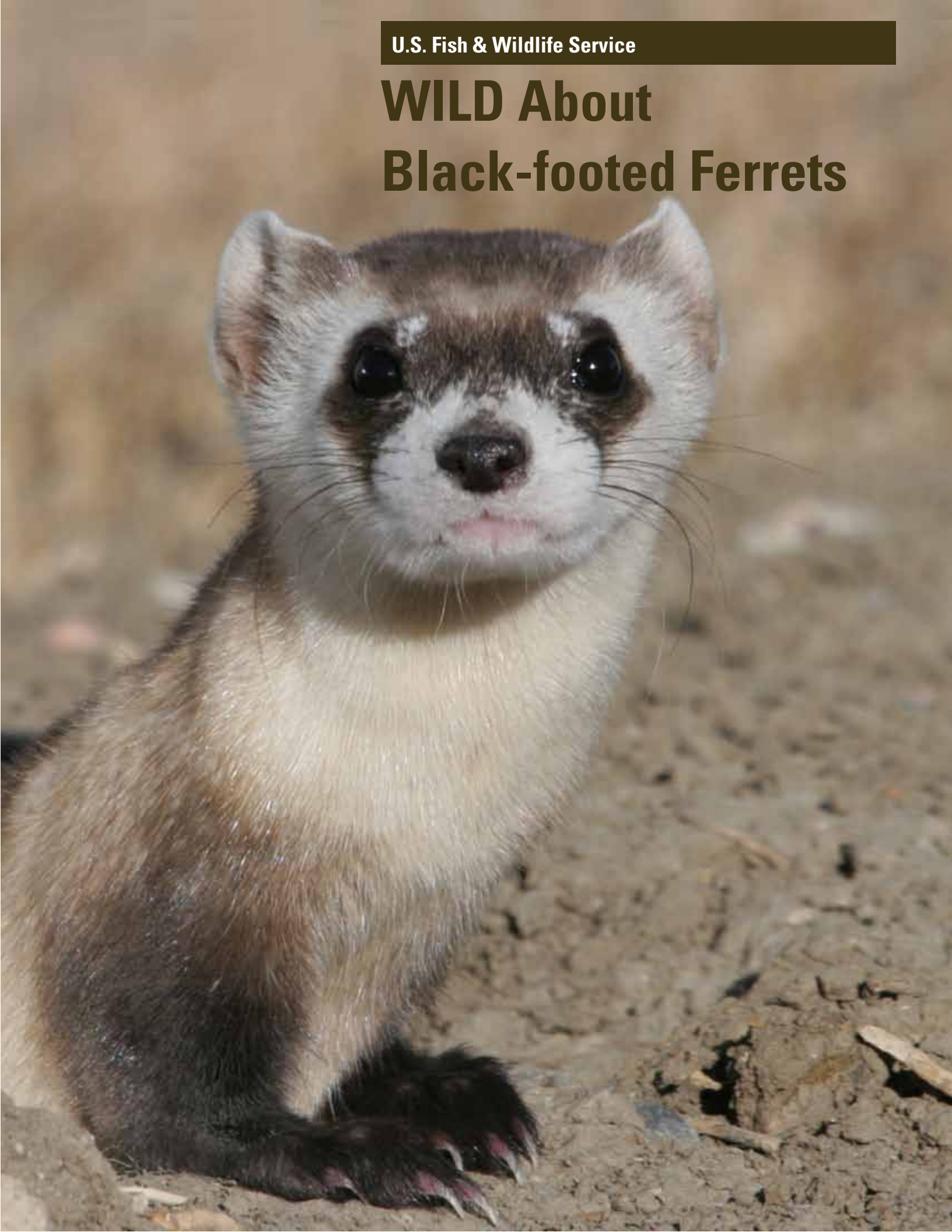
U.S. Fish & Wildlife Service

WILD About Black-footed Ferrets



WILD About Black-footed Ferrets

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Through an interactive simulation, students are introduced to the study of conservation genetics and population bottlenecks. Students will discover how the loss of genetic diversity and genetic characteristics can affect a population's ability to respond to changes in its environment. Students will describe how the Black-footed Ferret Species Survival Plan® minimizes the loss of genetic diversity in the captive-breeding population.

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In this activity, students are given background information on the recovery of black-footed ferrets and they are asked to summarize the information verbally and visually. In this summary activity, students will write a news, feature, or editorial article.

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Introduction

The sea, the woods, the mountains, all suffer in comparison with the prairie...The prairie has a stronger hold upon the senses. Its sublimity arises from its unbounded extent, its barren monotony and desolation, its still, unmoved, calm, stern, almost self-confident grandeur, its strange power of deception, its want of echo, and, in fine, its power of throwing a man back upon himself.

Albert Pike, *Journeys in the Prairie* (1831-32)

A world of grass and flowers stretched around me, rising and falling in gentle undulations, as if an enchanter had struck the ocean swell, and it was at rest forever...

Eliza Steele, *Summer Journey in the West* (1840)

Less than 200 years ago, the Great Plains were described by the first European visitors as an ocean of grass. It was a land of terrible winds, violent storms and vast vistas, and it teemed with life. Vast herds of bison thundered over the land, sustaining the lives of indigenous people. The largest predators - grizzly bears, lions, and wolves had no lack of prey. Elk, deer, pronghorn, and even moose wandered the sandhills and high plains. Seasonal wetlands, prairie potholes, and rivers supported masses of waterfowl and shorebirds. Huge prairie dog towns covered the landscape and provided shelter for other burrowing species, open land for ground nesting birds, and food for raptors, badgers, foxes, and black-footed ferrets.

The native prairies represented both opportunities and enormous challenges for European American settlers who dreamed of teasing out an existence on the rich soils. The difficultly of plowing through the dense root systems of the sod grasses, the extremes of weather, and frequent drought tested the limits those who would subdue the plains. Nonetheless, the grassland kingdom was eventually conquered; becoming one of the most fragmented and altered environments on earth. Many of the species that originally lived there suffered significant population declines, and some were threatened with extinction.

One animal that was almost lost was the black-footed ferret. Black-footed ferrets are a highly specialized species that depends on prairie dogs for both food and shelter. They were once found on black-tailed prairie dog colonies across the Great Plains from southern Canada to northern Mexico, and on white-tailed and Gunnison's prairie dog colonies across the intermountain west.

A national effort to eradicate prairie dogs, along with habitat loss and disease all took a toll on black-footed ferrets. For a number of years, scientists believed the black-footed ferret to be extinct. Then, in 1981, the last remaining population of black-footed ferrets was discovered near Meeteetse, Wyoming on a privately owned ranch. At first, these animals were left on the ranch. They were closely monitored and their natural history was studied. Then, a plague and canine distemper outbreak caused the black-footed ferret population to plummet to 18 individuals. These last remaining ferrets were trapped and a captive breeding program was started.

Since that time, the black-footed ferret, once the rarest mammal in the world, has made an astonishing comeback. Years of research and unshakable commitment to captive breeding has produced thousands of offspring. The threats of canine distemper and sylvatic plague to black-footed ferrets have been controlled both through the development of vaccines for ferrets and the dusting of prairie dog colonies to kill the fleas that carry plague.

By 1991, there were enough captive offspring to begin re-introducing black-footed ferrets to their native habitat. The reintroduction efforts have been helped by giving the re-introduced ferrrets a special designation under the Endangered Species Act called a 10(j) permit. This designates the population as experimental and nonessential, which allows reintroduction efforts to occur without effecting land use practices, including hunting and ranching. A 10(j) designation allows the U.S. Fish & Wildlife Service the regulatory flexibility needed to make the most of partnerships with state and tribal agencies, private groups, and even other nations, to recover the black-footed ferret.

Private landowners were instrumental in the initial rescue of the black-footed ferret, and will continue to be crucial to recovering the animal from the endangered species list. The potential exists for delisting in the next decade! It will be an incredible conservation success story – self-sustaining populations of black-footed ferrets on restored and intact portions of grassland habitats.

About this Guide

WILD About Black-footed Ferrets invites your students and community to celebrate the progress of the black-footed ferret recovery program and get involved in the black-footed ferrets' journey home. Every activity is designed to encourage creative thinking and problem-solving skills – both of which are vital to taking action and making decisions that conserve wildlife and respect human needs. While some of today's conservation problems may seem insurmountable, the story of the black-footed ferrets' comeback demonstrates that dedicated people can work together to create a positive vision of the future.

To help students learn about the intricate web of life on the prairie, we encourage you to spend as much time outside with them as you can, and to make use of the many resources that exist in your community. Many communities have pieces of the recovery effort right in their own backyard and don't even know it! Students may discover that a local zoo participates in part of the captive-breeding effort or that a reintroduction site is nearby. Current information about these sites is available at www.blackfootedferret.org.

The activities found in ***WILD About Black-footed Ferrets*** are designed to support national academic standards in Science, Geography, History, and Language Arts for grades 5 through 8. The core lessons will take approximately two weeks (ten 45-minute class sessions) to complete. A supplemental activity, Talk of the Town, is included in ***Appendix A*** for those educators who would like to give students the opportunity to learn about and study animal behavior.

WILD About Black-footed Ferrets was developed through a partnership with the U.S. Fish & Wildlife Service and the Colorado Division of Wildlife.

Standards

	Ferreting Out the Full Story Part I	A Prairie Home	No-Nonsense Night Sense	Finding Ferrets	The Prairie Web of Life	Dog Gone It!	Bottleneck Genes	Ferreting Out the Full Story Part II	Appendix A: Talk of the Town
Geography: National Geography Standards (1994)									
1: Understands the characteristics and uses of maps, globes, and other geographic tools and technologies		x						x	
2: Knows the location of places, geographic features, and patterns of the environment		x		x	x	x		x	
3: Understands the characteristics and uses of spatial organization of Earth's surface		x		x		x			
4: Understands the physical and human characteristics of place		x			x	x		x	
5: Understands the concept of regions		x			x			x	
6: Understands that culture and experience influence people's perceptions of places and regions						x		x	
7: Knows the physical processes that shape patterns on Earth's surface		x							
8: Understands the characteristics of ecosystems on Earth's surface		x		x	x	x		x	x
9: Understands the nature, distribution and migration of human populations on Earth's surface						x		x	
10: Understands the nature and complexity of Earth's cultural mosaics						x		x	
11: Understands the patterns and networks of economic interdependence on Earth's surface						x		x	
12: Understands the patterns of human settlement and their causes						x		x	
13: Understands the forces of cooperation and conflict that shape the divisions of Earth's surface						x		x	
14: Understands how human actions modify the physical environment						x		x	
15: Understands how physical systems affect human systems						x		x	
16: Understands the changes that occur in the meaning, use, distribution and importance of resources						x		x	
18: Understands global development and environmental issues						x		x	
History, National Center for History in the Schools (NCHS, 1996)									
Historical Understanding:									
1: Understands and knows how to analyze chronological relationships and patterns		x				x		x	
2: Understands the historical perspective		x				x		x	
Language Arts: International Reading Association (IRA), National Council of Teachers of English (NCTE)									
Writing:									
1: Uses the general skills and strategies of the writing process	x	x	x					x	
2: Uses the stylistic and rhetorical aspects of writing	x	x	x					x	
3: Uses grammatical and mechanical conventions in written compositions	x	x	x					x	
4: Gathers and uses information for research purposes	x	x	x	x	x	x	x	x	x
Reading									
5: Uses the general skills and strategies of the reading process	x	x	x	x	x	x	x	x	x
6: Uses skills and strategies to read a variety of literary texts	x	x	x	x	x	x	x	x	x
7: Uses skills and strategies to read a variety of informational texts	x	x	x	x	x	x	x	x	x
Listening									
8: Uses listening and speaking strategies for different purposes	x	x	x	x	x	x	x	x	x
Science: National Science Education Standards (National Research Council, 1994)									
4: Understands the principles of heredity and related concepts							x	x	
5: Understands the structure and function of cells and organisms		x	x	x	x	x	x	x	x
6: Understands relationships among organisms and their physical environment		x	x	x	x	x	x	x	x
7: Understands biological evolution and the diversity of life		x	x	x	x	x	x	x	x
11: Understands the nature of scientific knowledge		x	x	x			x	x	x
12: Understands the nature of scientific inquiry	x	x	x	x			x	x	x
13: Understands the scientific enterprise			x	x			x	x	x

Ferreting Out the Full Story - Part I

Duration

- One 45-minute indoor class period

Materials

- Student Pages (one copy per student) : *Ferreting out the Full Story – Part I, Mind Map: What I Know Right Now about Black-footed Ferrets*
- Pencils or pens
- Small pieces of writing paper or post it notes
- Stapler (optional)

Summary

In this introductory activity, students will discuss the definition of the term “ferret” and read some information about black-footed ferrets. Combining this information with their prior knowledge about these animals, students will construct a concept map (mind map) about black-footed ferrets. Each student will then construct a reporter’s notebook to collect information about black-footed ferrets as they complete activities throughout this guide.

Objectives

Students will:

- Be able to define the term “ferret”.
- Construct a concept map (mind map) that demonstrates their current knowledge of black-footed ferrets in a visual form that can easily be examined and shared.

Background

Black-footed ferrets are considered one of North America’s most endangered animals. “Endangered” means that they are in danger of becoming extinct throughout their historic range. Twice, scientists believed they were extinct – no longer existing anywhere on Earth. In 1964, when the U.S. government was about to declare the black-footed ferret extinct, a small population was located in Mellette County, South Dakota. By 1971, scientists were so worried about the low numbers of that population that they captured six animals to start a breeding program. Unfortunately, four of these ferrets died after being given a modified distemper vaccine. The vaccine had been tested and proved to build immunity in Siberian ferrets, but the captive black-footed ferrets reacted differently. Three more black-footed ferrets were brought in to bolster the captive breeding attempt and kits (baby ferrets) were produced, but none survived. By 1974, there were no more wild ferrets in Mellette County. When the last captive animal died at Patuxent Wildlife Research Center in Laurel, Maryland in 1979, the ferret was again presumed extinct.

Amazingly, in 1981, another population of several hundred black-footed ferrets was discovered near Meeteetse, Wyoming. Then, canine distemper struck the population. In 1986, shortly before distemper wiped out all the remaining wild ferrets in Wyoming, the last 18 animals were captured for captive breeding. Unlike the efforts in the 1970s, scientists were very successful breeding the animals in the

1980s. By the fall of 1991, the captive-breeding population had grown to a large enough size to permit the first experimental reintroduction into the wild.

The story of what has happened in the 30 years since a black-footed ferret was discovered near Meeteetse is nothing less than extraordinary. While it is a story that is still being written, the possibility of a full recovery of this species is within reach. And, it is possible that your students will play a role in this recovery effort.

Vocabulary

- Captive breeding program
- Endangered
- Extinct
- Ferret
- Weasel

About this Activity

Students tend to draw on what they already know or believe as they take in new information and concepts. This activity will help you get a feel for what your students already know about black-footed ferrets, so that you can focus your instruction where the students need it most. You will be able to identify inaccuracies, assumptions, opinions, and misunderstandings students hold regarding this species. Assessing prior knowledge will also allow for a more complete assessment of the knowledge and skills that the students gain from this unit. *Ferreting out the Full Story Part I* is used as both a pre-assessment and as an introduction to this unit. The concluding activity, *Ferreting out the Full Story Part II,* will assess what students have learned from the unit.

While there are many ways to assess prior knowledge, this activity uses a mind map (sometimes called a concept map or web). Mind maps are graphical tools for organizing and representing knowledge. The topic to be studied is placed in the center of a mind map. Sub-topics are linked in all directions from the center. Other sub-topics and facts will branch off of these. It is important to recognize that a mind map is never finished. Students should be encouraged to revise their map as the unit progresses.

Teaching Strategies

1. Point out that "ferret" is a word that can be used as both a noun and a verb. As a noun, ferret refers to either a domesticated ferret that can be purchased in a pet store or a wild North American weasel with black mask-like markings – the black-footed ferret. As a verb, ferret refers to looking for and gathering facts, to solving mysteries and problems – to uncover and bring to light by searching.
2. Tell students that they will be learning about the black-footed ferret and gathering facts about it.
3. Pass out the student page *Ferreting out the Full Story – Part I* and ask several students to read out loud to the class.
4. If possible, show students the short video clip at:
   http://www.arkive.org/black-footed-ferret/mustela-nigripes/video-00.html
   Please be aware that there are many short video clips on this web site, but only this video of the two ferrets coming out of a prairie dog burrow at night should be shown at this time.
5. Then, ask students to turn to the second page *Mind Map: What I Know Right Now about Black-footed Ferrets*. Tell students that they can gather clues about a word from the context of a sentence; they can gather clues about a subject from a picture. Ask students what information the picture provides. (The ferrets are looking out of a hole, there is a moon in the background, there doesn't seem to be much in the background, etc.) Write all the answers in a visible place.
6. Explain that the class will be making a concept map or mind map of what they know about black-footed ferrets. A mind map is a visual representation of the linkages and connections of everything they know about a subject.
7. Hand out post-it notes or small pieces of paper, or ask students to cut a piece of notebook paper into eight pieces.
8. Ask students to list one thing that they know or think they know about black-footed ferrets on each piece of paper. (They can get or make more slips of paper if they know more than eight facts.)
9. Write the words "*black-footed ferrets"* in the center of the board. Tell students that they will contribute their facts one by one. As each student contributes, ask him or her to bring up the piece of paper with the fact and place it on the board.
10. Continue to call on students until there are no facts left. As each student brings up their piece of paper, group similar topics or facts together.
11. Ask students to rank the concepts in each cluster from "most general and inclusive" to "least general and inclusive" or from "most important" to "least important". This step will require several minutes.
12. Write the "most general" or "most important" concepts around the words "*black-footed ferrets"* on the board.
13. Explain to students that you want first want them to connect these "most important" concepts from their clusters to the words "Black-footed ferrets," one pair at a time, with directional links; and most

importantly, to label the linking lines (*e.g.*, Black-footed ferrets → noctural (linking word is “are”) OR Black-footed ferrets → burrows (linking words are “live in”).

14. Next, have students link the “most important” concepts to the “least important” concepts in each cluster. Continue this process until all concepts appear on the map.
15. Ask all students to copy down the collective mind map that was drawn on the board onto their mind map page. Do not collect the students’ mind maps. Tell students that they will be uncovering the story of what has happened to the black-footed ferret in the last 30 years. Ask students to set up a special section in their science notebook or in their binder to collect information about black-footed ferrets.

Assessment

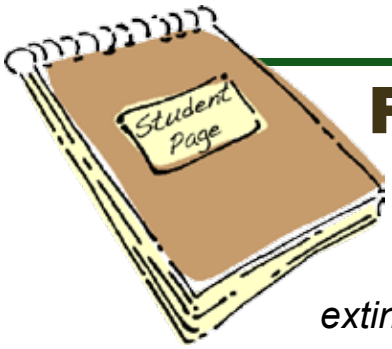
The student-constructed mind map serves as the assessment of collective prior knowledge of the students about black-footed ferrets.

Extension

Ask students to brainstorm places to get information about black-footed ferrets:

a. Who are some people that could be interviewed?
b. Where else can you look for information? The library? The Internet? Newspaper archive?

Ryan Haggerty / USFWS



Ferreting out the Full Story – Part I

Black-footed ferrets are considered one of the most endangered animals in North America. Twice, scientists believed they were *extinct*. In 1964, as the U.S. government was about to declare the black-footed ferret extinct, a small population was located in Mellette County, South Dakota. That population continued to decline and nine ferrets were taken out of the wild to begin a *captive breeding program*. The captive breeding attempt failed. By 1974, there were no more wild ferrets in Mellette County. When the last captive animal died at Patuxent Wildlife Research Center in Laurel, Maryland in 1979, the ferret was again presumed extinct.

Most scientists gave up hope of ever finding another black-footed ferret. While many had searched far and wide, they did not find any more in the wild. A lucky incident changed all that. At about 3 a.m. on September 26, 1981, cattle rancher John Hogg and his wife, Lucille, were awakened by their dog's furious barking just outside the bedroom window. They figured that Shep had gotten tangled up with a porcupine and they went back to sleep.

When John Hogg looked around the next day, he found the carcass of a strange little animal. He had never seen one like it before. It had a black mask, black feet, and a black-tipped tail. It also had a broken back. Lucille suggested they make a mount of it. They took it to a Meeteetse taxidermist. The taxidermist realized that it was a black-footed ferret. Amazingly, another black-footed ferret population was soon discovered near Meeteetse, Wyoming.

One of the last wild black-footed ferrets near Meeteetse, Wyoming, in 1986. Dean Biggins / USFWS

Mind Map

What I Know Right Now about Black-footed Ferrets

A Prairie Home

Duration
- Two 45-minute indoor class periods

Materials
- Student Pages : *A Prairie Home, Grassland Adaptations*
- *Shortgrass Prairie Species Cards* (30)

Summary

In this activity, students will learn about the Great Plains and some of the climatic factors that create the shortgrass, mixed-grass, and tallgrass prairies. Students will list the challenges that living organisms would face in the shortgrass prairie biome and suggest physical or behavioral adaptations that organisms might have to cope with these challenges.

Objectives

Students will be able to:

- Describe a shortgrass prairie ecosystem.
- Describe the habitat needs of shortgrass prairie plants and animals.
- Define adaptation and be able to distinguish between physical and behavioral adaptations and give examples of each.
- Describe the adaptations of one or more shortgrass prairie species and how those adaptations allow it to survive on the shortgrass prairie.

Background

An animal's **habitat** is a place where an animal makes its home. A habitat meets all of an animal's needs for survival – food, water, shelter, and space. The shortgrass prairie is the habitat of the black-footed ferret and is also home for many other animals and plants. All of the living things that live and interact with each other in a habitat are called a **community**.

Plants and animals need special adaptations to be able to survive on the shortgrass prairie. **Adaptations** are unique inherited traits or features – any body part, behavior, or physiological capability - that increases a plant or animal's ability to survive in its environment. These features help them get food, protect themselves from enemies, cope with weather conditions, and reproduce.

Both plants and animals can have **physical adaptations**. Physical adaptations can be structural or physiological. Structural adaptations are body features that can be seen. Physiological adaptations are body processes. For example, some frogs produce a chemical in their cells which acts like antifreeze to help prevent them from freezing and dying in winter. The events that trigger the frog to produce

the substance, and the order in which the frog's body slowly shuts down, is a physiological adaptation that evolved over time.

Physical adaptations for a plant may include size, type of leaves and roots, covering (smooth, waxy, sticky, or hairy), shape of flower, and things like that. Physical adaptations for animals might include color and camouflage; size; size of ears, nose and other extremities; teeth; feet, and so on.

Animals also have **behavioral adaptations**. These can include how and when they search for food, how they defend themselves, how they communicate with others of their species, and so on.

Teaching Strategies

Day 1- Introduction to the Shortgrass Prairie

1. Hand out a copy of the Student Page, *A Prairie Home,* to each student.
2. Ask students to read the handout silently or in groups and respond to the questions at the end.
3. After students have completed the readings and their responses, discuss their answers. Compile a class list of the challenges that students think species might face if they lived on the shortgrass prairie. Then, compile lists of the student-generated survival strategies for plants, animals and humans to meet these challenges. Post all of these lists in a visible place.
4. Explain to students that plants and animals have **adaptations,** unique inherited traits or features (any body part, behavior, or physiological capability) that enable them to live and survive where they live, even human beings. Explain the difference between physical and behavioral adaptations.

About this Activity

This lesson introduces students to the shortgrass prairie and the challenges that living organisms might face to live there. You may want to supplement this discusstion with an activity from the **Project WILD K-12 Curriculum & Activity Guide** called *Prairie Memoirs*, which addresses the challenges that humans historically had to overcome to survive in this region.

Vocabulary

- Adaptation
- Biome
- Community
- Drought
- Ecosystem
- Grassland
- Great Plains
- Habitat
- Mixed-grass prairie
- Prairie
- Shortgrass prairie
- Tallgrass prairie

One fun way to drive home the concept of physical adaptation is to ask students to tie their shoes or braid someone's hair or drink from a glass without using their thumbs. Explain how the thumb is one of human's most important physical adaptations. To explain behavioral adaptations, you can discuss human facial expressions. Regardless of the culture that someone is born into or the language that they learn to speak, there are universal facial expressions for happiness, sadness, surprise, fear, disgust, and anger. These expressions are thought to be "hard-wired" in our genetics, allowing all humans to communicate on a very basic level.

5. Give each student a copy of the Student Page *Grassland Adaptations*.
6. Ask students to write the definition of adaptation on the top of the page.
7. Next, ask students to read the student page and circle the adaptations of grasses.
8. Give students one or more shortgrass prairie species cards, depending upon the size of your class. (It is important to hand out all of the species cards since they will be used for the next few lessons.)
9. Tell students that each of these species lives on the shortgrass prairie. Each of these species has adaptations that help them survive. Ask students to read their card(s). Using the chart on the student page, students should list the adaptations that the animal or plant has that allows it to survive on the shortgrass prairie.
10. When all students have completed their work, collect the species cards (you will need them for other lessons). Revisit the list of survival strategies that were posted earlier. Ask students if any of their species have an adaptation (physical or behavioral) that uses one of the strategies on the list.
11. As a class, try to identify common adaptations/survival strategies. For example, many animals may use the behavioral strategy of burrowing to avoid predators, bad weather or temperature extremes. If you make tally marks next to this survival strategy/adaptation, you will find that more than one third of the students have species with this survival strategy. Using burrows is a common behavioral adaptation.

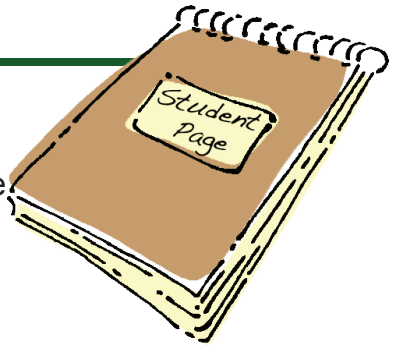
Assessment

The student generated list of shortgrass prairie species' adaptations serves as an assessment for this activity.

Extension

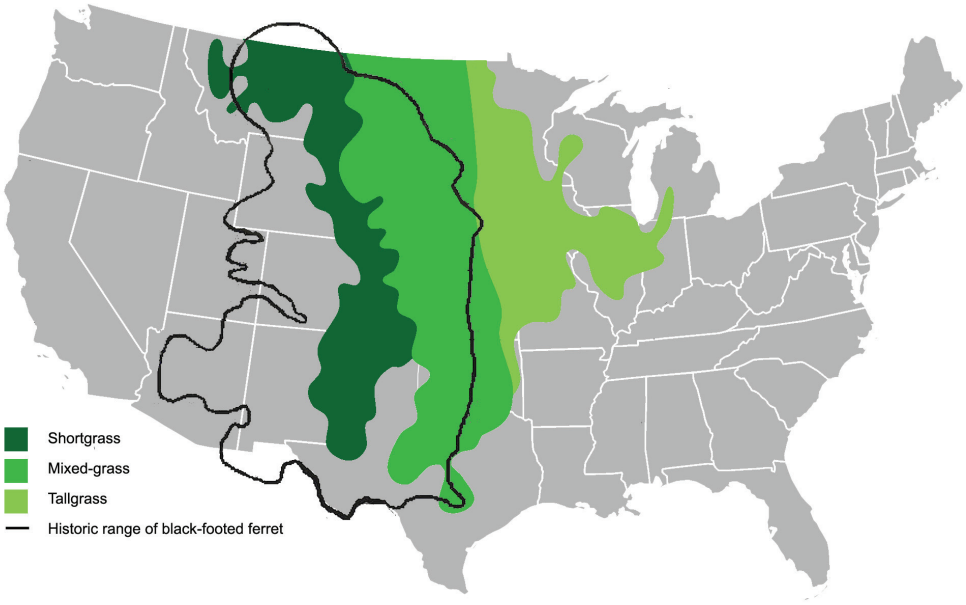
Students can study the unique geography and climate that create a grassland biome.
• What climatic and geographic conditions create grasslands?
• Where are prairies and grasslands located in other parts of the world?

A Prairie Home



When French explorers traveled through North America in the 1600s, they came upon a vast land of grass and colorful wildflowers. There were very few shrubs. Trees were found only by rivers and streams. They saw bison and pronghorn grazing. They met indigenous people who lived and hunted these animals. The French called the rolling plains of grass "**prairie**," from the French word for a meadow grazed by cattle.

These prairie **grasslands**, known as the **Great Plains,** once covered about 1.4 million square miles. They reached from Alberta, Saskatchewan, and Manitoba, Canada to southern Texas and stretched from the foothills of the Rocky Mountains to just east of the Mississippi River.



From east to west across the Great Plains, both the rainfall and therefore the height of the grasses decrease. In the eastern portion of the Great Plains, the **tallgrass prairie** grasses often grow to be 5 to 10 feet tall. In these areas, the annual rainfall approaches 40 inches. The **mixed-grass prairie** lies mainly in the middle portion. The grasses grow to be 2 to 3 feet tall. Typically, there are 14 to 23 inches of rain per year. The **shortgrass prairie** lies mainly in the western portion of the Great Plains, hugging the Rocky Mountains all the way into Canada. The grasses there grow to be no more than 2 feet tall. There is usually little more than 15 inches of rain per year.

The shortgrass prairie is a harsh environment. Rainfall varies from year to year. In addition, there is usually a long **drought** or dry period during the summer months. Every 30 years or so, there is a drought which lasts for several years. There is a wide range of temperatures, with hot summers and cold winters. Blizzards, floods, hail storms, thunderstorms, high winds, severe cold, and extreme heat can arrive suddenly. Sometimes lightning ignites the dry grass and fire spreads across the shortgrass prairie. These fires move rapidly across the land and do not burn animals burrowed underground or destroy the roots of plants.

The shortgrass prairie is one habitat used by the black-footed ferret. An animal's **habitat** is a place where an animal makes its home. A habitat meets all an animal's needs for survival – food, water, shelter, and space. The shortgrass prairie is also home for other animals and plants. All of the plants and animals and other living things that live and interact with each other in a habitat are called a **community**.

Imagine living on the shortgrass prairie. What are some challenges to survival for plants, animals, and humans who live on the shortgrass prairie? (List at least five.)

1)

2)

3)

4)

5)

How might plants, animals, and humans survive on the shortgrass prairie? Think of two shortgrass prairie survival strategies for plants, two for animals, and two for humans.

Plants 1)

2)

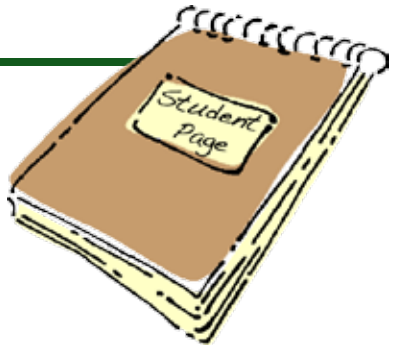
Animals 1)

2)

Humans 1)

2)

Grassland Adaptations



Part A: *What is an adaptation?*

As you read the six paragraphs below, circle or highlight all of the adaptations that grasses have that help them survive on the shortgrass prairie.

Grasslands are **biomes,** living communities with distinct vegetation and climate. Just as trees are the distinct vegetation in a forest biome, grasses are the distinct vegetation of grasslands.

What are grasses? Grasses are non-woody plants. Grasses have narrow leaves with parallel veins. Grasses grow from the base of the leaf. Unlike other plants, if the top of the grass leaf is removed or damaged, the grass will continue to grow. This is why people mow their grass but never mow their flower beds!

Grass stems are hollow except at the nodes (joints). Grass flowers are small so that they do not dehydrate in the wind. Grasses have many long thin roots that spread out through the soil. The roots are usually twice as deep as the plant is high. These roots anchor the plant in place and can gather any rain that falls near the grass.

Grasses store some of the energy they get from the sun in underground stems called rhizomes. If the top of the plant is destroyed, the rhizomes can produce new grass shoots.

Grass is extremely important to most people's lives, whether they know it or not. Grass is a major food source all over the world. Rice, corn, wheat and oats are grass plants, and most livestock animals feed primarily on grasses.

The shortgrass prairie has many types of grasses. Two of the most well-known shortgrass prairie grasses are buffalo grass and blue grama. Both of these grasses can tolerate long periods of drought and very high or low temperatures. Both can grow back even when heavily grazed. In fact, buffalo grass was the primary food source of the American bison.

Part B: *Other plants and animals also have adaptations. Animal adaptations can be physical or behavioral. What are the unique survival strategies of your shortgrass prairie species?*

Species	Adaptation	Type of Adaptation	How Adaptation Helps the Species Survive

Joy Viola / Northeastern University

Prickly Pear Cactus

Prickly pear cactus stems are blue-green or dark green pads. The spines are specialized leaves that protect the cactus. When other food is unavailable, the pads can be de-spined and fed to livestock. In times of food shortage, Native Americans ate its fruit either raw or stewed. The fruit can be boiled and the juice strained off to create syrup.

Magnus Manske

Milkweed

Milkweed can grow to 3½ feet tall and has flowers that grow in clusters. Inside the stem is a white, poisonous sap. The seeds grow in a pod and have a silky tuft of hair and they blow in the wind like little parachutes. Milkweed is food for bees, butterflies, and hummingbirds.

Alan Vernon

Ferruginous Hawk

Ferruginous hawks are the largest member of the hawk family in North America. They eat mainly prairie dogs and ground squirrels.

Cheryl Reynolds

Burrowing Owl

This small owl is about 8 inches tall and has long bare legs. Burrowing owls nest in abandoned prairie dog holes and feed on a wide variety of insects, small rodents, lizards, and birds. They are eaten by hawks, snakes, foxes, or coyotes.

Fritz Knopf

Mountain Plover

Mountain plovers choose nest sites on shortgrass prairies grazed by prairie dogs, bison and cattle. They feed on insects. They are eaten by hawks, snakes, foxes, and coyotes.

Kevin Cole

Western Meadowlark

Meadowlarks are ground-nesting birds. They weave dried grasses into dome-shaped nests with side tunnel entrances under clumps of taller grass. They eat insects, spiders, and grass and flower seeds. They are eaten by hawks, snakes, foxes, and coyotes.

Linda Tanner

American Kestrel

Kestrels hunt large insects, bats, mice, birds, and small reptiles. They prefer grassland areas with few trees, farmsteads, woodland borders, city parks, and suburban areas. They may be preyed upon by larger hawks.

Paul Anderson

Grasshopper

Approximately 600 species of grasshoppers are found throughout the United States. Grasshoppers have wings, powerful hind legs and strong mandibles, or mouthparts, adapted for chewing grass. They have a front pair of rigid wings and a hind pair of larger, membranous wings, often brightly colored. They are eaten by birds, reptiles, amphibians, and small mammals.

North Carolina State University

Carrion Beetle

The carrion beetle feeds on carcasses of dead or decaying animals and lays its eggs on the carcass so the larvae grow up feeding on rotting flesh. They have few if any predators. They secrete a strong, smelly odor that irritates other bugs and small animals.

Derek Ramsey

Monarch Butterfly

This orange and black butterfly feeds on milkweed flower nectar and lays its eggs on milkweed leaves and stems. Monarch caterpillars and adults absorb the milkweed sap which is both distasteful and toxic to birds.

National Park Service

Bullsnake (Gopher Snake)

Bullsnakes eat gophers, mice, voles, prairie dogs, ground squirrels, frogs, ground-nesting birds, and bird eggs. During the hottest part of the day, they take shelter in prairie dog burrows. Bullsnakes often imitate rattlesnakes by vibrating their tails in leaves and hissing. They may be eaten by hawks and eagles.

Pete Walker / Colorado Division of Wildlife

Western Hognose Snake

This snake eats toads, frogs, salamanders, lizards, small snakes, mice, and shrews. It has a shovel shaped snout to help it dig and burrow in loose, sandy soil. They may be eaten by hawks, eagles, and larger snakes.

Pete Walker / Colorado Division of Wildlife

Racer

Racers are snakes that eat mice, prairie dogs, voles, birds, reptiles, amphibians and large insects. They hunt by sight, so they avoid areas of dense vegetation. They hide in burrows to avoid being eaten by hawks and eagles.

Jennifer Kleffner / Colorado Division of Wildlife

Woodhouse's Toad

The Woodhouse's toad spends its day on the prairie inside prairie dog burrows. It comes out at night to hunt insects. These toads have glands on the side of their neck and behind each eye that secrete a sticky white liquid that inflames the mouth and throat of any would-be predator. Raccoons, skunks, snakes, herons and fish eat these toads.

Aaron Siirila

Black-tailed Prairie Dog

Prairie dogs eat grasses and other plants. They dig burrows and long underground tunnels and live in family groups called coteries. A group of burrows is called a prairie dog town. Prairie dog burrows provide shelter to many other animals. Black-footed ferrets, badgers, coyotes, foxes, eagles, hawks, owls, and many other predators eat prairie dogs.

USFWS

Pronghorn

Pronghorn feed on leafy plants and prairie shrubs. Pronghorns live in small herds. They are the fastest animals in the western hemisphere, running in 20-foot leaps at up to 60 miles per hour. Predators such as coyotes, bobcats, and golden eagles prey on pronghorn calves.

Jack Dykinga / USDA

Bison

Bison eat grasses and flowering plants. They live in groups called herds. The males and females only herd together during the breeding season. Historically, only wolves, grizzly bears, coyotes, and humans have been able to hunt and eat bison.

C. Burnett

Swift Fox

This small fox uses prairie dog burrows for shelter and for raising young. They also hide in the burrows to avoid predators like coyotes, golden eagles, and badgers. Swift foxes eat prairie dogs and other rodents, birds, and spiders.

Kevin Collins

Striped Skunk

Skunks are nocturnal and sleep in abandoned prairie dog burrows during the day. They eat insects, small mammals, fish, fruits, nuts, leaves, grasses, and carrion. Although they have one of the most effective defense mechanisms of any mammal, they are still preyed upon by owls, foxes, hawks, and coyotes.

Eugene van der Pijill

White-tailed Jackrabbit

White-tailed jackrabbits are nocturnal, feeding on grasses, flowering plants and shrubs from sunset to sunrise. During the day they rest in shallow depressions called “forms” which they dig into the earth under some form of plant cover. Jackrabbits are a favorite prey item of fox, coyote, badger, snakes, owls, eagles, and many species of hawks.

J. Michael Lockhart / USFWS

Black-footed Ferret

Black-footed ferrets are nocturnal predators that eat mainly prairie dogs and live in prairie dog burrows. Coyotes, great-horned owls, golden eagles, prairie falcons, badgers, coyotes, and foxes all prey on ferrets.

Wikimedia Commons

Deer Mouse

Deer mice make cup-shaped nests of shredded plants, fur, and feathers under logs, stumps, rocks or the abandoned burrows of other mammals. They eat insects, earthworms, snails, fruits, fungi, and carrion. They are eaten by hawks, owls, snakes, foxes, and coyotes.

David Hannigan / Colorado Division of Wildlife

Coyote

Coyotes eat mice, rabbits, prairie dogs and other rodents, black-footed ferrets, insects, reptiles, birds, and fruits and berries of wild plants. Coyotes dig dens or sometimes enlarge an old badger hole or a natural hole to rest and raise young. Few animals will prey on adult coyotes, but pups are eaten by large birds of prey and badgers.

Colorado Division of Wildlife

Great Plains Skink

Great Plains skinks have long bodies and small legs adapted for burrowing. They eat insects, spiders, and snails. Skinks have “breakaway” tails to evade predators to avoid predators like snakes and hawks. They also have a strong bite.

Suzanne Collins / CNAH

Ornate Box Turtle

Ornate box turtles are land-dwelling omnivores that will eat about anything they can find, including insects, spiders, caterpillars, reptiles, grass, and berries. They nest and overwinter in burrows. They make resting places called “forms” in soft soil and partially or completely bury themselves to avoid extreme temperatures and to maintain water balance. They are preyed upon by large birds, snakes, skunks, foxes, and coyotes.

Colorado Division of Wildlife

Plains Spadefoot Toad

Plains spadefoot toads are nocturnal and secretive. They spend nearly all their time burrowed deep in the ground. They burrow with the aid of a dark colored “spade” on their back feet. They eat insects and spiders. They are eaten by birds, coyotes, foxes, and snakes.

Chuck Evans

Black Widow Spider

Black widow spiders are shy and nocturnal and usually stay hidden in their webs, hanging upside down. They are venomous and eat insects. Wasps eat adult black widow spiders and flies will eat the spiders’ eggs.

Pete Walker / Colorado Division of Wildlife

Thirteen-lined Ground Squirrel

These squirrels are active during the day and eat insects, small mammals, fruits, seeds, leaves, grasses, and carrion. They dig burrows for nesting and hibernation. Their main predators are hawks and snakes.

Terry Spivey / USFWS

American Badger

Badgers are predators that dig with amazing speed and tunnel to catch their prey. They eat pocket gophers, ground squirrels, moles, prairie dogs, woodrats, black-footed ferrets, kangaroo rats, deer mice, voles, ground nesting birds, burrowing owls, lizards, and amphibians. Few predators will attack an adult badger, but young may be eaten by eagles, bobcats, and coyotes.

Wikimedia Commons

Earthworms

Earthworms are very important grassland invertebrates that maintain soil structure. They are decomposers that break down dead, decaying matter (either plant or animal) by eating it and returning its basic components to the soil as excreta (urine and/or feces). Many birds, reptiles, amphibians, and small mammals eat earthworms.

No-Nonsense Night Sense

Duration
- One or two 45-minute indoor class periods

Materials
- Student Pages: *Black-Out, No-Nonsense Night Sense, Night Eyes Notes*
- Photos/Pictures of Nocturnal Eyes: Eyeshine, Large Eyes, Large Pupils
- Chalkboard or whiteboard
- Blindfolds (4-6)
- Vanilla, Mint, and Orange Extract
- Four colors of construction paper
- Four plastic sandwich bags
- Four paper lunch bags

Summary

In this activity, students are asked to imagine functioning in darkness and infer the strategies needed to be a nocturnal animal. The students observe each other trying to complete a simple task using either the sense of sight, smell, hearing, or touch. They compare and contrast the use of and acuity of these senses in nocturnal and diurnal animals. Lastly, students compare the different eye structure of humans (representing diurnal animals) and black-footed ferrets (representing nocturnal animals).

Objectives

Students will be able to:

- Infer strategies necessary to survive as a nocturnal animal.
- Compare and contrast the senses and adaptations used by nocturnal and diurnal animals.
- Compare and contrast the structure and function of a human eye to that of a black-footed ferret eye.
- Describe the function of the tapetum lucidum.

Background

From the previous activity, students have already learned that many of the species that live on the shortgrass prairie are **nocturnal**. Worldwide, about 60 percent of carnivores and 40 percent of rodents are active at night. There are many advantages to nocturnal behavior, particularly in hot, dry regions such as the shortgrass prairie. These include:

- Avoiding the heat of the day and the accompanying water loss.
- Avoiding predators that are **diurnal** (active during the day). On the flip side, many predators are active during the night to match the activity level of their prey.
- Avoiding competition with an animal that is active during the daytime for food, water, shelter and space.

Nocturnal animals are well adapted for fulfilling their basic needs in the dark of the night. Although many nocturnal species have adaptations for better night vision, the other senses are also often much more developed in nocturnal species than in diurnal species. Taste, touch, hearing, and smell are all enhanced in nocturnal species.

Vision Adaptations (Sight)

In most ways, a nocturnal animal's eyes are very similar to our own. They differ from ours, however, in their ability to maximize the amount of light they receive, as well as in their sensitivity to that light. Here are some of the main differences:

- **Large eyes.** Most nocturnal animals have eyes that are very large relative to their body size so that they can collect more light.
- **Big pupils.** Bigger pupils let in more light. Not all animals have round pupils. Many nocturnal predators (think of house cats) have vertical or horizontal slit

About this Activity

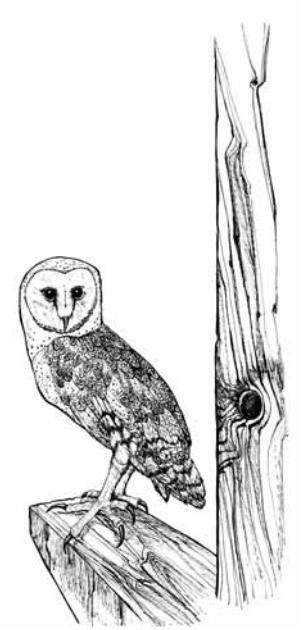
To prepare for this activity, you will need to cut 80 2-inch squares of each color of construction paper and then group and/or alter the pieces of colored paper as described below:

- **Set One**: Put five 2-inch squares of each color into this set. Place these squares in a paper bag labeled "Set 1".
- **Set Two**: You will alter the shapes of the five 2-inch squares of each color for this set. Shape the first color into triangles, round the corners of the five pieces of the second color, shape the five squares of the third color into rectangles, and leave the five squares of the fourth color as is. Place these pieces in a paper bag labeled "Set 2".
- **Set Three**: You will alter the scents of the five 2-inch squares of each color for this set. Place no scent on the first color, vanilla extract on the second color, mint extract on the third color, and orange extract on the fourth color. Keep differently scented pieces separated in plastic sandwich bags until just before the activity. Then, mix them into a paper bag labeled "Set 3".
- **Set Four**: This set will involve sound. You will place five 2-inch squares of each color in this set. For this set, prepare a note card for a non-blindfolded member of the group that instructs him/her to clap once for the first color, clap twice for the second color, clap three times for the third color and clap four times for the fourth color. The note card will instruct the clapping student not to speak during the activity. Place these pieces in a paper bag labeled "Set 4".

Vocabulary

- Cones
- Diurnal
- Echolocation
- Eyeshine
- Jacobson's Organ
- Lens
- Olfactory
- Nocturnal
- Photon
- Pupil
- Retina
- Rods
- Tapetum lucidum

shaped pupils. These types of pupils become a narrow slit in bright sunlight and widen almost completely in darkness.



- **More rods/less cones.** Nocturnal animals have a higher percentage of rod shaped light-receptor cells as compared to cones. Rods identify shapes and motion, but they only pick up black and white. Cones identify colors. Rods and cones work together to build an image of what the eye is seeing. Rods are extremely light sensitive, about 500 times greater than the sensitivity cone receptor cells. Only one photon, the smallest measurable unit of light, is required to stimulate a rod into sending a signal to the brain. Rods do not provide the high resolution and color vision that cones do. Most nocturnal animals are color blind.
- ***Tapetum lucidum*** (a Latin phrase meaning "bright carpet"). Most nocturnal animals have a structure designed to amplify the amount of light that reaches the retina. Called the *tapetum lucidum* (pronounced ta-pee-tum lu-cee-dum), this mirror-like membrane is found just behind the retina and reflects light. This layer of reflective cells reflects photons that were not captured by rod cells or cone cells back at these photoreceptors for a second chance. Whatever light is not absorbed on this return trip passes out of the eye the same way it came in—through the pupil, causing eye-shine. This is the reason that some animals' eyes glow at night. Different animals have different colored *tapetum lucidum*, a fact that can aid in nighttime animal identification (the topic of our next activity).

Make sure that students do not confuse eyeshine with "red eye" seen in photos. The human eye does not have a tapetum lucidum. We have dark-colored cells behind our retinas, which absorb light rather than reflect it. Red eye is a reflection of the red blood vessels on the retina.

Auditory Adaptations (Hearing)

Special auditory adaptations allow for excellent hearing in many nocturnal species

- **Offset ears** (owls) and **moveable ears** (big cats) allow these animals to pinpoint sound more accurately.
- **Large ears** (white-tailed jackrabbit) gather more sound.

Olfactory Adaptations (Smell)

- **Scent-marking** is an important communication tool for nocturnal mammals.
- **Highly developed olfactory systems** (good sense of smell).
- **Jacobson's organ** in the roof of the mouth, which improves their sense of smell.

Gustatory Adaptations (Taste)

Many nocturnal animals, especially snakes, use their tongues as a primary sense for navigation and location of prey. In invertebrates, taste and smell are very closely related and are collectively termed

chemoreception. In insects, taste receptors are located on the feet and mouthparts. Olfactory receptors are usually located on the antennae.

Tactile Adaptations (Touch)

- **Hairs with sensory receptors** that aid in navigation and finding food. In mammals, these take the form of whiskers. In arthropods, they take the form of hairs covering the animal's body.
- **Webs.** Spiders use webs as sensory tools to tell when their prey has been caught.

Other Sensory Adaptations

- **Echolocation**. Most bats are nocturnal and use this sensory system to navigate and locate food. They emit high-pitched sounds that bounce off nearby objects, including prey. The echoes of the sounds are used to determine the distance and direction of those nearby objects.
- **Heat-sensing pits**. Pit vipers such as rattlesnakes, boas, and pythons have heat-sensitive sensory receptors that help these predators sense and locate prey.

Teaching Strategies

1. As students enter the room, give them a copy of the Student Page *Black-Out*. Ask them to read the writing prompt on the handout quietly and write a response.
2. When all students have completed their response, ask if anyone has ever been in a power outage. What happened? What did they do to handle the event?
3. Hand out the Student Page *No-Nonsense Night Sense.* Tell students that they will be doing a group lab where a few students will try a task while the other students observe the results. Each group will have the task of separating pieces of colored paper into piles of the same color. Each piece represents a different kind of species. Some colors might be predators and others prey, so they need to be able to tell the difference. The students who are observing should be silent and observe. They should take careful notes of the behavior they observe when each group attempts the task and complete the table on the Student Page *No-Nonsense Night Sense.*
4. Ask the first group to come up. Do not blindfold any members of this group. Hand them **Set One** of paper squares and ask them to separate the colors. When they are done, ask them to show their results to the class.
5. Ask the second group to come up. All members of the group should be blindfolded. Give them **Set Two** of the paper squares. Do not give them any clues as to how to separate the paper, but tell them that they can talk with each other to figure out how to separate them. The observing students in the class should be silent and listening and watching what happens. When the group thinks they have completed the task, have them take their blindfolds off and show their results to the class.
6. Ask the third group to come up. All members of the group should be blindfolded. Give them **Set Three** of the paper squares. Do not give them any clues as to how to separate the paper, but tell them that they can talk with each other to figure out how to separate them. The observing students in the class should be silent and listening and watching what happens. When the group thinks they have completed the task, have them take their blindfolds off and show their results to the class.
7. Ask the fourth group to come up. All members of the group except one should be blindfolded. Give the group **Set Four** of the paper squares. Do not give them any clues as to how to separate the

paper, but tell them that the blindfolded students can talk with each other to figure out how to separate them. The student who is not blindfolded is not allowed to speak. The observing students in the class should be silent and listening and watching what happens. When the group thinks they have completed the task, have them take their blindfolds off and show their results to the class.

8. What senses were used in this experiment? Which were the most successful?
9. Discuss with students how animals might use the senses of touch, hearing and smell.
10. What other senses might work? (Discuss taste, echolocation, heat sensing)
11. Which senses do humans seem to rely on most? Humans seem to depend more on their eyesight than most other senses. This is true of many diurnal animals. Ask students - What sense do students think nocturnal animals use the most?
12. Hand out the student page *Night Eyes Notes*. Ask students to think about the differences they would expect to find between the eyes of animals that are active primarily in the daytime and that of animals that are active at night and list those differences.
13. Ask students - What is an eye and how does it work? (Whenever light shines on something, some light bounces off of it. The eye "sees" by gathering light rays that bounce off objects. The light passes into the eye, which sends a message about the light to the brain.)
14. Show students the photos of some nocturnal animals' eyes. Why are they large? Why are the pupils large? Why do the eyes glow?
15. Explain that the glow of the eyes is caused by a structure in the eye that helps nocturnal animals see well. This structure is almost like giving the animals a small flashlight to shine ahead of them. Most of the animals with eyeshine are night hunters, and their ability to use the available light twice, once on the way in and again on the way out, gives these nocturnal animals additional light to see by. Explain how the *tapetum lucidum* and draw or show the diagrams comparing human with ferret eyes. Have students draw the two eyes on their paper. Make sure that students show that ferret eyes have the extra structure, the *tapetum lucidum.*

Assessment

Show students this short clip of a black-footed ferret hunting a prairie dog at night and have them list all of the senses that they see the black-footed ferret using.

http://arkive.org/black-footed-ferret/mustela-nigripes/video-08.html

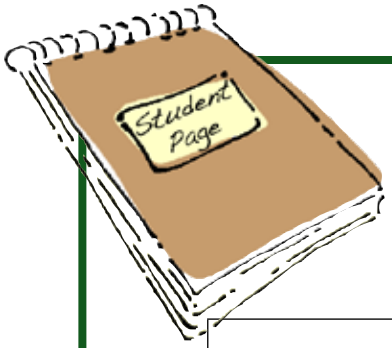
Extensions

1. Make arrangements to visit a zoo with an exhibit highlighting nocturnal animals. Observe and discuss the special adaptations of each species.
2. Perhaps you can make arrangements to visit a zoo at night. Visit all of the nocturnal animals and list their adaptations. Record eye shine colors of known animals.

Black-Out

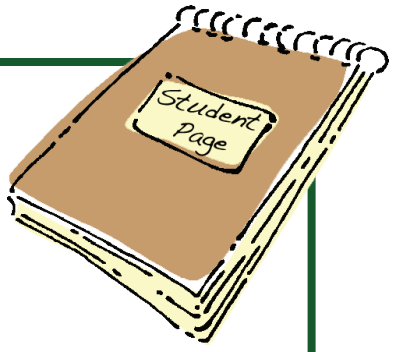
Imagine yourself sitting at your kitchen table or desk one night working on homework. You have a few cookies and a glass of milk nearby to snack on. Suddenly, there is a power outage and you find yourself sitting in darkness. You realize that you can't see a thing. You don't dare reach for your glass of milk for fear of spilling it. Moving about in the darkness, even in the familiar environment of your own house, is hazardous. The pile of books you left on the floor, the dreaded table leg - there's no telling what could happen if you left the safety of your chair.

Humans can't do very much at night without a source of light – even candles or flashlights make a huge difference. What if you were a black-footed ferret right now and you were active at night, usually underground? What challenges might you face to find prey, avoid predators, find a mate, and live your life in the dark? How might you overcome them?



No-Nonsense Night Sense

Group One	**Main Sense Used:** **How did you know? What did you observe?** **How successful was this group in completing their task?**
Group Two	**Main Sense Used:** **How did you know? What did you observe?** **How successful was this group in completing their task?**
Group Three	**Main Sense Used:** **How did you know? What did you observe?** **How successful was this group in completing their task?**
Group Four	**Main Sense Used:** **How did you know? What did you observe?** **How successful was this group in completing their task?**



List four eye adaptations that are common in nocturnal animals.

1.

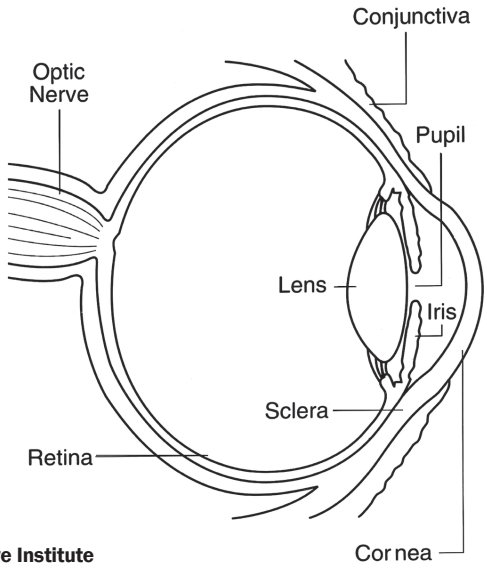
2.

3.

4.

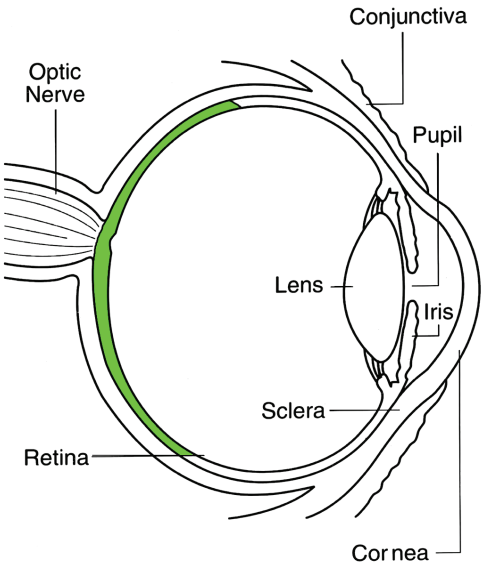
Below are illustrations of a human eye and a black-footed ferret eye. Label the tapetum lucidum and describe how light is used differently by human and ferret eyes.

Human Eye



National Eye Institute

Black-footed Ferret Eye



Eye Shine

Travis Livieri / Prairie Wildlife Research

Wikimedia Commons

Finding Ferrets

Duration
- One 45-minute indoor class period

Materials
- Access to the Internet or field guides and encyclopedias
- Optional Extension: Student Page: *Tube Sock Ferrets*, large men's tube socks, markers, and other craft supplies

Summary

In this activity, students will observe methods biologists use to locate ferrets. They will complete a comparison chart of North America mustelids and write three questions they would need to ask to determine if a black-footed ferret had been sighted versus another animal.

Objectives

Students will be able to:

- Describe the identifying characteristics of black-footed ferrets and compare and contrast those with other similar-sized mustelids.
- Students will be able to ask questions to determine whether a hypothetical animal sighting might be a black-footed ferret.
- Describe methods that scientists use to locate ferrets.
- Optional: Create a life-sized black-footed ferret model (appropriate weight and length).

Background

Black-footed ferrets are members of the Mustelidae family. Mustelids are musk-producing animals. Mustelids all have scent glands underneath their tails. Some well-known members of the mustelid family include mink, badgers, martens, fishers, weasels, stoats, polecats, wolverines, and the European, or domestic ferret. Most mustelids also have long bodies and short legs, well-developed claws, and short, rounded ears. They are all carnivores and their large skulls and strong jaws and teeth are adapted for eating meat. Black-footed ferrets are North America's only native ferret and they are a different species than ferrets found in pet stores. The animals sold in pet stores are European ferrets, a domesticated form of the wild European polecat.

Black-footed ferrets are 18 to 24 inches long, including a 5 to 6 inch tail. They weigh only 1.5 to 2.5 pounds. Males are slightly larger than females. Their short, sleek fur is a pale yellow-buff color, lighter on the belly and nearly white on the face and throat. They have a black face mask, black feet, and a black-tipped tail. Their color and markings blend so well with grassland soils and plants that they are hard to detect until they move.

Even when the prairie stretched for hundreds of miles, black-footed ferrets were not commonly seen. Black-footed ferrets are secretive animals and they probably spend 90% of their time below ground. When they do emerge from prairie dog burrows, it is usually at night. For the most part, black-footed ferrets are born, eat, sleep, raise their young, and die underground. These nocturnal animals rarely ever come above ground. Before leaving the safety of a burrow, black-footed ferrets survey their surroundings by poking their heads out of the hole and looking in all directions, a behavior that biologists call **periscoping**.

John James Audubon

Black-footed ferrets were first officially recognized by scientists in 1851 in a book by naturalist John James Audubon and the Reverend John Bachmann. Then, no one found another ferret for more than 20 years and no one saw any during their travels. Many people thought the animal didn't even exist. Finally, in 1874, more specimens were found and scientists finally believed that black-footed ferrets did exist.

Why did it take so long to find these animals? Most likely, no one ever looked for black-footed ferrets at the right time and they did not know what tracks and signs to look for. A **track** is the impressions left by the foot of an animal. A **sign** is anything besides a track that indicates the presence of an animal. Signs include bite or chew marks, rub marks, mounds, nests, burrows, feathers, bones, scat (animal waste), etc.

Once scientists learned a bit more about these animals, they had more success finding them. Knowing that black-footed ferrets are nocturnal and have a tapetum lucidum, biologists now search for these animals at night. They shine spotlights that reflect the emerald-green eyeshine of black-footed ferrets.

J. Michael Lockhart / USFWS

Also, it is easier to look for black-footed ferrets in winter. When snow covers the ground, black-footed ferret sign is more visible. Sign

Vocabulary

- Dirt diggings
- Drag marks
- Mustelid
- Periscoping
- Sign
- Track
- Trenches

includes **dirt diggings**, **trenches**, and **drag marks**. Dirt diggings are mounds of soil brought up from prairie dog burrows and piled on the surface. Trenches are formed when ferrets move backwards from burrow entrances dragging soil with their front legs. Zigzagging drag marks, sometimes called "kill drags" are left by ferrets tugging prairie dogs from the capture site to a burrow or from one burrow to another.

Because of their endangered status, it is important for scientists to be able to distinguish black-footed ferrets from all other mustelids. Every now and then, a citizen reports a sighting of an animal that they believe is a black-footed ferret. Scientists have been searching for other wild populations (populations that have not been part of the captive breeding and re-introduction program) for four decades and have not found any additional populations. While it is unlikely that an undiscovered population exists, it is not impossible. So it is important for scientists to ask critical questions to determine whether to send a crew out to explore the claim.

Teaching Strategies

1. Since students just completed an activity about eyeshine, it might occur to them that this is one way that people could find ferrets. Show them this short video clip from National Geographic:

   http://www.youtube.com/watch?v=g_xBPTjeT2E

2. Ask students to summarize the content of the video clip. (It is really difficult to find black-footed ferrets. Biologists must work the night shift to find ferrets. Using high-powered lights, the scientists go spotlighting to locate and identify black-footed ferrets. The animal's emerald green eyeshine is reflected by the spotlight at night. Once a ferret is located, a cage-trap will be set in the burrow where the ferret was found. Traps are checked often. Numerous other animals can also be observed while spotlighting including badgers, coyotes, owls, foxes, pronghorn, mule deer, porcupines and skunks. Upon capture, biologists determine if an animal is a wild born or a captive bred ferret. If the animal is wild born, it is anesthetized and a passive integrated transponder (PIT) tag is inserted just below the skin. The PIT tag allows the animal to be uniquely identified if it is ever recaptured. After the animal recovers from anesthesia, it is released in the same burrow where it was trapped.)

Travis Livieri / Prairie Wildlife Research

3. Another time that scientists look for ferrets is early winter. Here's a short video of black-footed ferret habitat in winter:

   http://www.arkive.org/black-footed-ferret/mustela-nigripes/video-02a.html

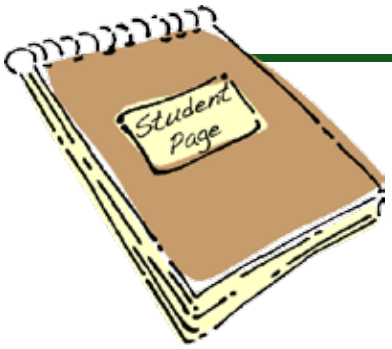
4. Share the following scenario with students. Tell them that to pretend that they work for a state, tribal or federal wildlife agency and that they have just received a call from a citizen that believes he/she has spotted a black-footed ferret. This sighting has occurred in an area that no ferrets have been re-introduced to. They will need to be able to distinguish black-footed ferrets from similar species. Their job is to complete the North American Mustelids chart and then think of three questions they would ask this person to determine the likelihood that they have observed a black-footed ferret.
5. To complete the North American Mustelids chart, divide the class into 10 groups (if the class size is large enough) and assign each group one of the mustelid species on the chart.
6. When all groups have completed the information on the chart for their assigned species, each group should present their information to the rest of the class so that each student has a completed chart.
7. Students should then work individually to devise the three questions that they would ask a person who thought they spotted a black-footed ferret.

Assessment

Each student's ability to sift out important identifying characteristics of black-footed ferrets and ask three identifying questions serves as an assessment for this activity.

Extension

Students can create a ferret from a tube sock. Students should measure and make sure their animal is the correct length and weight. This activity will help students get a sense of the size of the black-footed ferret. They can compare their finished tube sock ferrets to the size and weight of other common objects or animals.



North American Mustelids

Put weights, lengths, and identifying characteristics in the appropriate columns.

	Weight	Length	Identifying Characteristics / Habitat / Prey
Least Weasel			
Long-tailed Weasel			
Short-tailed Weasel (Ermine)			
Black-footed Ferret	1.5 – 2.5 pounds, males bigger	18–24" body, including 5–6" tail	Yellowish brown to buff, black-tipped tail, black feet and black mask. Lives on shortgrass prairie and eats prairie dogs.
Marten			
Fisher			
Mink			
River Otter			
Sea Otter			
Badger			
Wolverine			

Adapted from *The Black-footed Ferret: Understanding an Endangered Species,* National Park Service

Tube Sock Ferrets

Black-footed ferrets are 18 to 24 inches long, including a 5 to 6 inch tail. They weigh only 1.5 to 2.5 pounds. Males are slightly larger than females. Their short, sleek fur is a pale yellow-buff color, lighter on the belly and nearly white on the face and throat. They have a black face mask, black feet, and a black-tipped tail. Using these photos, a men's tube sock, stuffing materials, markers and other craft supplies, create your own Tube Sock Black-footed Ferret.

J. Michael Lockhart / USFWS

J. Michael Lockhart / USFWS

The Prairie Web of Life

Duration
- Two 45-minute indoor class periods

Materials
- Student Pages: *The Prairie Web of Life, Shortgrass Prairie Species Niche Chart, Help Wanted!*
- *Species Information Cards* (from activity: *A Prairie Home*)
- Index cards
- Markers
- Yarn
- Bulletin board, butcher paper, bed sheet or other display space to create a food web

Summary

In this activity, students will create a shortgrass prairie food web and identify each organism's ecological niche. They will create Help Wanted advertisements for shortgrass prairie species.

Objectives

Students will be able to:

- Define trophic level and give examples of producers, consumers, and decomposers.
- Define and give examples of herbivores, carnivores, omnivores, and scavengers.
- Illustrate a shortgrass prairie food chain and a food web.
- Research one or more plant or animal species that lives on shortgrass prairie.
- Define ecological niche.
- Distinguish between generalist and specialist species.
- Describe the ecological role (niche) of a species in the prairie ecosystem by creating a *Help Wanted* advertisement.

Background

Each species in the shortgrass prairie community has a ecological role or function called a **niche**. To understand each plant and animal's niche, we first need to look at how each obtains energy and nutrients. Ecologists often group species in an ecosystem according to their position in the food chain, or their **trophic (feeding) level**.

All living things require a constant source of energy to survive. Ultimately, the source of energy for nearly all living things on Earth is the sun. The sun's energy is converted to chemical energy by plants, green and red algae, and cyanobacteria. Organisms such as green plants are called **producers** because they can make their own food from the sun's energy. Through a process called **photosynthesis**,

plants use sunlight energy to combine water and carbon dioxide and make sugars (stored energy) and oxygen. Plants use some of the sugar energy to stay alive and some to grow. Plants absorb nutrients and minerals from the soil and combine them with sugar to form fats, proteins, and starches. (*Misconception Alert: It is critical that students understand that the minerals or nutrients that plants absorb from the soil are not what provides plants with energy. Remind students that at some point they probably did an experiment of growing a seed using just water.*)

Animals are not capable of photosynthesis. They must get their energy from eating plants or other animals – they are **consumers**. Animals that eat only plants are called **herbivores**. Animals that eat only other animals are called **carnivores**. Animals that eat both plants and animals are called **omnivores**. **Predators**, animals that kill and eat other animals, can be either carnivores or omnivores. The animals that predators hunt and eat are called **prey. Scavengers** are consumers that eat dead animals that they find. **Decomposers**, such as bacteria and fungi, break down dead plants and animals. Decomposers return minerals to the soil to be used by plants again.

Vocabulary

- Carnivore
- Consumers
- Decomposer
- Food chain
- Food web
- Generalist
- Herbivore
- Niche
- Omnivore
- Photosynthesis
- Producers
- Scavenger
- Specialist
- Trophic level

About this Activity

This lesson is lengthy, but extremely important. It presents some of the core concepts of ecology. You may want to supplement or reinforce the concepts in this lesson with the activity *Energy Pipeline* from the ***Project WILD K-12 Curriculum & Activity Guide***.

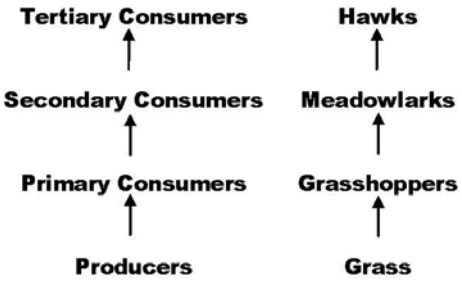
Energy moves through the environment in a pathway. Energy from the sun is used by green plants to make food, which are eaten by animals that eat plants, which are eaten by animals that eat other animals. The transfer of energy from one organism to another is called a **food chain**. Each step in the food chain is referred to as a **trophic level**.

Level 1: Plants and algae that make their own food are called producers.

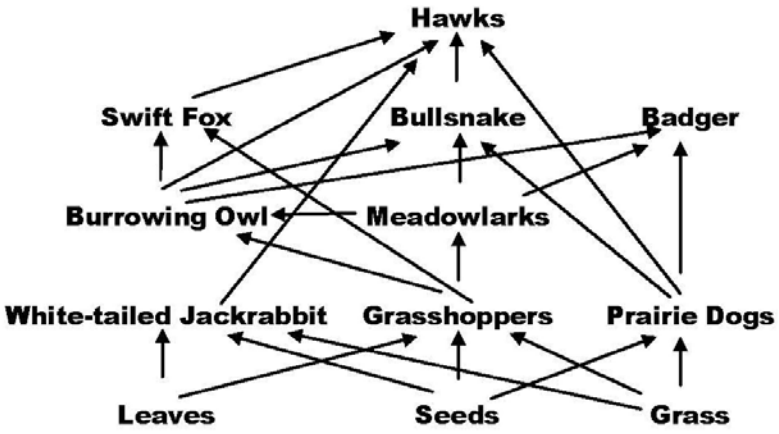
Level 2: Herbivores eat plants and are called primary consumers.

Level 3: Carnivores and omnivores which eat herbivores are called secondary consumers.

Level 4: Carnivores and omnivores which eat other carnivores are called tertiary consumers.



Food chains are simple to understand but they aren't really accurate. For example, while meadowlarks do eat insects, they also eat grass seeds. In addition, the food chain makes it seem as if there are only four species in a community, when most communities contain far more. Most organisms in a community hunt more than one kind of prey and are hunted by more than one predator. These numerous predation interactions are more accurately shown by a **food web**.



Usually, the more diverse and complicated the food relationships are in a community, the more stable that community will be. Imagine a community that was described completely by the food chain: grass → insects → sparrows → hawks. If some disease destroyed the grass population, the insect population would be decimated. The loss of insects would wipe out the sparrow population, and finally, devastate the hawk population at the very top of the food chain. A more complex food web is able to absorb and withstand such disasters. If something were to happen to the grass in the food web, the primary consumers would all have some other food source to tide them over until the grass recovered.

For similar reasons, it is easy to see how **generalist** animals that eat a wide variety of foods have an advantage over **specialist** animals that rely on one or very few species as a food source. Generalists have a broader niche than specialists and can more easily adapt to changes in their environment. On the shortgrass prairie, an example of a generalist would be a coyote, while an example of a specialist would be a monarch butterfly or a black-footed ferret. Coyotes can adapt to live in almost any environment and will eat what is available to them. Monarch butterflies are dependent on milkweed and black-footed ferrets are dependent on prairie dogs for survival.

Teaching Strategies

Part 1- Vocabulary and Preparation

1. Give each student a copy of the Student Page *The Prairie Web of Life* and a sheet of paper for notes. Explain that you will be discussing new vocabulary words that they will need to learn and that each term is an answer on the crossword puzzle. They can take notes and draw diagrams on their sheet of paper and then use that information to complete the crossword puzzle.
2. Explain to students that each shortgrass prairie species occupies a unique **niche**. You may want to relate the niche to a "job" or "role." A specie's niche includes the resources it uses, how and when it uses the resources, and how it interacts with other species.
3. Explain that one of the most important components of an organism's niche is how it gets energy to stay alive. All energy comes from the sun, but only some organisms use the sun's energy directly. Explain that three major types of organisms live in an ecosystem: **producers**, **consumers**, and **decomposers**. Producers create their own food through the process of photosynthesis. Consumers must hunt or forage for the nutrients they need to survive. Decomposers obtain nutrients by breaking down parts of organisms into simple forms.
4. Review with students the three types of consumers: **herbivores**, **carnivores**, and **omnivores**. Explain that herbivores are animals that eat only plant material, such as the caterpillar. Carnivores eat animals; and omnivores eat both plant material and animal flesh. Humans are omnivores.
5. Next, define **trophic levels**, **food webs** and **food chains**. Draw the example of the food chain provided in the background section of this activity. Explain that grass is a producer and is found on trophic level 1. Draw an arrow from the grass to the grasshopper. Emphasize to students that the arrow points in the direction that the energy is flowing. Next, add the meadowlark and then the hawk. Finally, ask students to name a possible **scavenger** or decomposer which might eat or break down a dead animal.
6. Explain that food chains just represent one possible flow of energy transfer. Usually, there are many more possibilities. Usually, animals eat more than one type of food. This gives them choices if one kind of food is not available. Some animals only eat one kind of food. If that food is not available, they must move to where that food is or starve. Draw the example of the food web provided in the background of this activity.
7. Next, explain the difference between **generalist** and **specialist** species. Generalist species use a broad range of resources to meet their needs, while specialists use a narrow range of resources. With regards to how the species meets its need for energy, a generalist will eat a wide variety of food. Using the food web that has been drawn as an example, point out that if there were few rabbits, the hawk could eat prairie dogs or bullsnakes, or even a small fox. A specialist is a picky eater. A panda is an example of a specialist, because it only eats bamboo. If there is no bamboo available, the panda will not have anything to eat.
8. Give students time to review their notes and complete the crossword puzzle.
9. Tell students that they will be constructing a food web for the shortgrass prairie.

10. Give students one or more species cards, depending upon the size of your classroom. (It is important to hand out all of the species cards so that students can construct a complex food web during this activity.)
11. Give each student a copy of the student page *Shortgrass Prairie Species Niche Chart*.
12. Tell students that for each species they have, whether plant or animal, they must fill in the information on the *Shortgrass Prairie Species Niche Chart*. Tell students that the information will be used to construct a food web and look for other important interactions between species.
13. Give students time to complete their *Shortgrass Prairie Species Niche Chart*.

Part 2 – Building a Prairie Food Web

1. On your bulletin board, butcher paper, bed sheet or other display space that you will use to create a food web, draw a horizontal line near the bottom. Tell students that this line represents ground level on the prairie.
2. Ask students "Where does the energy for this food web come from?" (sun) Draw a sun on the top of the display area.
3. Ask students "Which species begin every food chain or web?" (producers or plants). Since grass species are the most abundant plants on the shortgrass prairie, draw clumps of grass on the line that represents the ground.
4. Ask students who have a plant species to come up to the display place and write the name of the species just above the line representing the ground.
5. Ask students which species should be put up next. (plant eaters or herbivores). Ask students who have herbivores to come to the display area. The students should write the name of their herbivore above the grass and plants. Ask each student which plants their species eats. If the student has a grass eating animal, that animal would eat the grass. Using a marker, the student should connect their herbivore with the grass or any plant it might eat. <u>The student should draw an arrow that points from the grass towards the animal. That arrow shows the direction the energy is flowing in the ecosystem.</u> If a student has an herbivore that eats only one species of plant (such as the monarch butterfly that feeds only on milkweed) then the arrow should point from that plant to that animal.
6. After all of the herbivores are on the food web display, ask students who have omnivores to come to the display area (for example, skunks and coyotes). These animals eat plants, but also eat

animals. Those students should draw arrows from the plants and animals that their species eats toward their species.

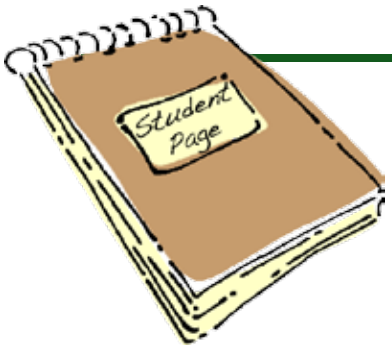
7. Continue as outlined above with the carnivores, scavengers, and decomposers.
8. After the entire food web has been built, ask students to look it over and decide which species eat the largest variety of foods and which eat the smallest. Ask them to identify the shortgrass prairie generalist and specialist species. The monarch butterfly and the black-footed ferret are both specialist species. What would happen to them if their food source was not available? (they would not be able to survive)
9. Ask students: Which species are most important in the food web? (They are all important, but every animal depends on plants either directly or indirectly.)
10. Ask students: What happens if a plant or animal is removed from the food web? Does it matter where in the food web a species is removed? (Removing one species affects the other species that either feed on it or are eaten by it. It does not matter where the species is in the food web, the impact spreads throughout the food web – all the species depend on each other)
11. Ask students: Which species in the food web are most important to the black-footed ferret? (Prairie dogs directly, and the plants indirectly.)
12. Give each student a copy of *Help Wanted*. Each student must choose one of their shortgrass prairie species and write an advertisement to highlight the special role that the animal or plant has in the ecosystem.
13. Ask each student to share their advertisement aloud and ask the class to guess which species the advertisement describes.
14. Re-collect the Species Information Cards for use in another activity.

Assessment

Student generated “Help Wanted” advertisements serve as an assessment for this activity.

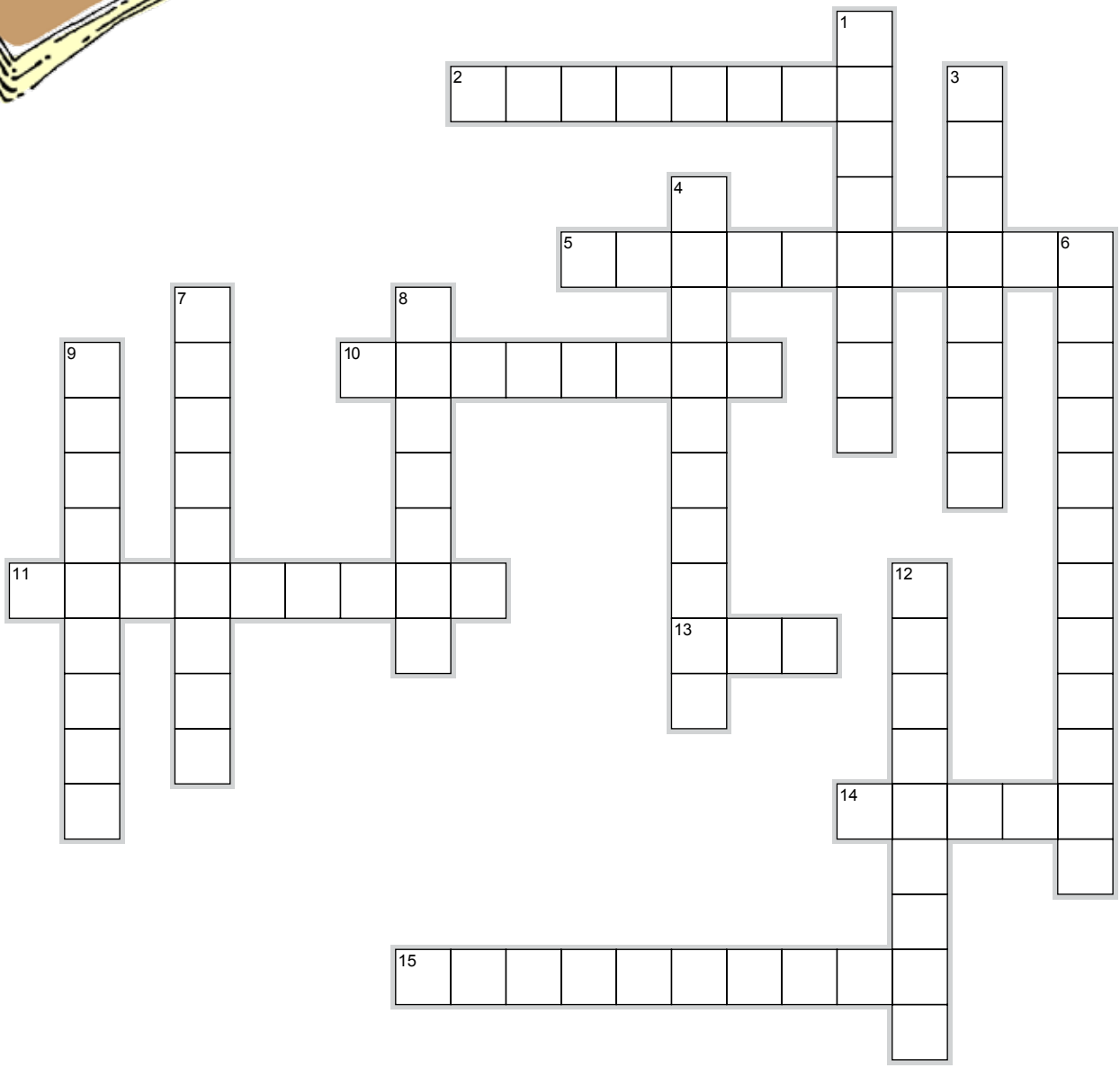
Extension

Students can also explore the changes in shortgrass prairie over time. Cities now exist where prairies once stood. Have populations of animals and plants changed over time with increasing numbers of humans? Explain.



The Prairie Web of Life

It's All About Energy



Across

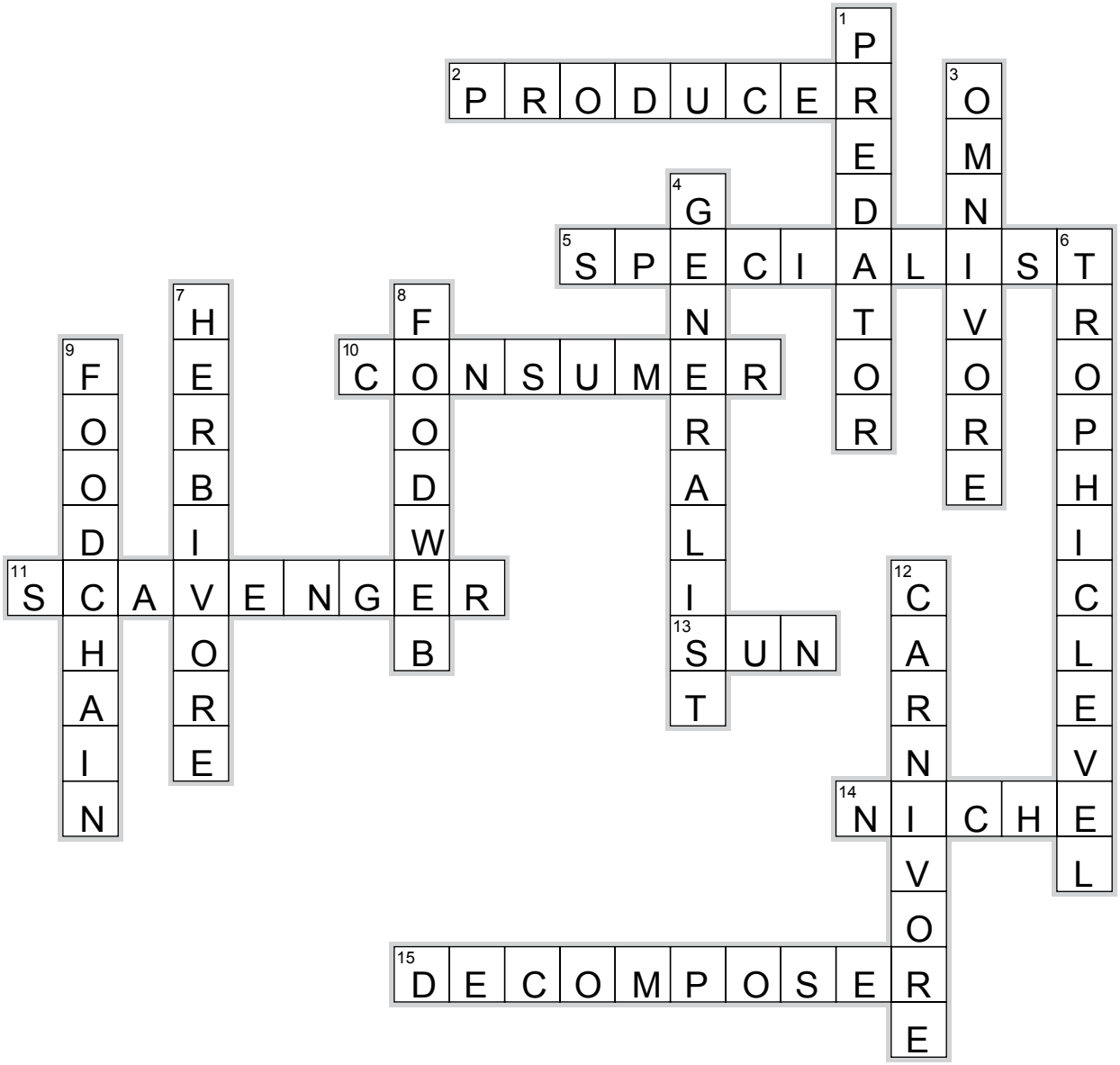
2. Plants, algae,and other organims that convert solar energy into chemical energy.
5. A species that uses a narrow range of habitat components to meet its needs and may only eat one type of food.
10. Animals that get their energy from eating plants or animals.
11. Animal that eats dead animals.
13. The source of all energy for living things on Earth.
14. The ecological role of an organism in an ecosystem.
15. Bacteria and fungi which break down dead plants and animals.

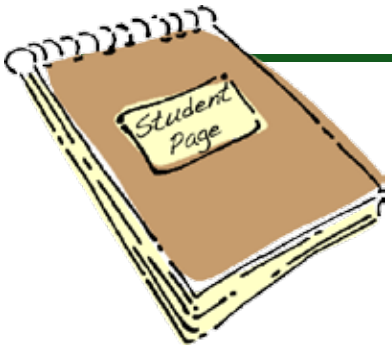
Down

1. A carnivore or omnivore that kills and eats other animals.
3. Animal that eats both plants and animals.
4. A species which eats a variety of foods and uses a broad range of habitat components to meet its needs.
6. A step in the food chain.
7. Animal that eats only plants.
8. All of the possible feeding relationships and energy transfers in an ecosystem.
9. The transfer of energy from one organism to another in an ecosystem.
12. Animal that eats other animals.

The Prairie Web of Life

It's All About Energy



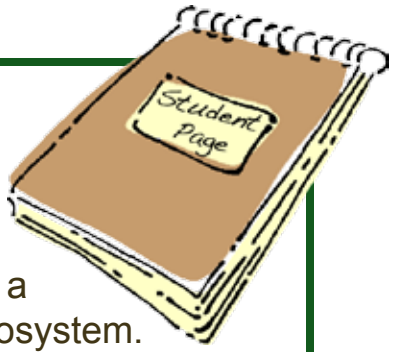


Shortgrass Prairie Species Niche Chart

Species name	
Producer or consumer?	
If consumer, is it an herbivore, omnivore, carnivore, scavenger or decomposer?	
What does it eat?	
What eats it?	

Species name	
Producer or consumer?	
If consumer, is it an herbivore, omnivore, carnivore, scavenger or decomposer?	
What does it eat?	
What eats it?	

Species name	
Producer or consumer?	
If consumer, is it an herbivore, omnivore, carnivore, scavenger or decomposer?	
What does it eat?	
What eats it?	



I Read it in the Want Ads

Create a Help Wanted Advertisement: Your species has a unique role or ecological niche in the shortgrass prairie ecosystem. Imagine you were going to place an advertisement in a newspaper to hire your species to do its job. What special adaptations (skills, tools, behaviors) would you be looking for? What is its niche? What job does it do in the shortgrass prairie community? What time of day or season will they work? Do any plants or animals depend on them? Does your species rely on any other plants or animals?

To get you thinking, here's an example advertisement for a sidewinder rattlesnake: *Help wanted hunting at night for warm rodents and sleeping birds; must be able to climb loose sloping sand by throwing loops of one's body up like coils. Seasonal, approximately six months, May through October.*

Dog Gone It!

Duration
- Two or three 45-minute indoor class periods

Materials
- *Species Information Cards* from the activity "A Prairie Home"
- *Student Pages from previous activities: A Prairie Home, Grasslands Adaptations, Shortgrass Prairie Species Niche Chart*
- Student Pages: *Dog Gone It, Challenge #1: Habitat Loss, Challenge #2: Prairie Dog Eradication Programs, Challenge #3: Sylvatic Plague, Challenge #4: Canine Distemper*

Summary

In this activity, students will determine the ecological role of prairie dogs in the grassland ecosystem and be able to support its classification as a keystone species. Students will create skits and a comic strip to demonstrate the challenges that must be overcome to recover black-footed ferrets.

Objectives

Students will be able to:

- Describe biodiversity as it relates to ecosystems and species.
- Identify, describe, and explain the reasons for the decline in shortgrass prairie habitat.
- Define and describe the characteristics of a keystone species.
- List and give examples for three main ways that prairie dogs promote species diversity in grassland ecosystems.
- Identify, describe, and explain the reasons for the decline of prairie dogs.
- Identify the four main challenges that must be overcome to recover black-footed ferrets.
- Understand reasons for preserving remnants of prairie.

Background

Biodiversity is short for biological diversity. It is the richness of life. Biodiversity includes the variety of ecosystems, the variety of species (**species diversity**) within an ecosystem, and the variety of genetic differences within species. Species diversity is a measure of the abundance and variety of living organisms in a specific geographic area or ecosystem. A change in the number or variety of species in an ecosystem can change other elements throughout the system.

The black-footed ferret lives in North America's most threatened habitat, so perhaps it is not surprising that they are endangered. The grasslands we know as the Great Plains once covered about 1.4 million square miles. They reached from Alberta, Saskatchewan, and Manitoba Canada to southern Texas and Mexico and stretched from the foothills of the Rocky Mountains to just east of the Mississippi River. Now, the North American prairie is rarer than the tropical rainforests. Most of the

prairie was lost to agricultural use and urban development as the United States and Canada's populations grew and moved west. Today, total prairie acreage in the U.S., Canada and northern Mexico has shrunk to under 203,000 square miles, less than 3 percent of the historical prairie. Those prairie lands that remain are fragmented bits and pieces.

This region now produces much of the food we eat, and no one would suggest turning back the clock to pre-settlement times. However, finding, managing, and linking the remaining intact prairie remnants are high conservation priorities for the United States and Canada. This is because protecting individual species and isolated pockets of wildlife habitat cannot alone preserve the biodiversity on which all life depends.

In the past, when there were thousands of miles of unbroken prairies, there were prairie dog colonies hundreds of miles wide. Total numbers of prairie dog populations at that time probably exceeded 5 billion animals. Only about 24 million black-tailed prairie dogs remain today, and they exist on only two percent of their historical home range.

For a variety of reasons, prairie dogs provoke strong emotional reactions for many people. They either love them or hate them. So, for some people, 24 million sounds like too many prairie dogs and for others, too few. An objective understanding of the role of prairie dogs in the prairie ecosystem is important to making good decisions that balance human needs with species conservation.

Prairie dog towns support a variety of species (species diversity). It is estimated that 40 percent of western wildlife, or more than 150 species, are associated with prairie dog colonies in some way. In fact, biologists call prairie dogs a **keystone species.**

Vocabulary

- Biodiversity
- Habitat fragmentation
- Habitat loss
- Keystone species
- Pest
- Species diversity
- Sylvatic plague
- Varmint hunting

About this Activity

It is impossible to discuss a future for black-footed ferrets, and many other species, without talking about habitat loss and the ecological role of prairie dogs. This activity should not be used to raise alarm, find fault, or depress students. The activity, as designed, should increase awareness of the intricate species relationships and conservation challenges of preserving the biodiversity of the shortgrass prairie ecosystem.

This is because they have a unique and significant impact on the grassland ecosystem and because so many other species depend on them. Here's why:

1. Prairie dogs are a ***prey source*** for many predators. Black-footed ferrets, ferruginous hawks, snakes, badgers and many other animals eat them.
2. Prairie dogs are ***grazers and they keep the vegetations short***. Prairie dogs eat grass, leaves and roots surrounding their town.
    a. Birds such as the mountain plover and chestnut-collared longspur that prefer open habitat depend on prairie dogs to maintain ground-nesting sites.

    b. Clipping and grazing by prairie dogs alters the plant community. Scientists have discovered that there is higher nitrogen content in grasses that are continually grazed. Grasses that are allowed to grow tall have much less nitrogen, an important nutrient for many animals. So, the short grasses and plants found on prairie dog towns are more nutritious for large grazing animals such as bison and pronghorn.
3. Prairie dogs ***dig and create burrows***.
    a. Prairie dog digging redistributes and aerates the soil, improving soil moisture and plant growth. Also, prairie dog urine and feces help fertilize the soil.
    b. Prairie dog burrows offer shelter and nest sites for many species, from snakes to burrowing owls to insects. Prairie dog burrows are constructed to provide optimum living conditions. When excavating a new burrow, prairie dogs always position one entrance at a slightly lower elevation than the main entrance. If the topography of the land does not allow for this, they build a volcanic-shaped mound around the main entrance to make it higher. The air flows into the lower hole and out of the upper hole – achieving perfect ventilation. Burrows are dug deeply enough that they provide shelter from the hot summer heat and bitter winter cold. Species such as salamanders, box turtles, lizards, toads, and insects find a moist, protected environment in the dark tunnels.

While prairie dogs provide definite benefits to the ecosystem, they are often considered **pests** or **varmints**. As European settlers moved west, much of the Great Plains was converted to farming or pastureland. The great bison herds were replaced by cattle. Ranchers noticed that prairie dogs ate grass and logically assumed that prairie dogs must compete with their livestock for food. In addition, ranchers feared that

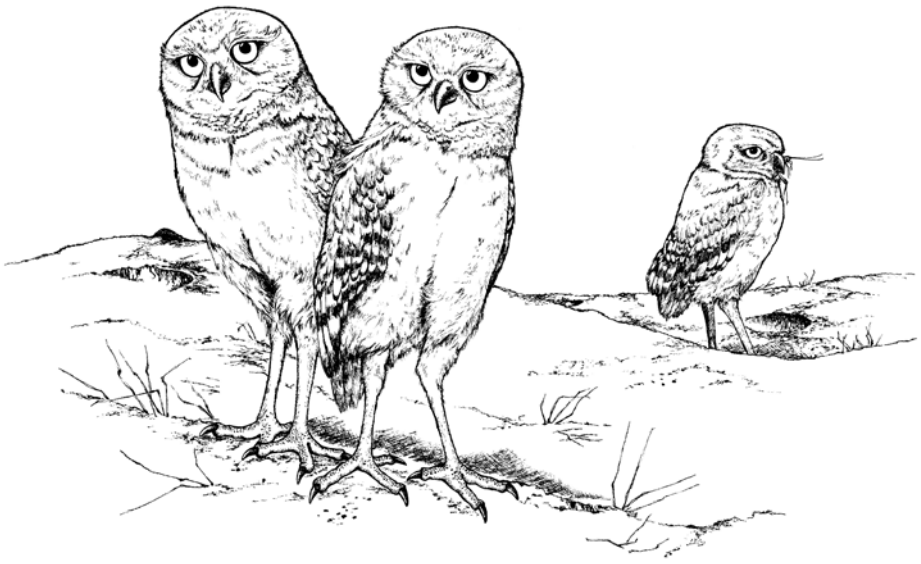
cows and horses could break their legs by stepping into prairie dog burrows. Farmers were just as frustrated with prairie dogs because their burrow systems made plowing difficult.

To protect their livelihood and provide food for a growing nation, farmers and ranchers began eradicating prairie dogs. Poisoning and shooting of prairie dogs began in the late 1800s and soon developed into large-scale, well-organized campaigns. Bounties were offered to varmint hunters for prairie dogs and other pests. (**Varmint hunting** is the practice of hunting as a means of pest control, rather than for food).

The federal government began allocating money for poisoning in 1915, and by the 1920s, millions of prairie dogs had been killed. Today, many local, state, and federal agencies still recognize the need to control prairie dogs on some portions of agricultural land and about 10 to 20 percent of prairie dog colonies are poisoned annually. There have been efforts to reduce poisoning where it is not needed, but some states still require landowners to poison prairie dogs on their land if neighbors complain.

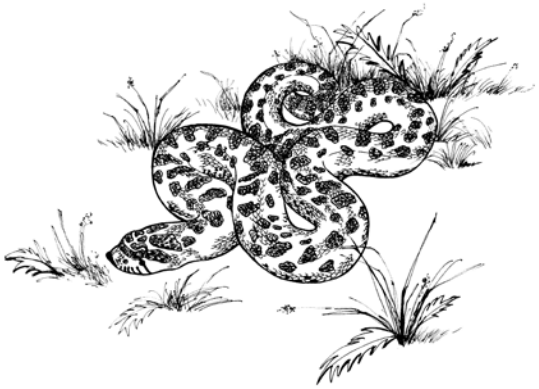
Residential and road development has also taken a toll on prairie habitat. As communities develop, many people are concerned about prairie dog towns near their homes because of the potential health risks. Prairie dogs are highly susceptible to disease, especially flea-borne sylvatic plague. Called bubonic plague or Black Death in humans, the bacterium that causes sylvatic plague was introduced into the United States from Asia early in the 20th Century. Outbreaks of plague can wipe out an entire prairie dog colony.

These plague outbreaks are worrisome to nearby human communities. Bubonic plague killed millions of people in Europe during the Middle Ages when they were bitten by fleas from infected rats. In modern times, cases of human plague are rare and antibiotics are effective against the disease. According to the Centers of Disease Control and Prevention (CDC), about 10 to 15 people a year come down with the plague in the United States. Less than 6 percent of those cases have been linked to prairie dogs.



Teaching Strategies

Part 1



1. Give each student one or more *Species Information Cards* from the activity *A Prairie Home* and ask them to refer to three Student Page handouts from previous activities: *A Prairie Home, Grassland Adaptations,* and *Shortgrass Prairie Species Niche Chart*.
2. Give each student a copy of the Student Page *Dog Gone It*.
3. Explain the terms biodiversity and keystone species to the class. Make sure that students understand that keystone species affect the species diversity in an ecosystem.
4. Tell students that the class will be looking for species that depend upon prairie dogs in some way. This will be a whole class activity, but every person should record the information.
5. Copy the table from the Student Page *Dog Gone It* onto the board or in some other visible place.
6. Remind students that one of the most direct relationships between living things is a feeding relationship. Ask students if they have any *Species Information Cards* listing species which eat prairie dogs. Make hatch marks in the appropriate place in the table and have students figure out what percentage of species eats prairie dogs.
7. Point out that some of the species that eat prairie dogs would not be in the ecosystem without prairie dogs. One way that prairie dogs promote species diversity is as prey for other animals.
8. Now discuss the role of prairie dog grazing. How does prairie dog grazing affect any other species? Have students give examples of species that are helped by eating grasses where prairie dog graze and burrow. It may not be obvious to students that grasses depend on the grazing to grow. You may need to have students refer to the Student Page *Grassland Adaptations.* Ask questions such as: How might a prairie dog burrow help grasses grow? How might the prairie dog burrow affect the absorption of water into the ground? How does the prairie dog burrow affect oxygenation and watering of the ground? In an area with hot and dry summers, how do you think the prairie dog burrow affects the ability of grasses to survive?
9. Ask students if they have any *Species Information Cards* listing species which eat prairie grasses and plants. Make hatch marks in the appropriate place in the table and have students figure out what percentage of species graze where prairie dogs live.
10. After all the species that benefit from grazing are identified, ask students to look for species that prefer open habitat where grasses are short. These might be ground-nesting birds, snakes, or small mammals. Make hatch marks in the appropriate place in the table and have students figure out what percentage of species prefer open habitat. Some of these species may have been identified previously as either eating prairie dogs or grazing on grasses. It is okay to count them again.

11. Next, ask students to look for species that require prairie dog burrows. What animals use a prairie dog burrow? As before, determine the number of species that benefit from prairie dog burrowing and digging and record that number. Figure out as a class the percentage of species that benefit from this behavior. Again, count each species that benefits from digging or burrows, even if the species has been counted in another category.
12. As students to calculate the total percentage of their prairie species that have some sort of relationship with prairie dogs. Ask students to copy the class-generated table onto their copy of the Student Page *Dog Gone It.*
13. Then, as a class, complete question #2: What are three ways that prairie dogs support a diversity of life (species biodiversity) on the shortgrass prairie? (As prey, grazing, burrowing).
14. For question #3, ask students what would happen if prairie dogs were to disappear from an area. How would that affect the diversity of plants and animals of that area? (Make sure students do not just simply state “decrease biodiversity,” they should be able to give specifics.)
15. Ask students to explain how the information in the table supports or doesn’t support scientists designating the prairie dog a keystone species. Students can answer questions #4 and #5 as a group or individually.

Part 2

1. Divide the class into four groups.
2. Tell students that there are challenges faced by both prairie dogs and black-footed ferrets. Each group will receive information about one of those challenges. The group’s task is to read and understand the information and then devise a short skit to present that information to the other three groups.
3. Students should be given an adequate amount of time to read the information and prepare skits. Students can use props or make visuals. They should not read the information from the handout.
4. When students are ready, give each group an adequate amount of time to present their information to the class. The audience should take notes and ask questions.

5. When all students have completed their presentations, discuss the importance of some of the challenges that must be overcome to recover black-footed ferrets:
    c. *Challenge #1 Habitat Loss*: How do prairies contribute to species biodiversity? What factors contributed to the loss of prairie habitat? How might loss of prairies affect the species that lived there (anything from insects to black-footed ferrets)? Why is it important to conserve prairies? What can be done to preserve what remains of the prairie?
    d. *Challenge #2 Prairie Dog Eradication Programs* (Note: This is a sensitive topic and it is important to tell students that they must discuss their views in a respectful manner and listen respectfully to viewpoints which may differ from their own): Why did farmers and ranchers need to control prairie dogs? Why is prairie dog control still needed in some places but not in others?
    e. *Challenge #3 Sylvatic Plague*: Why is this disease such a problem? What species are vulnerable? What can be done to protect animals and humans from plague?
    f. *Challenge #4 Canine Distemper*: What species are vulnerable? What happens to black-footed ferrets that get distemper? Is there anything ordinary citizens can do to help? (immunize pet dogs).
6. Homework: After the class discussion is complete, tell students that they will be summarizing one of the four main challenges to recovering black footed ferrets by creating a comic strip. Tell students that it does not matter if they good at drawing. The comic strip should be designed from the perspective of the black-footed ferret. One challenge and a possible way to overcome the challenge should be included in the comic strip. Each comic strip should have a minimum of three boxes.

Optional: Post or share comic strips if students feel comfortable sharing their work.

Assessment

Student designed comic strips of a challenge that black-footed ferret recovery efforts must overcome serve as an assessment for this activity.

Extensions

Invite guest speakers to talk about prairie restoration projects or visit a prairie restoration site. Check the USFS National Grassland web site and Nature Conservancy Website for possible speakers and locations nearby.

http://www.fs.fed.us/grasslands/

http://support.nature.org/site/PageServer?pagename=preserve_map&s_src=hpmap&s_subsrc=findmap

Dog Gone It!

1. What percentage of shortgrass prairie species depend on prairie dogs?

Attribute	# of Species with attribute	# of Total species	% of Species With attribute
Eats prairie dogs			
Grazes on highly nutritious grass			
Ground nesting bird			
Lives in prairie dog burrow			
Needs aerated moist soil			

2. What are three ways that prairie dogs support a diversity of life (species biodiversity) on the shortgrass prairie? Give examples of each:
   a.

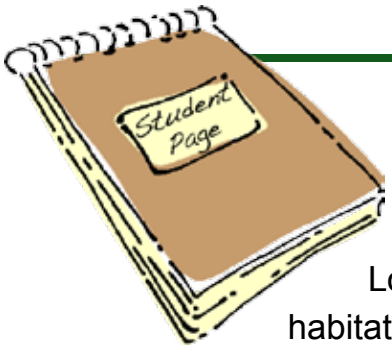
   b.

   c.

3. If prairie dogs were to disappear from an area, how might that affect the diversity of plants and animals of that area? Why?

4. Why are prairie dogs considered by scientists to be a keystone species?

5. Why is the future of black-footed ferrets linked to the future of prairie dogs?



Challenge #1: Habitat Loss and Fragmentation

Loss of habitat threatens the survival of all grassland species. When habitat is lost, all of the species that depend on that habitat are also lost. Habitat fragmentation is also a problem. Habitat fragmentation is when roads, railroads, development, and other barriers separate parts of the habitat. Fragments of habitat may not be large enough to provide species with food, water, shelter and space to rear young.

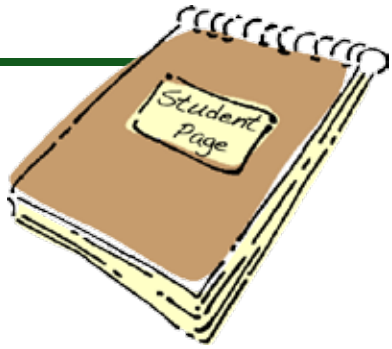
The grasslands we know as the Great Plains once covered about 1.4 million square miles. Today, less than 3 percent of the native grasslands remain. Acreage in the United States, Canada and Mexico has shrunk to under 203,000 square miles.

What happened? After the Louisiana Purchase of 1803, the government encouraged Americans to move west across the frontier. Congress gave free land to citizens who promised to farm it for at least five years. Farming was very difficult on the prairie. Much of the land was not suitable for growing crops. Farmers could grow crops in wet years, but not during the frequent serious droughts. They lost crops to storms. The winters were bitter.

Still, the lure of free land brought more and more people to the west. Almost 6 million settlers homesteaded the Great Plains by 1890. Other people also moved west. Soldiers came to protect the new homesteaders. Prospectors came in search of gold and other precious materials. Railroad builders, merchants, bankers, and others came to provide goods and services. Cities and towns sprung up over the Great Plains.

More and more land was plowed to try to feed the newcomers. Once the land was plowed, the deep grass roots were gone. The soil had nothing to hold it in place and began to blow or wash away. During the Great Depression, millions of tons of topsoil blew away.

Since the 1930s, government agencies and private conservation groups have been working to restore lands that were not suitable to farming or ranching. In areas suitable for agriculture, research and education have helped develop farming techniques that reduce erosion and provide wildlife habitat. Wildlife species, including many declining, threatened or endangered species such as the black-footed ferret, are thriving in these restored habitats.



Challenge #2: Prairie Dog Eradication Programs

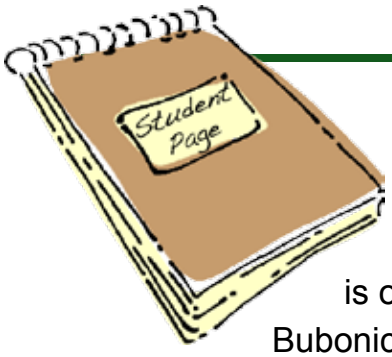
Bison were largely eliminated from the Great Plains during the westward expansion of the United States. Ranchers filled the large open ranges of the plains with cattle and sheep. The lush grasses of the prairies were nutritious and seemed perfect for livestock. At first cattle were allowed to roam the prairie, grazing different areas just like bison. As the population grew and disputes about cattle ownership increased, barbed wire was invented and people began fencing in areas.

Ranchers noticed that prairie dogs ate grass and logically assumed that prairie dogs must compete with their livestock for food. In addition, ranchers feared that cows and horses could break their legs by stepping into prairie dog burrows. Farmers were just as frustrated with prairie dogs because their burrow systems made plowing difficult.

To protect their livelihood and provide food for a growing nation, farmers and ranchers began eradicating prairie dogs. Poisoning and shooting of prairie dogs began in the late 1800s and soon developed into large-scale, well-organized campaigns. Bounties were offered to varmint hunters for prairie dogs and other pests. (Varmint hunting is the practice of hunting as a means of pest control, rather than for food).

The federal government began allocating money for poisoning in 1915, and by the 1920s, millions of prairie dogs had been killed. Even today, many local, state, and federal agencies recognize the need to control prairie dogs on some portions of agricultural land and about 10 to 20 percent of prairie dog colonies are poisoned annually.

Today, there have been efforts to reduce poisoning where it is not needed. There are also federal, state and private programs that provide incentives for landowners to set aside some land for prairie dog habitat.



Challenge #3: Sylvatic Plague

Sylvatic plague is a bacterial disease that is transmitted by fleas. This disease can infect many mammalian species, including humans. It is often called bubonic plague or Black Death when it infects humans. Bubonic plague killed millions of people in Europe during the Middle Ages when they were bitten by fleas from infected rats.

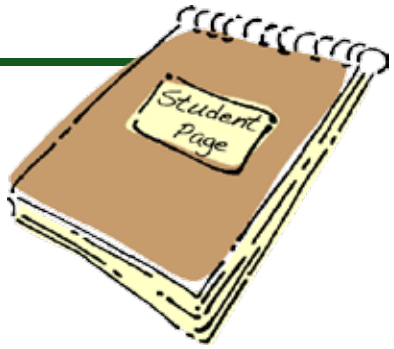
The bacterium that causes sylvatic plague was introduced into the United States from Asia in the early 1900s. Outbreaks of plague can wipe out an entire prairie dog colony. Black-footed ferrets are also highly susceptible to plague. Black-footed ferrets can get plague by eating infected prey or from flea bites.

The bacterium that causes plague is now widespread in the western United States. Fortunately, scientists have developed a vaccine to protect black-footed ferrets from plague. Starting in 2008, all captive-born ferrets released into the wild receive this vaccine.

Even if the immunized black-footed ferrets do not get the disease, they are still vulnerable if the prairie dog population die offs from plague. So, biologists need to control the disease in prairie dogs too. So, biologists also need to control the disease in prairie dogs. Currently, the most common practice is to dust individual prairie dog burrows with pesticides that kill plague-infected fleas. Dusting is difficult to do and expensive. Scientists have been working on a vaccine that can be fed to prairie dogs in bait. There is still work to do before this vaccine can be used. Scientists must be sure that the vaccine-laden bait does not harm other rodents or domestic animals.

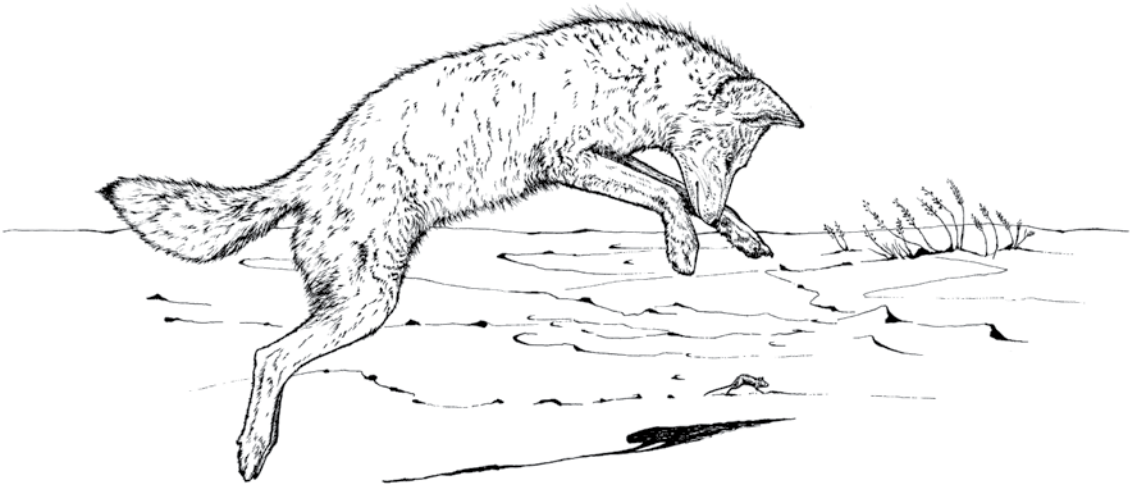
Plague outbreaks in nature are worrisome to nearby human communities. In modern times, cases of human plague are rare and antibiotics are effective against the disease. According to the Centers of Disease Control and Prevention (CDC), about 10 to 15 people a year come down with the plague in the United States. Less than 6 percent of those cases have been linked to prairie dogs.

Challenge #4: Canine Distemper



Canine distemper, a common viral disease of domestic dogs, can cause disease in wildlife. Animals with distemper may have watery eyes and nose or pus coming from their eyes or nose. They may also sneeze, cough, or have diarrhea. Many animals have nervous system signs, such as trembling, stumbling, falling down, having difficulty getting up, circling, or convulsions. Domestic dogs are usually vaccinated to avoid getting or spreading the disease.

Raccoons, skunks, foxes, coyotes, wolves, and all mustelids can be infected with the canine distemper virus. The disease is 100 percent fatal in black-footed ferrets. The first attempt at immunizing captive black-footed ferrets in the 1970s was not successful. In the 1990s, veterinarians and research scientists developed a vaccine specifically for black-footed ferrets. This vaccine is given to all captive-born black-footed ferrets released into the wild. However, kits born in the wild may still be susceptible to canine distemper.



Bottleneck Genes

Duration
- One 45-minute indoor class period

Materials
- One large plastic bottle with a narrow neck
- Pony beads (craft beads approximately 3/8" in diameter and ¼" in length). You will need 30 beads of each of the following colors (about 270 beads total): yellow, black, orange, pink, dark blue, green, purple, red, and white
- Student Pages: *Environmental Situation Cards, Black-footed Ferret Bottleneck Scenario*
- Access to the internet, an LCD projector, and a screen (or a "Smartboard")

Summary

Through an interactive simulation, students are introduced to the study of conservation genetics and population bottlenecks. Students will discover how the loss of genetic diversity and genetic characteristics can affect a population's ability to respond to changes in its environment. Students will describe how the Black-footed Ferret Species Survival Plan® minimizes the loss of genetic diversity in the captive-breeding population.

Objectives

Students will be able to:

- Describe how hereditary information (an inherited trait or characteristic) is contained in genes.
- Describe biodiversity as it relates to genetic diversity within populations of a species.
- Calculate the percent genetic diversity of a hypothetical black-footed ferret population.
- Describe the traits present in a hypothetical population of black-footed ferrets and predict the survival of the population based on random changes in their environment.
- Explain why lack of genetic diversity makes a species less resilient to changes in the environment.
- Describe what a Species Survival Plan® (SSP®) is and why it is essential to the recovery of the black-footed ferret.

Background

The black-footed ferret, once thought to be extinct, is now being reintroduced to its natural habitat on the North American plains after an incredible intervention by scientists. Few species have edged so close to extinction as the black-footed ferret and recovered, but through **captive breeding** and **reintroduction**, the species is slowly recovering.

Genetic diversity, the variety of *genetic* differences within a species, is one component of **biodiversity**. Living things contain **genes** in their cells, which are the basic instructions for their physical and behavioral traits. **Genetic diversity** is the variety of heritable characteristics present in a population of the same species. It serves an important role in species survival. For a species to adapt to ever-changing circumstances in their environment, a significant level of genetic variation must be present.

Black-footed ferret kits at the National Black-footed Ferret Conservation Center. Ann Marie Gage

One could say that genetic diversity is a measure of the possible choices of information provided by a gene. For example, a particular gene may determine the color of an animal's fur. Different choices may exist for that gene (i.e. black fur, white fur, brown fur). In each case, the same gene determines fur color. When all or nearly all the members of a population have the same choice of a gene, that population is said to have low genetic diversity at that gene. If many variants exist for a gene, that population has high genetic diversity at that gene. Variety is important. A white-furred animal may be more visible to predators in a dark environment and less likely to survive than a brown or black-furred animal.

If genetic diversity becomes low in a species, that species is increasingly at risk of extinction. It has only one possible choice of information at all or nearly all of its genes -- in other words, all the individuals are nearly identical. If new pressures (such as changes in the environment) occur, a population with high genetic diversity

Vocabulary

- Adaptation
- Behavior
- Biological diversity (Biodiversity)
- Bottleneck effect
- Gene
- Genetic diversity
- Heredity
- Species Survival Plan® (SSP®)

About this Activity

This hands-on activity simulates genetic variation within a population that has gone through a bottleneck. This activity is adapted and included with permission from the Smithsonian Conservation Biology Institute.

has a greater chance of having some individuals with a genetic makeup that allows them to survive. However, if genetic diversity is very low, the individuals in a population may not have the characteristics needed to cope with the new environmental conditions. Such a population could be wiped out.

Population bottlenecks occur when a population's size is reduced for at least one generation. When the number of individuals in a population decreases, the variety of genes also decreases. Black-footed ferrets are an extreme example of a population bottleneck. Only 18 animals remained when the captive breeding program began. There were 11 males and seven females. To minimize any additional loss of genetic diversity, the captive breeding program for black-footed ferrets has a Species Survival Plan® or SSP®.

The Species Survival Plan® (SSP®) program was developed in 1981 by the Association of Zoos and Aquariums to help ensure the survival of species in zoos, aquariums, and other captive-breeding facilities. SSP® programs are developed for animals that are in danger of extinction in the wild when conservationists believe captive breeding programs may be their only chance to survive. SSP® programs identify population management goals and recommendations to maintain or increase a healthy, genetically diverse, and demographically stable population. A genetically healthy and diverse population has a greater chance of survival in the wild.

The black-footed ferret SSP® has been highly successful. The black-footed ferret captive program maintains a core breeding population of at least 270 adults (90 males, 180 females). Captive breeding populations are currently housed at six locations across the United States and Canada. A studbook, or pedigree record, is maintained for all the animals in the captive breeding program to minimize genetic loss.

Because there were so few animals, frozen semen is stored at the National Zoo's Smithsonian Conservation Biology Institute Black-footed Ferret Genome Resource Bank. In species that have short life spans like the black-footed ferret, the use of cryopreserved, or frozen, sperm extends an individual's reproductive life. The bank's contents help ensure that these males can be represented in future generations. The bank also serves as insurance against catastrophes in the wild populations, such as a disease outbreak.

Through the implementation of the Black-footed Ferret SSP®, captive propagation has been able to maintain 87 percent of the genetic diversity of the Meeteetse, Wyoming population. Since 1986, more than 7,000 ferret kits have been produced in captivity and over 2,600 kits have been released into the wild. The Black-footed Ferret SSP® has been highly successful. There were 310 kits born in the program in 2010 and the current wild black-footed ferret population is estimated to be around 1,000. Information about kits born and ferrets released each year is listed on www.blackfootedferret.org.

Teaching Strategies

The National Black-footed Ferret Conservation Center in Colorado. Ryan Haggerty / USFWS

1. Review some history of the black-footed ferret. Remind students that all living black-footed ferrets are descendents of the original animals placed in the captive breeding program in 1987. Show students a short video clip of the captive breeding, preconditioning, and reintroduction program (5 minutes 25 seconds)

   http://www.thefutureschannel.com/dockets/realworld/the_blackfooted_ferret/
2. Divide the class into groups of two to four students. Give each group a copy of the Environmental Situation Cards and Black-footed Ferret Bottleneck Scenario.
3. Review the terms biodiversity, genetic diversity, and population bottlenecks.
4. Review the gene color key. Discuss the benefits of the different attributes.
5. Place all of the genes (colored beads) into one plastic bottle (this could be a plastic water bottle or soda bottle). Shake it gently to mix the colors. Explain to student that you will distribute the genes randomly to each group, so the genes are randomly distribute, just as in a real population.
6. Distribute 14 beads through the bottleneck to each group. Tell students that these beads represent the genes available from the seven original surviving females and their mates (seven genes from the male and seven genes from the female) to the population of black-footed ferrets for their group. Give each group the first 14 beads that come out of the bottle. It does not matter if they do not receive every color. Not every population will have all the genes.
7. Have the students match their genes to the gene key and circle the colors or genes on the Key to Genetic Characteristics for their ferret population.
8. Have each student group select five Environmental Situation Cards randomly from the deck.
9. Students work with the Black-footed Ferret bottleneck Scenario worksheet to complete the following:
   - Calculate the genetic diversity in their population.
   - Describe their population according to its current genetic makeup.
   - Develop and write a prediction for their population in the environmental situations they have chosen for approximately a 1-year period. You may want to go through one example with students. (Use Situation #1: A farmer tries to protect his wheat fields by exterminating resident prairie dogs.) In this situation, the black-footed ferret population would need to respond by moving to another location where food (prairie dogs) is available. The population might need speed and agility, acute hearing, and accurate sense of smell to move and locate another prairie dog colony.

10. Discuss the following questions in class:
    - Why does genetic diversity help protect a population?
    - Why would a smaller population have a higher risk of being eliminated than a large population?
11. Introduce the concept of a Species Survival Plan® (SSP®) and discuss why an SSP® would be necessary for any captive breeding program, especially one involving a highly endangered animal such as the black-footed ferret. The Species Survival Plan® (SSP®) helps insure the maximum genetic diversity of a species.

Assessment

Completion of the Student Page: Black-footed Ferret Bottleneck Scenario and participation in class discussion serves as an assessment for this activity.

Extension

1. After completing the activity as described, randomly pair the groups to see how combining genes from different populations affects diversity. Discuss how habitat fragmentation might lead to decreased genetic diversity.
2. Visit a local zoo or SSP® site and talk to staff members about their attempts to ensure genetic diversity in their breeding animals.

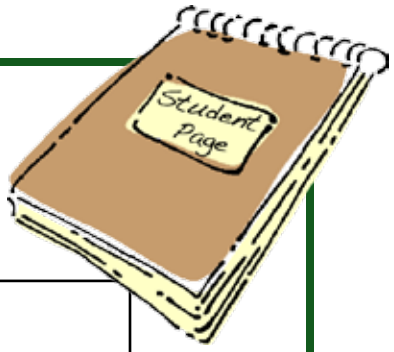
Environmental Situation Cards

1. A farmer tries to protect his wheat fields by exterminating resident prairie dogs. Can your population find a new source of food?
2. The survival rate of this year's baby black-footed ferrets is high. As the babies grow into adulthood, do they have the ability to disperse from your population into adjacent prairie dog towns to establish a new colony?
3. Humans building homes 10 miles away wiped out a prairie dog colony. Can your population survive when black-footed ferrets from that colony invade your territory for food?
4. Female ferrets in your population can only produce one kit per year unless they have the gene for a healthy rate of reproduction. What will happen to your population if it cannot produce enough kits?
5. Residents allow their dogs to run loose (hint: domestic dogs carry dog diseases). Will your population die of canine distemper?
6. A new generation of captive-born black-footed ferrets is released at a nearby reintroduction site. Will these black-footed ferrets be welcome in your habitat?
7. Sylvatic plague strikes the resident prairie dog colony; there is an 80% prairie dog mortality rate. Can your population find a new source of food?
8. A coyote prowls at night. A good sense of smell would allow you to avoid this predator.

Environmental Situation Cards

9. An aggressive prairie dog prey fights back in its dark, narrow, winding burrow system. Does your population have healthy, strong jaws to hang on and win the fight?
10. A great horned owl relies on its keen eyesight to spot potential prey in the dark. Can your black-footed ferrets remain unseen?
11. A badger sneaks around the prairie dog town. Can your black-footed ferrets hear it coming with enough time to flee?
12. A prairie dog colony is established on a nearby Native American reservation. Can your population expand onto the new colony?
13. Severe rains flood the prairie dog burrows. Can your population survive?
14. An interstate is built nearby. Most of the prairie dog colony is across the highway. Can your population get the food it needs?
15. Drought causes the prairie soil to compact and harden. Does your population have strong legs to dig and adapt the burrows stolen from their prairie dog prey to make their homes?
16. A golden eagle hunts for a meal. Good vision would help your ferrets avoid capture.

Black-footed Ferret Bottleneck Scenario



Key To Genetic Characteristics	
Yellow	Camouflage
Black	Precise Vision
Orange	Accurate Sense of Smell
Pink	Strong Claws and Forearms
Dark Blue	Healthy Jaw Formation
Green	Speed and Agility
Purple	Acute Hearing
Red	Healthy Rate of Reproduction
White	Immunity to Canine Distemper

1. On the Key to Genetic Characteristics Table, circle the colors and genetic characteristics your population received through the bottleneck.

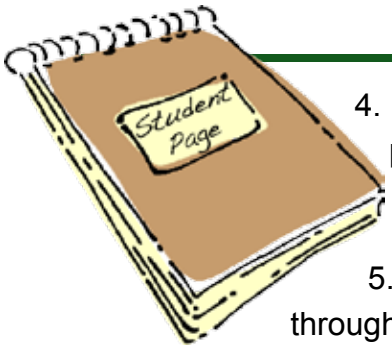
2. Calculate the percentage of genetic diversity of your population:

   Nine genes (colors) represent 100 % genetic diversity in the original population.

   _____genes received ÷ 9 possible genes =_____(decimal) x 100 = _____%

3. List the genetic characteristics that your population received through the bottleneck: (Colors received)

Color	Characteristic
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____



4. What is the total number of gene traits (colors) your black-footed ferret population received? _____

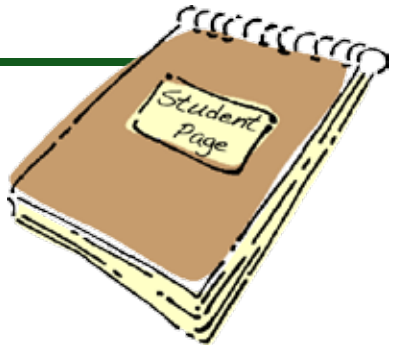
5. List the genetic characteristics that your population lost when it came through the bottleneck: (Colors not received)

Color	Characteristic
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

6. Pick five Environmental Situation Cards and write those five situations on the chart below. Write down the response that would be needed to survive the situation. Using the five environmental situations, identify the genetic characteristic needed by your population to survive each situation and write a prediction about what happens to your population during the coming year. (Some environmental situations might require your population to have a combination of genes, not just a single gene).

Population Predictions

Environmental Situation	Response Needed to Survive Situation	Survival Prediction and Reason



7. How do the random changes in the environment listed on your cards affect the population?

8. If all of these situations occurred in one year, would your population survive? Explain why or why not.

9. How does a high or low percentage of genetic diversity affect the population's chances for survival?

10. How does a Species Survival Plan® (SSP®) help minimize loss of genetic diversity in populations of endangered species?

Ferreting Out the Full Story - Part II

Duration
- Two 45-minute indoor class periods

Materials
- Student Pages: "*Recovering" Black-footed Ferrets,* *Mind Map: What I Know Right Now about Black-footed Ferrets*
- Copies of local and national newspapers (usually libraries will lend old copies)
- Access to computers and the internet (optional)

Summary

In this activity, students are given background information on the recovery of black-footed ferrets and they are asked to summarize the information verbally and visually. In this summary activity, students will write a news, feature, or editorial article.

Objectives

Students will:

1. Organize and present information in written form that explains the reasons for the decline of the black-footed ferret and the methods used in the species recovery (captive breeding, reintroduction, etc).
2. Analyze, through editorial writing, the issues surrounding the decline and recovery of and examine strategies to resolve those issues.
3. Describe the importance of an informed citizenry to the recovery of the black-footed ferret.

Background

Most scientists had given up hope of ever finding another black-footed ferret when the last known animal died at Patuxent Wildlife Research Center in Laurel, Maryland. Many people had searched far and wide, but they did not find any more in the wild. A lucky "incident" changed all that. At about 3 a.m. on Sept. 26, 1981, cattle rancher John Hogg and his wife, Lucille, were awakened by furious barking by their dog just outside the bedroom window. They figured that Shep just got tangled up with a porcupine and went back to sleep. When John Hogg looked around the next day, he found the carcass of a strange little animal. He had never seen one like it before. It had a black mask, black feet, and a black-tipped tail. Lucille suggested that they take the carcass to a Meeteetse taxidermist. The taxidermist recognized it as a black-footed ferret. He contacted wildlife professionals, and the black-footed ferret recovery program was born.

The Endangered Species Act of 1973 requires the U.S. Fish & Wildlife Service to protect federally endangered and threatened species and to develop recovery plans for them. Recovery plans are meant to stop the decline of the species and increase their population size so that their long-term survival is possible. The goal is full recovery of the species – maintaining self-sustaining populations of the species in

its natural habitat. Since their rediscovery in 1981, hundreds of people and multiple agencies and non-profit organizations have worked to bring black-footed ferrets back from the brink of extinction.

Teaching Strategies

1. Give each student a copy of the Student Page "*Recovering" Black-footed Ferrets*. All students must read this handout – either individually, in groups, or as a class.
2. Discuss the reading as a class and make sure that students understand the definitions in the article.
3. Now that they are knowledgeable about black-footed ferrets, they need to write an article to share their knowledge with others. (The class will brainstorm story ideas, but students will complete the assignment individually as homework.)
4. Look at copies of local and national newspapers with students. Look at the different sections that most papers have: News, Sports, Entertainment, Comics, and so on. A newspaper contains many types of writing, including news, feature and editorial articles. Each has a different purpose and structure. News stories use some variation of an inverted pyramid, in which important details are found at the top of the story and less important ones are toward the end. Feature stories employ more informal writing styles, with emphasis on descriptive language and personal quotes. Editorials are organized to promote one point of view and discredit others.
5. Have students brainstorm possible different angles that could be taken on the black-footed ferret story. Tell students that they should consider the views of their audience. Students should keep in mind that a news story must answer the five W's and one H questions: who, what, when, where, why and how questions. Good reporters also ask themselves questions such as "Who cares, and why?" Students could write news, features, or letters to the editor. They can also be creative and do an entertainment, sports, or business story about black-footed ferrets.
6. As a class, ask students to brainstorm the question, "What stories could be written about this subject?"
7. Ask students about research - where could they find additional information? Most will suggest the library or the Internet. Tell students that http://www.blackfootedferret.org is the official web site of the black-footed ferret recovery program.
8. Give students adequate time to complete the assignment as homework.

Vocabulary

- Editorial
- Endangered Species
- Extinct
- Extirpated
- Feature story
- News story
- Preconditioning
- Recovery Plan
- Reintroduction Site
- Threatened Species

9. Before students hand in their completed assignment, you may choose to share some of the work in class. Students could “pair-share” or you could call for volunteers to present their story to the entire class.
10. Discuss as a class why it is important for citizens to have accurate information about conservation issues.
11. Revisit the mind map completed in Ferreting out the Full Story Part I. As a class, follow the procedure described in Part I and complete a new mind map. How different are the maps?

Assessment

Student completion and presentation of their written article serves as an assessment of this activity. The student-constructed mind map serves as the assessment for the entire unit.

Extensions

1. Students can publish this as an online or print newspaper and distribute it to others in the school or the community.
2. In addition to, or instead of a written article, students could do a news show.
3. Students can produce artwork, cartoons, or other visual representations of the story of the black-footed ferret.

"Recovering" Black-footed Ferrets

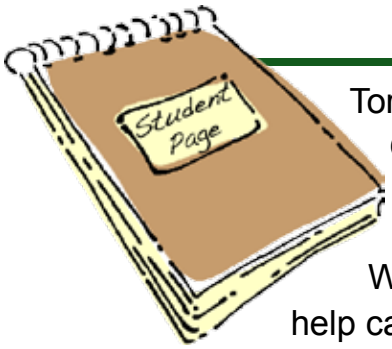
The black-footed ferret was one of the original animals placed on the endangered species list in 1967. Endangered species are animals in immediate danger of becoming **extinct** – completely disappearing from Earth. Some of these species have been **extirpated** from their native range - they are no longer found in the wild. Other species on the list may be listed as threatened species, which means they are rapidly declining and may become endangered.

The Endangered Species Act of 1973 requires the U.S. Fish and Wildlife Service to protect federally endangered and threatened species and to develop recovery plans for them. Recovery plans are meant to stop the decline of the species and increase their population size so that their long-term survival is possible. The goal of recovery is to return the species to its natural habitat.

Loss of habitat, widespread eradication of prairie dogs, and susceptibility to plague and canine distemper all contributed to the endangerment of black-footed ferrets. The current recovery plan for the black-footed ferret was approved in 1988. An earlier recovery plan was drafted in 1978, when black-footed ferrets were thought to be extinct. A revision to the recovery plan is underway. The goal of the 1988 Recovery Plan was to establish a population of 1,500 free-ranging adult black-footed ferrets in 10 or more populations with no fewer than 30 breeding adults at any reintroduction site. The year 2011 marks 30 years after the discovery of a black-footed ferret near Meeteetse, Wyoming. Biologists think that they are almost halfway toward the goal of recovery.

So much has been learned over the past 30 years. We have learned how to breed ferrets in captivity. Black-footed Ferrets are currently being bred in captivity at the U.S. Fish and Wildlife Service's National Black-footed Ferret Conservation Center (Colorado), National Zoo's Smithsonian Conservation Biology Institute (Virginia), Louisville Zoological Gardens (Kentucky), Phoenix Zoo (Arizona), Cheyenne Mountain Zoo (Colorado) and the

Phoenix Zoo Black-footed Ferret Breeding Center. Ann Marie Gage



Toronto Zoo (Ontario, Canada). Over 7,000 kits have been born since breeding began in 1986.

Preconditioning pen at the National Black-footed Ferret Conservation Center in Colorado. Ryan Haggerty / USFWS

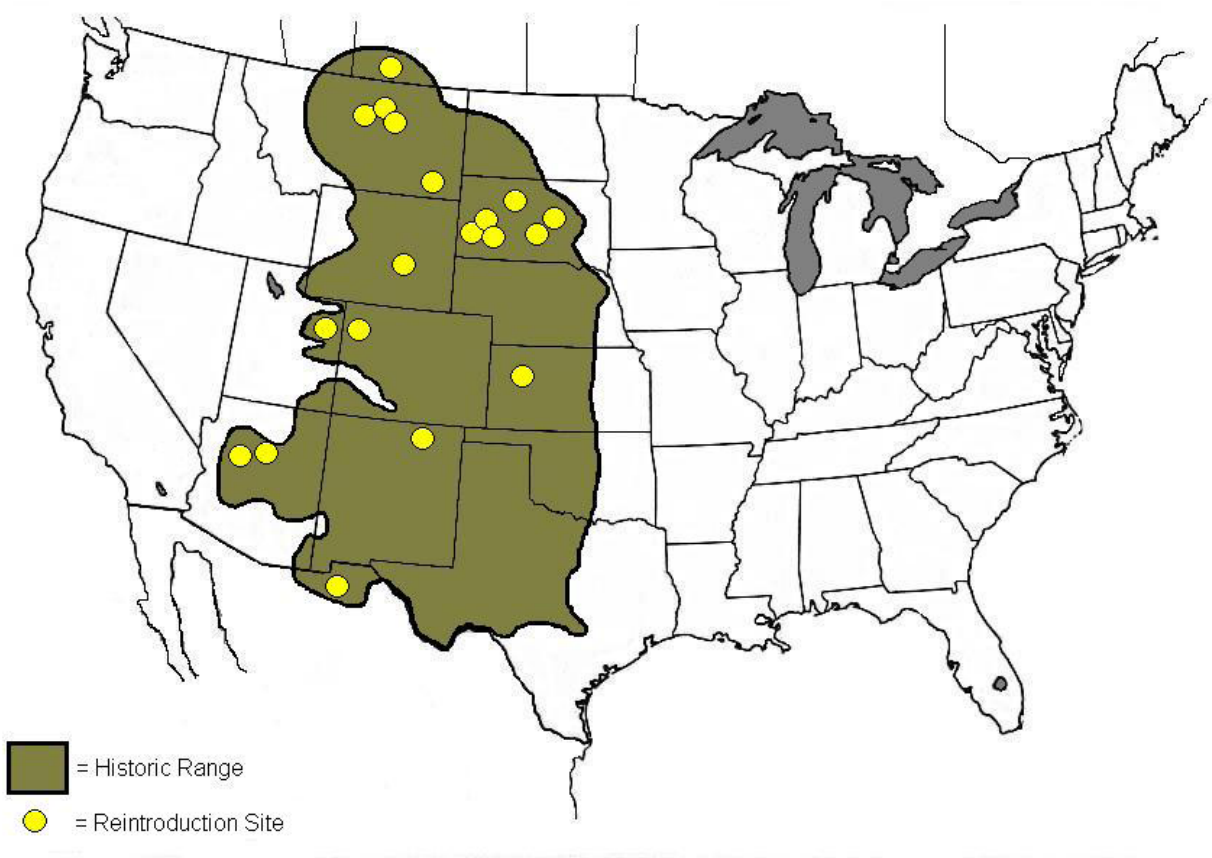
We have also learned how to help captive-bred ferrets sharpen their survival skills before releasing them back into the wild. Three-month old ferret kits that are destined for release are **preconditioned** in large, natural outdoor pens – usually with their mothers. There, they can get used to living on a grassland in natural burrows. They gain experience finding and killing prairie dogs. The young ferrets improve their hunting skills, further increasing their chances of survival in the wild. When they are four months old and ready to be independent, they are prepared for reintroduction. Before they are released into the wild, all ferrets are vaccinated against canine distemper and plague. Scientists have also learned that dusting prairie dog holes protects prairie dogs and black-footed ferrets from plague. After all, what's the use of being a healthy young ferret if you can't find a meal?

There are now 19 black-footed ferret reintroduction sites located in eight states with one site in Mexico and one site in Canada. Black-footed ferrets have been reintroduced in Wyoming, South Dakota, Montana, Arizona, Colorado, Utah, Kansas, and New Mexico.

Rancher, Larry Haverfield, with USFWS biologists on his Kansas ranch that is now home to black-footed ferrets. Travis Livieri / Prairie Wildlife Research

Things are looking up, but full recovery of black-footed ferrets depends on finding more reintroduction sites. Since there is a limit of publicly owned land that is suitable for ferrets, black-footed ferrets have benefitted from and will continue to benefit from the help of private landowners.

Black-footed Ferret Historic Range and Reintroduction Sites



Mind Map

What I Know Right Now about Black-footed Ferrets

Appendix A:
The Talk of the Town

The Talk of the Town

Duration
- Two 45-minute indoor class periods
- One 45-60 minute outdoor observation

Materials
- Carpet squares or other material for students to sit on for outdoor observation
- Student Pages: *Animal Communication K-W-L, Talk of the Town, Prairie Dog Ethogram*
- Clipboards (or sturdy pieces of cardboard and a paper clip)
- Pencils
- Timepiece (a second hand is helpful but not necessary)
- Optional: tape recorder, camera or camcorder, binoculars

Summary

Ethology is the study of animal behavior and usually emphasizes behavior in the animal's natural habitat. In this activity, students will observe prairie dogs and use an ethogram to quantify their behavior. They will graph and discuss their observations and then generate testable questions about prairie dog behavior.

Objectives

Students will be able to:

- Identify and describe different forms and purposes of animal communication.
- Compare animal and human communication behavior.
- Develop a catalog (ethogram) of prairie dog behavior.
- Collect detailed observations of prairie dog behavior (collect quantitative data).
- Collect, analyze, interpret, and report data in written format.
- Develop a simple investigation of prairie dog behavior (within small student groups).
- (Optional Extension) Define, compare, and contrast "communication" and "language."

Background

Ethology is the scientific study of animal behavior, or everything animals do. It includes such topics as how animals communicate, find and defend resources, avoid predators, choose mates and reproduce, and care for their young. This activity will focus on studying animal communication. By focusing on one aspect of animal behavior, it will be easier to to conduct a guided inquiry and anticipate student questions.

Ethologists study the biological roots and meanings of animal actions. Often, the first step in that process is to construct an ethogram. In its simplest form, an ethogram is a quantitative description of an animal's normal behavior. Constructing a useful ethogram demands time spent watching animals, taking careful notes, and making sense of the observed behaviors. The observations are compiled into an annotated catalogue of behavioral patterns that describe what a given species does in a given environment.

David Hannigan / Colorado Division of Wildlife

Vocabulary

- Abiotic
- Alarm call
- Anthropomorphism
- Communication
- Cooperation
- Coterie
- Ethogram
- Ethology
- Jump-yip call
- Native
- Rodents
- Social animal
- Territory
- Town
- Ward

About this Activity

This activity uses two charts. The first chart is a worksheet for an instructional technique known as K-W-L. Teachers activate students' prior knowledge by asking them what they already Know; then students (collaborating as a whole classroom or within small groups) set goals specifying what they Want to learn; and after the activity students discuss what they have Learned. Students apply higher-order thinking strategies which help them construct meaning from what they read and observe.

The second chart is a basic ethogram used to observe prairie dog behavior. Your students will explore the different forms and purposes of communication, read a short article about prairie dogs, watch a short video clip that shows some prairie dog communication, watch the animals in their natural habitat, construct an ethogram, graph their data, and lastly, describe a testable question to study the function of one or more behaviors. As an extension, students could conduct research on their questions or delve into the distinction between communication and language.

While it is ideal to do this activity at a prairie dog town that is not feasible for many schools. Therefore, a 30-minute video of life of a prairie dog colony is provided for those who wish to do this activity but cannot visit a prairie dog site.

The ethogram for black-tailed prairie dogs shown below was compiled by Dr. P.L. Bernstein and provided by the Behavioral Advisory Group (BAG) of the Association of Zoos and Aquariums (AZA). While this ethogram discusses the meaning of each behavior, encourage your students to just look for behaviors. As a class, you might brainstorm the functions of each behavior that were not discussed in the students' reading.

Postures

Kiss-greet: The most common friendly behavior. Individuals approach one another, open their mouths, tilt their heads, and actually lock incisors, in what looks like a kiss. Often occurs between adults and pups, but also occurs between adults. Is most common in spring and summer. Sometimes only one individual will perform all the behaviors, and sometimes individuals will greet by only touching noses.

Challenge: The most common unfriendly behavior. A bluffing encounter or ritual fighting. Usually done to establish and maintain territorial boundaries. Also acts as an agreement between neighbors. In a typical challenge, one individual will suddenly lunge at another. They may face each other, tooth chatter, fluff out their fur, hold their tails up, turn around and present anal glands and sniff the glands of their opponent. Occasionally the individuals may fight. Individuals usually repeat the above behaviors in a long series of turnings, while standing 1 to 2 feet apart at a territorial boundary. Challenges may be very brief or may last for many minutes (some last for as long as half an hour).

Allogroom: One individual grooms the fur of another with its teeth, a useful activity as well as a friendly one, as it removes pests and dirt from the fur. Often the individual being groomed will stretch and turn for grooming in favored spots. Individuals also groom themselves.

Play: Done mostly by pups, although sometimes in summer adults will also play. Play includes batting, chasing, and sometimes play fighting. Play fighting in pups is more exaggerated than adult fighting, but there is hardly ever any biting and usually no one gets hurt.

Vocalizations

Jump-yip: One of the most commonly occurring and obvious signals. A 2-part bark given as the animal flings the front half of its body in the air and then descends. Often several are given in a row, by one or more individuals. This signal is given when an individual who was prepared to escape in now no longer likely to do so. Often serves as an all-clear signal.

Sharp bark: Single, loud bark by an individual as it runs to a hole or otherwise prepares to escape. Often many individuals give them at the same time as each responds to a danger, such as a coyote. It often serves as a warning signal.

Continuous bark: Barks repeated at varying brief intervals. Often done by an individual sitting at its hole and being challenged by another individual. The individual giving the continuous bark may not return the challenge but will continue to monitor the situation and will fight to defend its burrow if necessary. Often serves as a defensive warning.

Chitter bark: Rapid sequence of barks. Usually given as individual is actually escaping, running down into its burrow. May serve as a final warning.

Tail Signals
Tail up: An individual with its tail up is behaving indecisively and gathering information about the situation. Often seen during challenges, as the individual goes back and forth between preparing to escape while at the same time gathering information about how the other individual is responding, which then influences its own behavior. May often serve as a quiet way to attract attention to possible trouble or uneasiness.
Tail out: An individual with its tail out is attending to a particular individual, area, or object (such as food or its burrow), conspicuously focusing its attention on it. The tail acts as a pointer.
Tail on ground: An individual with its tail on ground is sitting or lying, usually engaged in some solitary activity, such as eating or resting. Serves as a resting position for the tail, but also identifies an individual as one not very likely to move.
Tail flicking: One or several rapid flicks. An individual who flicks is choosing between two activities that cannot be done at the same time or in the same place, such as remaining on the surface versus going underground, or eating food at one location versus moving to eat food at another location. The most rapid flicking occurs when escape is a strong possibility. Often serves as a silent way to attract attention to possible escape movements.

Teaching Strategies

First indoor 45-minute period:

1. What is communication? Ask students to define or describe communication in their own words. Most will come up with the idea that it involves a sender transmitting an idea, information, or feeling to a receiver. Note that effective communication occurs only if the receiver understands the exact information or idea that the sender intended to transmit.
2. Have students brainstorm a list of the different ways people communicate with each other.
3. Divide this list into categories: How many of those methods involve sound? How many involve smells? How many involve body motion? How many involve colors? How many involve symbols such as words, letters, or pictures?
4. Have students think of sounds (other than words) that have a meaning associated with them. On the board, make a list of the sounds they name. (Examples: The doorbell means someone is at the door. The phone ringing means someone wants to talk to you. A whistle stops action in a basketball game. A fire alarm tells people to go outside. A bell tells students to line up after recess.)
5. Next, ask students to think of gestures that have a meaning associated with them. On the board, make a list of the gestures they name. (Examples: a wave, an “okay” gesture, a “shush” gesture, a thumbs-up, football signals such as “touchdown,” baseball signals such as “out” and “safe.”)
6. Create a list of “information” (i.e. the weather outside, favorite color, birthday, etc.).
7. Ask the students to practice ways of communicating that information to another classmate - without talking!
8. Compare these forms of communication strategies with the ways that dogs or cats communicate. Which type of communication strategies do these animals rely on the most?
9. Give each student a copy of the Student Page Animal Communication K-W-L. Ask students to fill out the chart with information they already know about animal communication. What else do students know

or want to learn about animal communication? Ask students to complete the "What I WANT to Know" section. Leave the "What I Learned" column blank (they will fill in that information as their assessment after they have completed the activity.)

10. Using whatever method or reading strategies that you feel comfortable with, ask students to read the student page Talk of the Town. Check for understanding.
11. Tell students that communication is just one aspect of animal behavior. Animal behaviors are strategies for survival. They will be studying prairie dog communication.
12. If possible, show the short video clip that demonstrates both the prairie dog alarm call for a coyote and the "all-clear" jump-yip.
    http://animal.discovery.com/videos/mutual-of-omahas-wild-kingdom-sounding-the-alarm.html
13. Tell students that they will be prairie dog ethologists and that their goal is to construct an ethogram and a graph that describes the typical behavior of a prairie dog. Tell them that to become excellent at doing research on animal behavior, there is no substitute for learning to know the animals first, by their own observations. Our main goal in studying prairie dogs is to observe them closely and compile a comprehensive list of every distinguishable behavior we observe. They will need to describe every behavior, but try not to assign a function or purpose to the behavior. For example, if they saw a squirrel burying a nut, they would describe that in a squirrel ethogram as digging a hole, burying a nut, not as "storing food." Finding the meaning of the behavior will come later. When they begin studying an animal it's better to begin describing behavior for itself rather than attributing function too soon, since it's easy to misjudge function through **anthropomorphism**, which is attributing human characteristics to animals. Student lists, or ethograms, are not a final research product in themselves, but a step on the way to asking testable questions about animal behavior.
14. If you will be going to visit a prairie dog colony, tell students that they will need to come to school tomorrow prepared to do research outside. That means they must dress for the weather, and wear closed-toe shoes (no sandals or flip flops). Otherwise, follow the directions below using the video provided.

Outdoor observation period:

1. (Assumes travel to the prairie dog observation site) Assign students to groups of four or five students. Give each student a carpet square (or other item to sit on), clipboard, pencil, and the page showing five prairie dog behaviors, and the ethogram. Make sure each student also has a blank sheet of notebook paper.
2. Step 1: Ad-Lib Observation – First 15 Minutes. Tell students they will first do **AD LIB (AD LIBITUM)** sampling. It is an informal type of observation and note-taking; describing all the activity that is seen. It is a first step in finding out all they can about the activities of prairie dogs.
3. Tell students to select a place where their group can view prairie dogs. Be cautious and look around for any danger (snakes, etc) before sitting down. Tell them they will need to settle down quietly and try not to alarm or interact with any of the prairie dogs. Then, they will need to record the **abiotic** or non-living factors of the environment:
    - Date & Time of observation
    - Location where they observed the animal

- Habitat in which they found the animal (a fields of grass, dense shrubbery, rocky outcrop. etc.)
- General weather conditions (hot sun? foggy? Cool evening?)

4. Each student should observe prairie dogs for a total of 15 minutes. They should begin by picking one animal and oberving it for as long as possible. Working independently from their partners, students should take detailed notes. If that animal moves out of sight, the student should find a new animal to watch. If the animal interacts with another animal, students should describe the interaction as best they can, focusing on one individual rather than trying to describe everything that both are doing. Students should pay very close attention to vocalizations and try to distinguish different kinds of calls.
5. After the 15 minute observation is finished, students should work with their partners and their notes to create a narrative description of what the prairie dogs did. Students should be as specific as possible in describing the behaviors. The goal is to provide enough detail so that someone who reads the description can recognize the behavior if they see it. Students should avoid anthropomorphism (attributing human characteristics to the animal). Students should not interpret the animal's behavior; they should **simply describe it**.
6. Next, students should compare notes to the Student Page *Prairie Dog Ethogram*. Are there any behaviors that the group saw that are not on this list? If so, add the behaviors to this list.
7. Tell the students that they will now use the Prairie Dog Ethogram to do a **FOCAL ANIMAL SAMPLING**. Their group will concentrate on getting all possible information about one animal's activities and how long those activities are performed. For the next 30 minutes, at least one person in their group will focus on just one animal and make a hatch mark in the column next to the behavior each time it is observed. (If there is a group of five students, three of them should do this). Another person in your group will attempt to write down what one animal does in sequence. That student can make up initials for each behavior if that helps to record them faster (i.e. jump-yip is JY, groom is G, etc.). The remaining student should assist the second student and focus on the time the individual spends in each activity. This student will call out time (in seconds) for each activity the second student records. The remaining student(s) should focus on what the small group of prairie dogs may be doing and the interactions of the group as a whole. Take detailed notes of the interactions.
8. When the 30 minutes is complete, gather as a large group and return to the school classroom.

Second indoor 45-minute period:

1. Tell students, "We will summarize the data you collected yesterday about behaviors into percentages and graph them."
2. "Add up number of times your prairie dog did each behavior during the time you watched your subjects. Then divide the number of times an activity occurred by the total number of all activities observed. Make a pie chart of the percentages of frequency of various activities. The percentages on the pie chart should add up to 100%."
3. What was the most common behavior? The least?
4. Now, total the time each prairie dog spent doing each behavior. Which behaviors occurred for the longest period of time? The shortest?
5. Look at your pie charts and compare the chart to the notes the other members of your group compiled. What can you infer about the prairie dog behaviors and vocalizations you observed? Write a short summary of what you observed and what purpose you think the behaviors might serve.

6. See if students have a question about a prairie dog behavior that could be answered through tallying more observations. Student questions should be able to tested with a limited set of data. Here are some possibilities:
    a. Do prairie dogs spend as much time eating at noon as in late afternoon?
    b. Do juveniles stay closer to each other than to their parents?
    c. Are juveniles are more exploratory (or playful or aggressive, etc.) than adults?
7. Lastly, ask students how they would collect the observations to answer their questions.

Assessment

Ask students to complete the "What We Learned…" column on their K-W-L chart about animal communication. Each student should list a specific concept that they learned and give an example of that concept.

Extensions

1. Do male and female prairie dogs respond differently to threats? This short video by National Geographic demonstrates some gender-related behavior in Utah prairie dogs:
   http://video.nationalgeographic.com/video/index.html
   To find the video, type "Prairie Dog Alarm" in the search box on this National Geographic web site. Ask students why male and female prairie dogs might exhibit different behavior when faced with a predator.

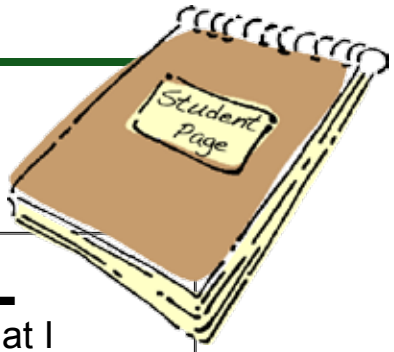
2. Recent research indicates that prairie dogs have relatively sophisticated vocal communication abilities, including many of the characteristics of language. In this extension, students can read a short article online and observe and listen to specific prairie dog calls that the researcher associates with specific actions. Use the link below:
   Prairie Dogs Use Complex Language
   http://news.bbc.co.uk/earth/hi/earth_news/newsid_8493000/8493089.stm

   After viewing the two video clips, discuss the following questions.

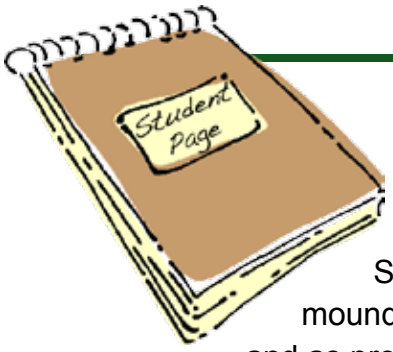
   - Do you consider the communication you observed to be an animal "language"? In your opinion, is animal communication the same as a language? (Not even the experts agree about these questions!)
   - Did you notice any other types of communication (postures, tail movements, etc.) associated with the sound? If so, do you think the sounds would be as effective without these other displays?
   - What do you think of the researcher's methods? How would you set up an experiment to test the meaning of prairie dog vocalizations?

3. Depending on the maturity level of your students, you may want to show a short video of breeding behavior in Utah prairie dogs by National Geographic.
   http://video.nationalgeographic.com/video/index.html
   To find the video, type "Prairie Dog Romance" in the search box on this National Geographic web site. How is the "kiss-greet" between male rivals different than the "kiss-greet" normally observed? What aggressive behaviors do the males exhibit?

Animal Communication
K-W-L



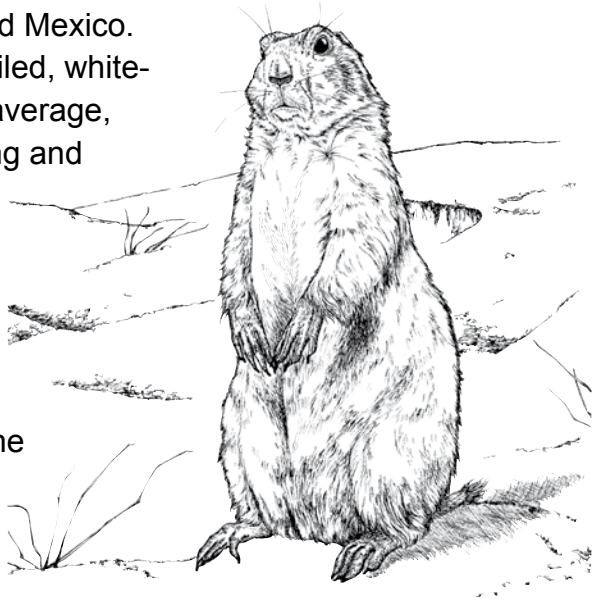
K What I **KNOW**	**W** What I **WANT** to Know	**L** What I **LEARNED**



Talk of the Town

Prairie dogs are burrowing **rodents.** They are a type of ground squirrel. Prairie dogs may dig long burrows. Tunnels are an average of 24 feet long. Several burrows may be connected underground. The prairie dogs make a mound of soil around the entrance of the main burrow to serve as a lookout post and as protection against flooding. Most burrows have a nest chamber. The nest chamber is usually lined with grasses.

Prairie dogs are **native** to the grasslands of North America. They are found in three countries: the United States, Canada, and Mexico. There are five different species of prairie dogs: black-tailed, white-tailed, Gunnison, Utah, and Mexican prairie dogs. On average, prairie dogs will grow to be between 12 to 17 inches long and weigh between one to three pounds.

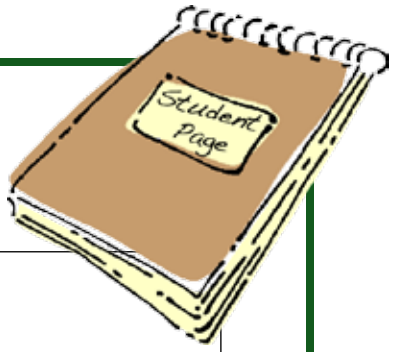


Prairie dogs are very **social animals**. They live in groups in prairie dog **towns**, which range from one to over 1,000 acres. The towns are divided into territorial neighborhoods or **wards**. Wards are further divided into ***coteries***. Coteries are family groups made up of one male, one to four females, and their young up to two years of age. Prairie dogs greet family members with a **kiss** - by touching their bared teeth together. The members of each coterie protect their **territory** from intruders, including prairie dogs from other coteries within the town.

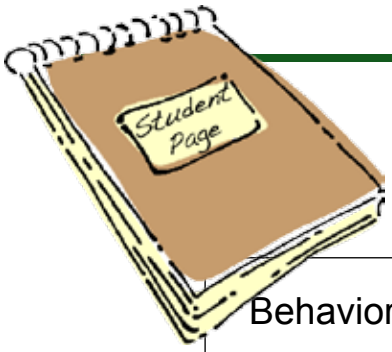
Cooperation and **communication** are very important to prairie dog survival. They need to work together to search for food, maintain their burrows, and protect each other from predators. Prairie dogs have specific duties in their coterie. One prairie dog acts as the sentinel, standing on the mound and watching for predators. If danger is detected, the "sentinel" warns the other prairie dogs with an **alarm call**, which is a series of high-pitched "chirk" sounds. When the predator has disappeared from view, the sentinel gives a **jump-yip**, or "all-clear" call.

Prairie dogs are very easy to observe because they are active during the day in open areas. People have studied prairie dogs to learn more about **animal behavior**. **Ethology** is the scientific study of an animal's behavior in the animal's natural habitat. Some behaviors, such as eating, escaping predators, cooperating in the construction of a burrow, or aiding each other in defense of the territory are obvious survival strategies. But other behaviors may not be as easily understood. Prairie dogs can be seen grooming each other, playing with one another, or standing side by side on a mound of earth. How do these behaviors help them survive?

Prairie Dog Behaviors



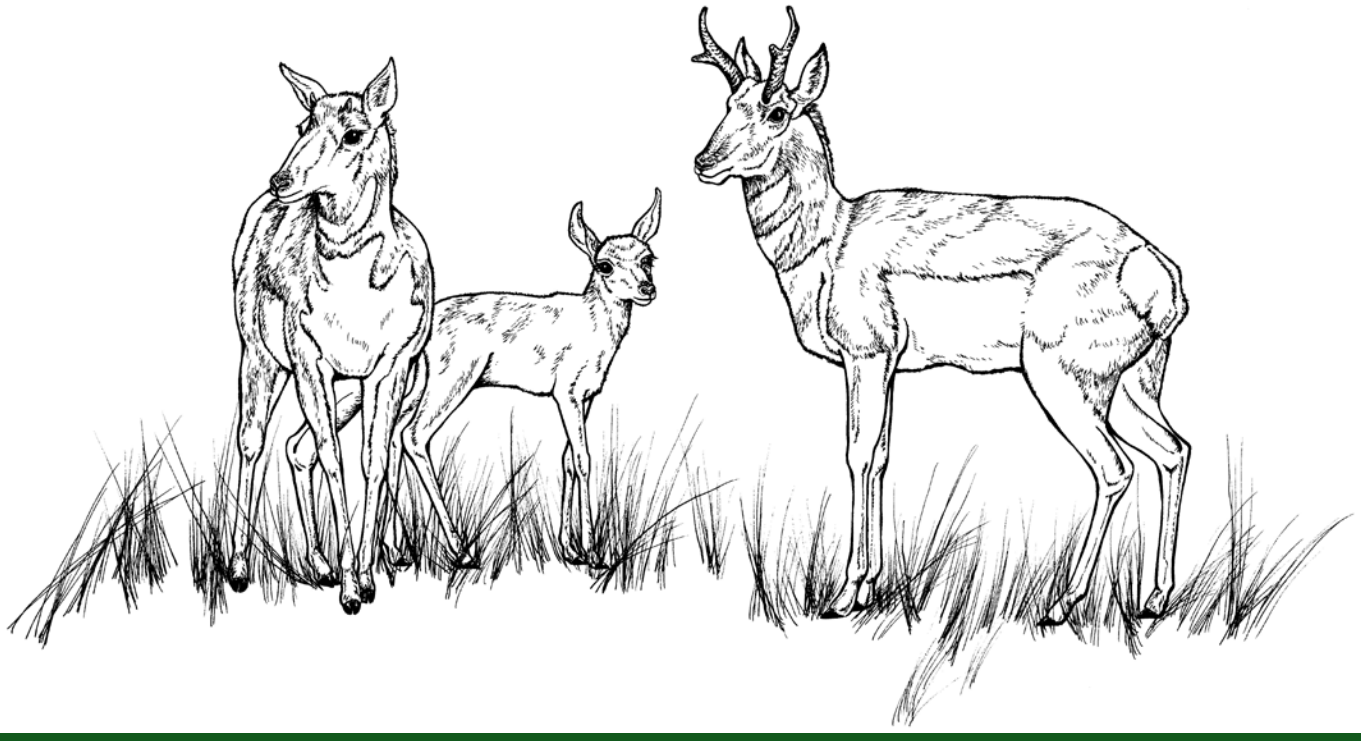
 Renee Tristan	Jump-yip Call
 Wikimedia	Grooming
 Mila Zinkova	Kissing
 John J. Mosesso / USGS	Lookout
 Ron Singer / USFWS	Crouching



Prairie Dog Ethogram

Behavior Observed	Number of Times/How Long
Alarm Call	
Jump-yip Call	
Feeding	
Playing	
Grooming	
Kissing	
Lookout	
Walking	
Running	
Crouching	
Other:	
Other:	
Other:	
Other:	
Other:	

Appendix B: Glossary



Abiotic – non-living factors in the environment.

Adaptation - any body part, behavior, or physiological capability that increases an animal's ability to survive in its environment.

Alarm Call - a series of high-pitched "chirk" sounds made by prairie dogs to sound a warning.

Anthropomorphism - attributing human characteristics to animals.

Behavior - anything an animal does involving action and/or response to stimulation.

Biodiversity (Biological Diversity) - the variety of ecosystems, the variety of species, and the variety of genetic differences within species.

Biome – a biotic community with distinct vegetation and climate.

Biotic – living components of the environment.

Bottleneck Effect – the loss of genetic diversity in a population when a population's size is reduced for at least one generation.

Camouflage - coloration that blends in with the surrounding environment.

Captive Breeding Program - the process of capturing animals from the wild and breeding them in captivity in order to increase their numbers and minimize loss of genetic diversity under protected conditions.

Carnivore - an animal that eats only animals, a meat-eater.

Communication – a process that involves a sender transmitting an idea, information, or feeling to a receiver. Effective communication occurs only if the receiver understands the exact information or idea that the sender intended to transmit.

Community - all of the plants and animals and other living things that live and interact with each other in a habitat.

Cones – cells in the retina that are sensitive to color.

Conservation - taking care of our environment by wisely managing its resources.

Consumer – animals that must get their energy from eating plants or other animals.

Cooperation – collaborate or work together so that all members of the group benefit.

Coterie - family groups of prairie dogs made up of one male, one to four females, and their young up to two years of age.

Decomposer – organisms such as bacteria and fungi that break down dead plant and animals.

Dirt Diggings - mounds of soil brought up by black-footed ferrets from prairie dog burrows and piled on the surface.

Diurnal – active during daylight hours.

Drag Marks – marks left by black-footed ferrets tugging prairie dogs from the capture site to a burrow or from one burrow to another.

Drought – a prolonged period without precipitation.

Echolocation - a sensory system used by bats and other animals to locate objects by emitting high-pitched sounds and determining the time for an echo to return and the direction from which it returns.

Ecosystem - a unit of plants, animals, and nonliving components of an environment that interact.

Energy - the capacity to do work (includes heat energy).

Environment - the total surroundings and forces that act upon a living thing.

Endangered Species - a species in danger of becoming extinct.

Ethogram – a quantitative description of an animal's normal behavior.

Ethology - the comparative study of animal behavior.

Ethologists – scientists who study the biological roots and meanings of animal actions.

Extinct - when there are no more members of a species alive on the Earth.

Extirpated – a species that is missing from its native range but is not extinct.

Eyeshine – light reflected back out of the eye from the tapetum lucidum.

Food Chain - the transfer of energy from one organism to another.

Food Web – all of the possible feeding relationships (energy transfers) in an ecosystem.

Gene - the basic instructions for the inherited traits or characteristics of species.

Generalist – a species which utilizes a broad range of habitat components to meet its needs (such as eating a wide variety of foods).

Genetic Diversity - the variety of heritable characteristics present in a population of the same species.

Grasslands – an ecosystem dominated by grasses.

Great Plains – traditionally, the term for the grasslands that extend from Alberta, Saskatchewan, and Manitoba Canada to southern Texas and Mexico and from the foothills of the Rocky Mountains to just east of the Mississippi River.

Habitat - the area that supplies an organism or group of organisms with all their basic needs for survival including food, water, shelter, and space.

Habitat Fragmentation – the breaking up of an organism's habitat into discontinuous chunks by vegetation loss or by barriers that prevent species from being able to use all parts of a habitat.

Habitat Loss – any action that leaves an area functionally unable to support the species present.

Herbivore - an animal that eats only plants.

Heredity - the passing of traits to offspring.

Jacobson's Organ – a second olfactory sense organ found in many animals.

Keystone Species – a plant or animal species upon which many other organisms in a community depend. Such species affect many other organisms in an ecosystem and they help to determine the types and numbers of various other species in a community.

Lens – the part of the eye that focuses light onto the retina.

Mixed-grass Prairie – the middle portion of the Great Plains with grasses growing two and three feet tall and annual precipitation of 14 to 23 inches.

Mustelid – a family of musk-producing mammals with scent glands underneath their tails.

Native – species historically present in an area.

Niche - an organism's ecological role (or function) in its environment.

Nocturnal – animals that are active at night.

Nodes - joints in grass stems.

Olfactory – related to the sense of smell.

Omnivore - an animal that eats both plants and animals.

Organism - a living thing, such as a plant or animal.

Periscoping – a black-footed ferret behavior of surveying their surroundings by poking their heads out of prairie dog burrows and looking in all directions.

Pest - any animal deemed by people to be unwanted and destructive.

Photon – the smallest measurable unit of light.

Photosynthesis – the process by which plants use sunlight energy to combine water and carbon dioxide and make sugars (stored energy) and oxygen.

Prairie – a term for North American grasslands that is derived from the French word for a meadow grazed by cattle.

Preconditioning - preparing captive-bred black-footed ferrets for reintroduction into their native habitat.

Predator - an animal that kills and eats other animals.

Prey - an animal that is hunted and eaten by another animal.

Producer – organisms like plants that can make their own food from the sun's energy.

Pupil – the dark center of the eye that opens and closes to regulate the amount of light the retina receives.

Recovery Plan – a plan developed to recover threatened or endangered species.

Retina – a layer of light-sensitive cells lining the back of the eye.

Reintroduction – an attempt to re-establish a population of a species in an area that was once part of its historical range, but from which it has been extirpated.

Rhizomes – underground stems of plants.

Rodents - a group of small mammals with continuously-growing front teeth used for gnawing or nibbling.

Rods – cells in the retina that are most sensitive to light and dark changes, shape and movement.

Scavenger - consumers that eat dead animals that they find.

Shortgrass Prairie - the western portion of the Great Plains where grasses grow up to two feet tall and annual precipitation is less than 15 inches.

Specialist – a species that uses a narrow range of habitat components to meet its needs (such as an animal that eats only one prey species).

Species Diversity - the variety of species in an ecosystem.

Species Survival Plan® (SSP®) - the American Species Survival Plan® or SSP® program was developed in 1981 by the Association of Zoos and Aquariums to help ensure the survival of selected species in zoos and aquariums, most of which are threatened or endangered in the wild.

Social Animal - an animal that is highly interactive with other members of its species to the point of having a recognizable and distinct society.

Sylvatic Plague – a bacterial disease carried by fleas that is fatal to many animals and is known as bubonic plague or Black Death in humans. Antibiotics are used to treat humans who contract the illness.

Tallgrass Prairie - the eastern portion of the Great Plains, with grasses reaching five to 10 feet tall and annual precipitation approaching 40 inches.

Tapetum lucidum – a mirror-like layer of tissue in the eye of many vertebrate animals, that lies immediately behind or sometimes within the retina. It reflects visible light back through the retina, increasing the light available to the photoreceptors in the retina.

Territory – an area that an animal defends against others of the same species.

Threatened Species – species not in immediate peril of extinction, but vulnerable because they exist in small numbers or in such limited range that they may become endangered.

Town – a prairie dog colony.

Trenches – long depressions made when ferrets move backwards from prairie dog burrow entrances dragging soil with their front legs

Trophic Level – place or role in the food chain.

Varmint Hunting - the practice of hunting as a means of pest control, rather than for food.

Ward – a sub-colony or “neighborhood” made up of several prairie dog coteries.

Weasel - small carnivorous mustelid with short legs and elongated body and neck.

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