0	14
	Oropsylla tuberculata tuberculata	3	2	5

Figure 15. Flea species and the number collected from burrows and Gunnison's prairie dogs caught in Valles Caldera National Preserve in northern New Mexico.

The scientists found that *Oropsylla hirsuta* and *Oropsylla tuberculata tuberculata* were the two primary flea species involved in outbreaks of plague. It had been reported that *Oropsylla hirsuta* is the most important flea because of how fast it transmits the plague among prairie dogs.

- Look at Figure 15. What do you notice about the number of fleas present between the spring and the summer? Why do you think there might be this difference?
- What species of flea was most commonly found on the Gunnison's prairie dog? In the burrows? Why do you think this might be important information for the scientist to know?

Discussion

The scientists know that an important flea species for transmitting plague is *Oropsylla hirsuta*. This species was found in the largest numbers on the prairie dogs and in the burrows. This finding supports the idea that *Oropsylla hirsuta* may be the flea species that causes transmission of plague in prairie dogs in the Valles Caldera National Preserve.

The scientists believe that burrows are an important factor in the transmission of the plague. Burrows are good places for fleas to live and reproduce. Fleas can also easily move from one rodent to another in the burrows. Even after the plague has killed off a large portion of the prairie dogs in a particular area, fleas can live for several more months. Therefore, other rodent populations that come into the burrows may be infected by the fleas that are still living there.

- Do you think it is important for scientists to study how the plague affects the prairie dogs? Why or why not?
- Does this research have any importance for understanding how fleas might transmit diseases between other types of mammals? Why or why not?

Glossary

aerate (**er** āt): To supply with air.

bacteria (bak **tir** ē ə): A group of microscopic, single-celled organisms that live in all environments.

burrow (**bər** ō): A hole in the ground made by an animal.

cay (**kē**): small, low-lying sandy island formed on the surface of a coral reef.

coordinate (kō **ȯrd** nət): Any of a set of numbers used to locate a point on a line or surface or in space.

immunity (i **myü** nə tē): The power of the body to resist an infectious disease.

infectious (in **fek** shəs): Capable of causing infection.

mammal (**ma** məl): Any of a class of warm-blooded vertebrates. This includes people and other animals that feed their young with milk from mammary glands. Their skin is usually more or less covered with hair.

montane (mān **tān**): Of, relating to, growing or being in the zone of moist cool upland slopes below tree line.

nutrient (**nü** trē ənt): A substance that plants, animals, and people need to live and grow.

plague (**plāg**): A serious disease that is caused by a bacterium, occurs or has occurred in several forms including bubonic plague, and is usually passed to human beings from infected rodents and especially rats by the bite of a flea or is passed directly from person to person.

prairie (**prer** ē): A large area of level or rolling grassland.

rodent (**rō** dənt): Any of an order of fairly small mammals that have sharp front teeth used for gnawing.

species (**spē** shēz): A class of individuals having common attributes and designated by a common name.

susceptible (sə **sep** tə bəl): Having little resistance.

transmit (trans **mit**): To transfer from one person, animal, or place, to another.

Accented syllables are in **bold**. Marks and definitions are from http://www.merriam-webster.com.

Web Resources

National Geographic Prairie Dogs
http://animals.nationalgeographic.com/animals/mammals/prairie-dog/

National Zoo Prairie Dogs
http://nationalzoo.si.edu/Animals/NorthAmerica/Facts/fact-pdog.cfm

Adapted from Friggens, M.M.; Parmenter, R.R.; Boyden, M; Ford, P.L.; Gage, K.; Keim, P. 2010. Flea abundance, diversity, and plague in Gunnison's prairie dogs (*Cynomys gunnisoni*) and their burrows in montane grasslands in northern New Mexico. Journal of Wildlife Diseases. 46(2) pp:356-367. http://www.ncbi.nlm.nih.gov/pubmed/20688629.

If you are a Project Learning Tree educator, you may use Activity 26: Dynamic Duos or Activity 45: Web of Life.

FACTivity

Time needed:
One class period

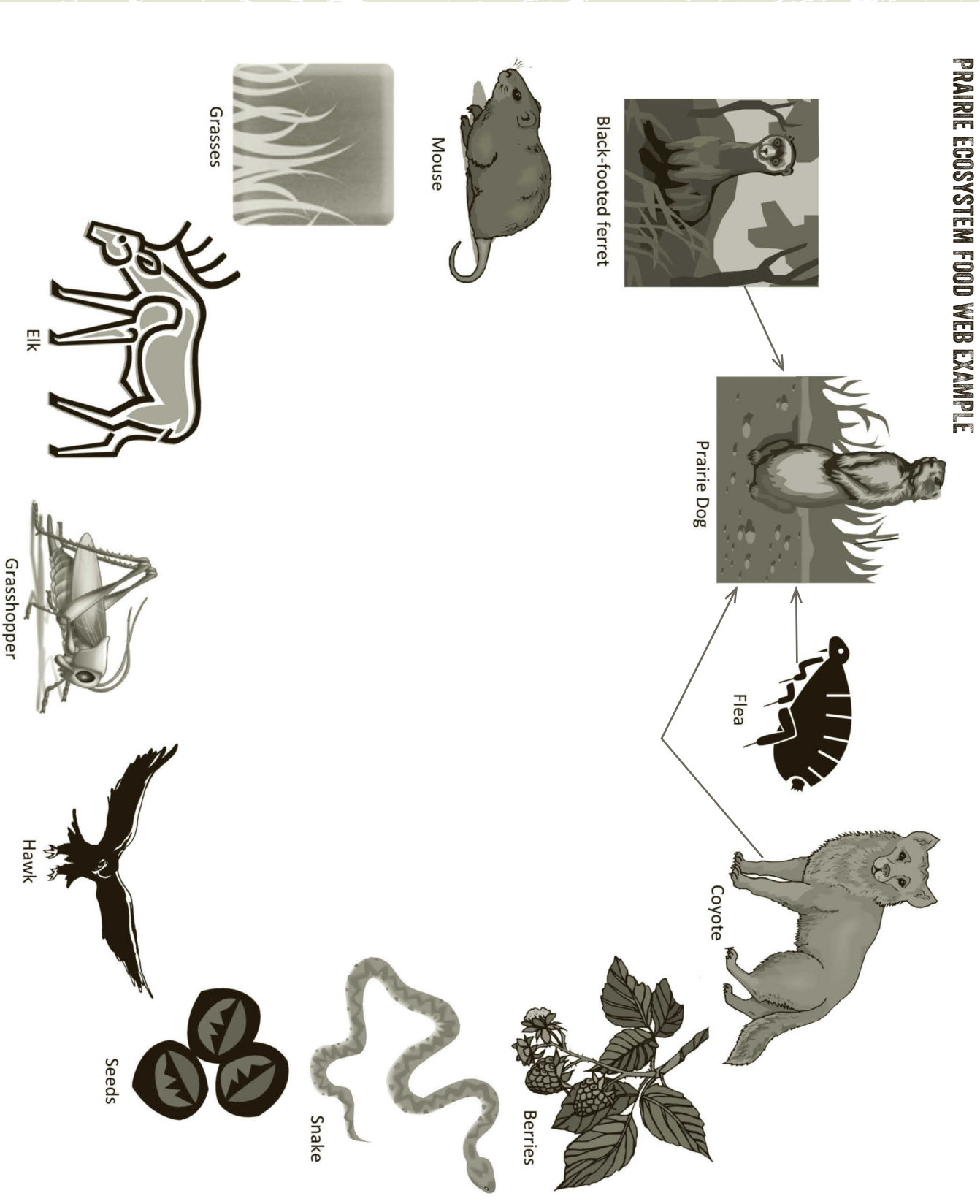
The question you will answer in this FACTivity is:
How does the decline of prairie dogs affect the prairie food web?

Materials

- "Prairie Dog Days" article
- Copies of the prairie ecosystem food web sheet on page 87, one for each student
- Pencil, one for each student

The process you will use to answer this question is:

1. Look at the animals and plants found in the prairie ecosystem food web.
2. Draw arrows to connect the animals between predators and the prey they eat. The arrow should be drawn from the predator to the prey. In other words, the arrow should point to the thing that is eaten. A few connections have been drawn for you. Reference the "Prairie Dog Days" article if you need help figuring out the connections. If your teacher allows it, you can also work together with your classmates. Note: More than one connection can be drawn between the animals.
3. Using the completed food web, answer the following questions:
   a. What animal and/or plants are at the lowest level of the food web?
   b. What do prairie dogs eat?
   c. What animals feed on prairie dogs?
4. Next, cross out the prairie dog. Placing an "X" over the image represents the decline or removal of prairie dogs from the food web. Using the revised food web, answer the following questions:
   a. How does the food web change when prairie dogs are removed?
   b. Will animals that feed on prairie dogs have other food options?
   c. How will populations change without the prairie dogs? For example, will any animal or plant populations grow or shrink in numbers?



FACTivity Extension:

Complete an additional food web removing prairie dogs from the ecosystem. Discuss as a class how the rest of the ecosystem would be affected if prairie dogs were removed from the habitat.

STUDENT NAME: ______________________________

PRAIRIE ECOSYSTEM FOOD WEB