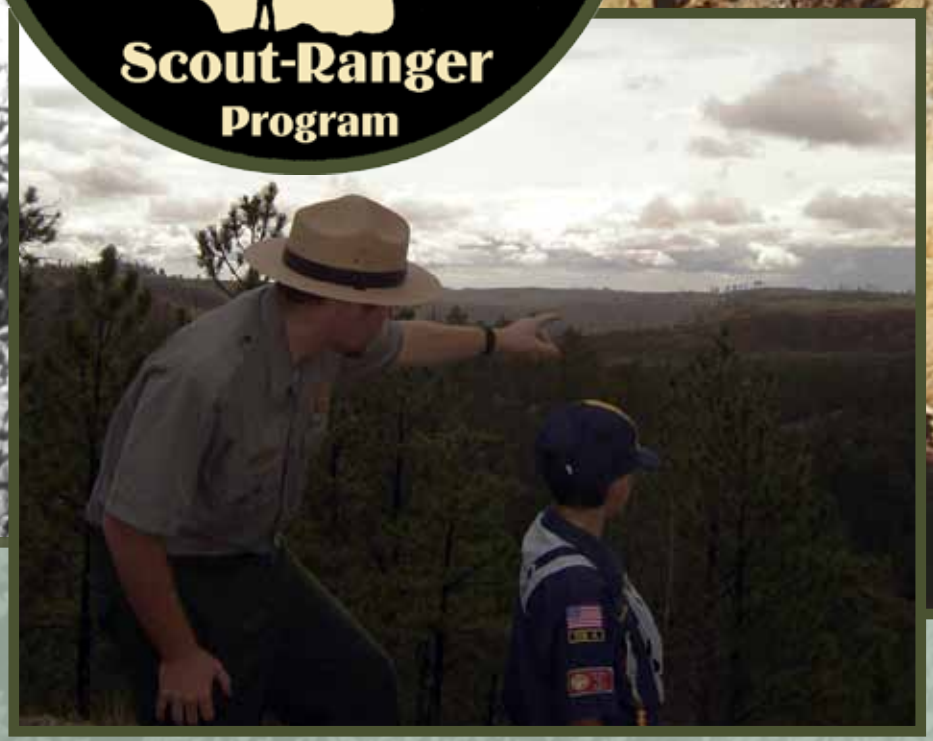
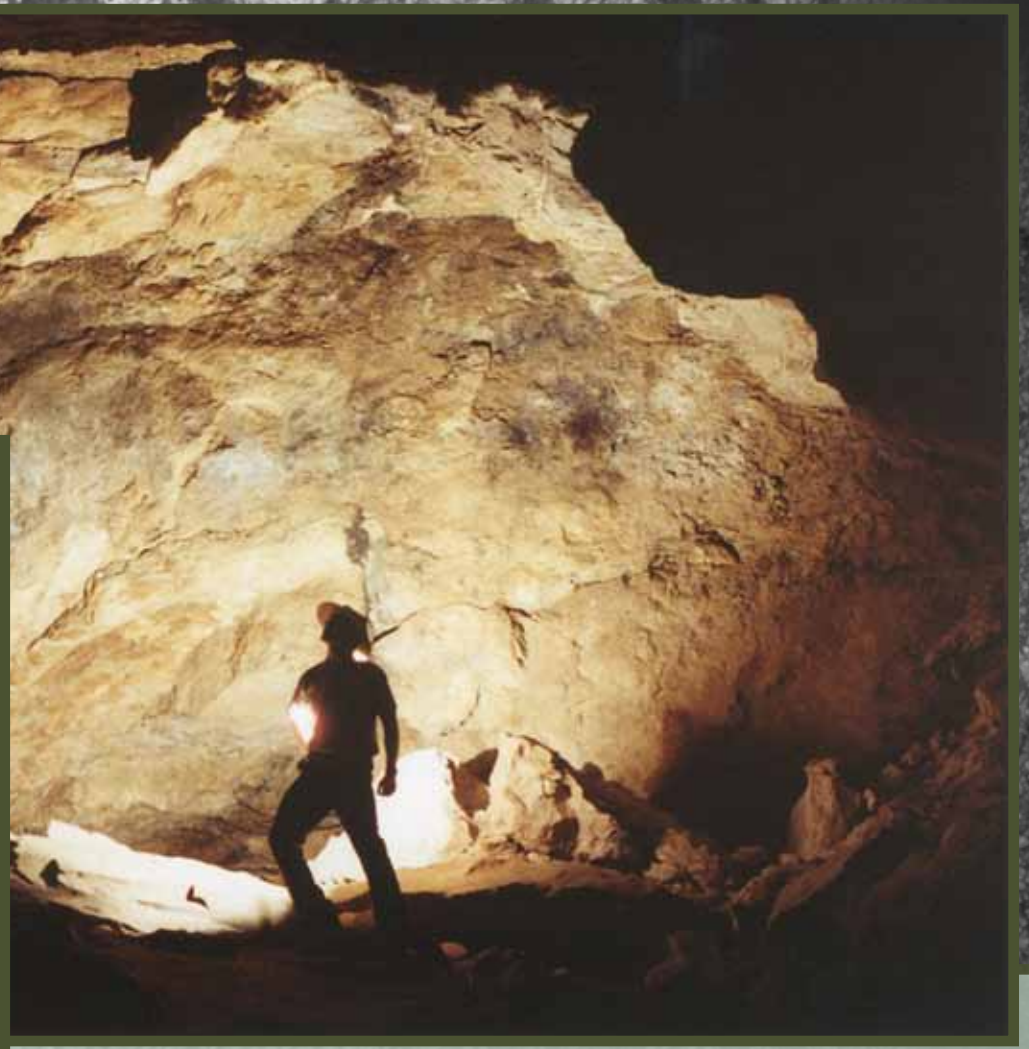
National Park Service
U.S. Department of the Interior

Jewel Cave National Monument Scout-Ranger Program



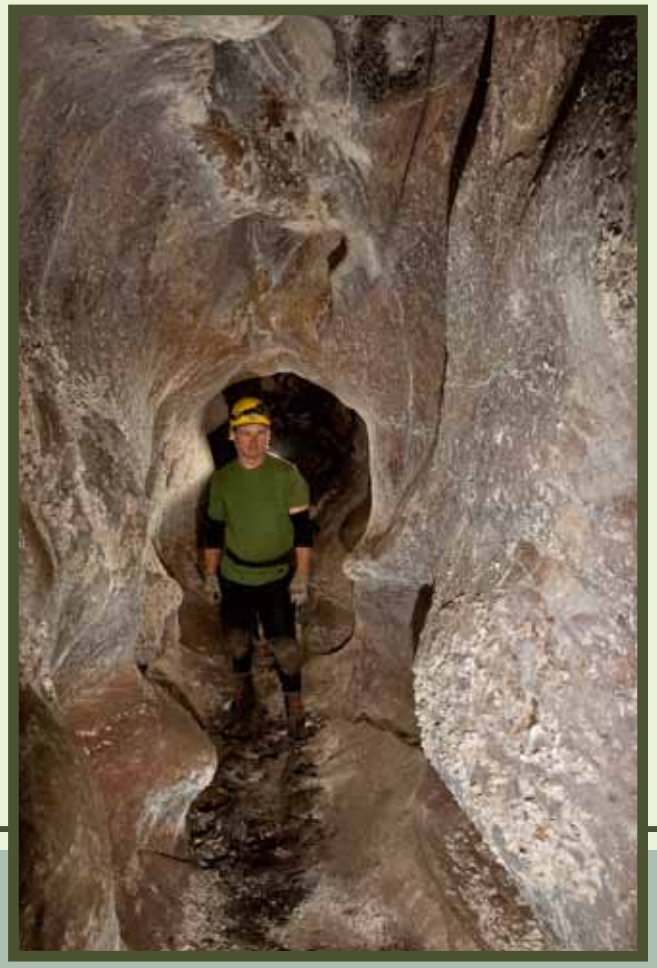


Welcome

Jewel Cave National Monument would like to welcome the Boy Scouts of America to the second longest cave in the world. From its discovery in 1900 until today, Jewel Cave has been a place of exploration. We hope that you too will join us in discovering the wonder that is Jewel Cave.

Allow this booklet to be your guide to the Monument. Within it, you will find the cultural history and the sciences surrounding the cave and what the National Park Service does to protect this delicate and vast system of cave passages and pine-covered hills.

The activities within this text will guide you to a better understanding of this site, and their completion is necessary to earn the Jewel Cave National Monument Scout Ranger Badge.



Contents and Badge Requirements

This booklet is divided into five sections: history, geology, flora and fauna, wildland fire, and invasive species. To earn the Jewel Cave Scout Ranger Badge, you must (a) read through this booklet and complete one activity in four of the five sections, (b) complete a three-hour volunteer service project on the Monument, and (c) participate in a ranger-led interpretive activity, such as a cave tour or guided nature hike.

Joseph Hallenbeck, Editor and Project Manager
Co-Written by Clint Augustson,
Bethany Costello, and Skylea Wright
Seasonal Park Rangers Summer 2009

Cave cover photographs by Dan Austin
Left photograph by Dave Bunnell

Jewel Cave's Early Years

Two brothers, Frank and Albert Michaud, discovered Jewel Cave in 1900 while riding their horses through Hell Canyon in the Black Hills of South Dakota. They came upon a vent of cold air blowing out of a cliff. After looking into the vent and finding a crystal-covered room inside, the brothers decided to go back to their father Felix's house and gather some dynamite. They used the dynamite to blast apart the cliff face and expose the cave inside.

The crystals turned out to be nailhead spar, a calcite mineral that would be an unprofitable hassle to mine. However, if the brothers wanted to control their discovery, they would have to file a mining claim. Therefore, the two brothers, along with their friend Charles Bush, filed the Jewel Tunnel Lode claim on the site. Because their claim was within the Black Hills Forest Reserve, the government required them to remove some crystals from the cave in order to prove they were an active mine. The Michauds removed crystals from side passageways, and in one instance, sold them to a church grotto in West Bend, Iowa.

However, the Michauds were not interested in mining the cave. They hoped that visitors would be willing to tour the cave and see the crystals. Unfortunately, no roads ran to Jewel Cave and it was a thirteen mile journey from the town of Custer.

Left: The park uniform of the 1930s resembled a cavalry uniform.

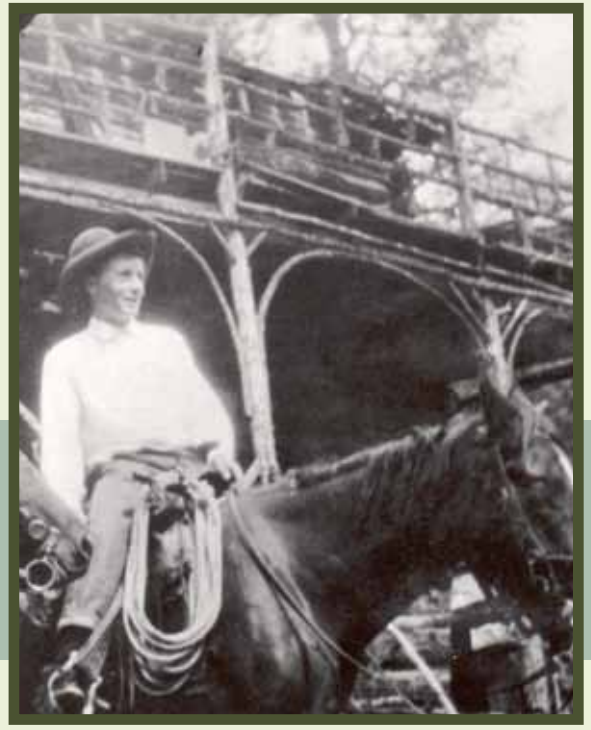
The brothers built a road through the woods and a hotel for overnight visitors. However, they received few visitors and often gated the cave while they sought alternative work away from their discovery.

In 1906, President Theodore Roosevelt signed the Antiquities Act. This act allows presidents to declare places on federal land that are "landmarks, structures, and other objects of historic or scientific interest" as National Monuments. Two years later, he would use this power to proclaim Jewel Cave a National Monument.

The brothers still held a mining claim to the cave, and they disputed that the government owed them $4,000 for the rights. The fight over who controlled the cave would continue until Frank Michaud's death in 1927. The widow, Mamie Michaud, facing the need to raise a family and lacking monies with the death of her husband, sold the claim to the Jewel Cave Corporation for $300.

The cave changed hands again in 1933 when President Franklin Roosevelt proclaimed that control of national monuments on Forest Service land would go to the National Park Service. The National Park Service has managed and protected this resource by providing the public with tours and expanding the survey and mapping of known cave passages.

The Michaud's log hotel was also a dance hall.

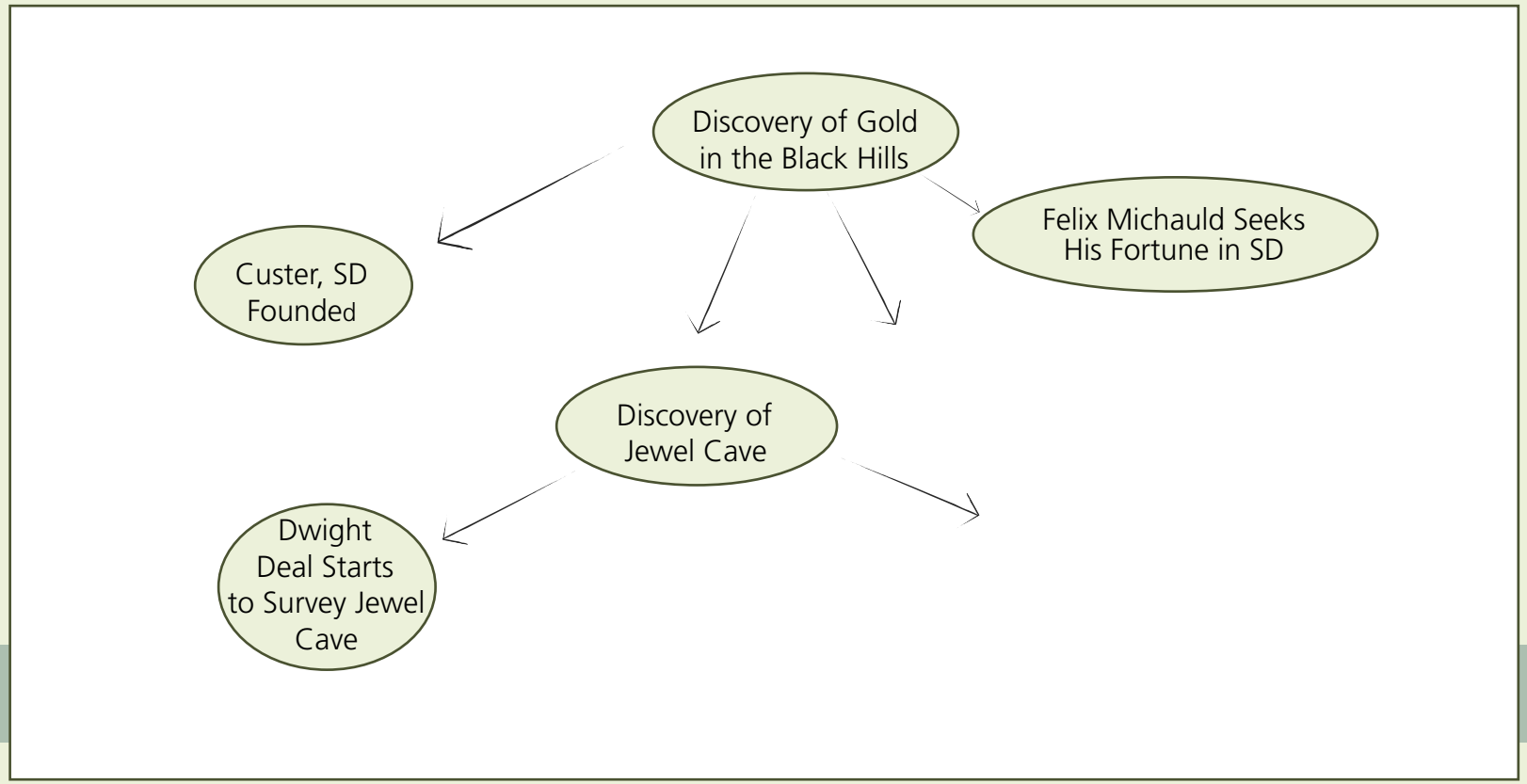


Historic Photography

Photographs are an important record for understanding the past. Early photographs of Jewel Cave National Monument give visitors a glimpse of structures and people that have long disappeared. Find, or take four photographs of historic structures, people, or events from the history of Jewel Cave and attach them to this page.

Connecting the Past

The discovery of Jewel Cave connects to many places and people in history. Numerous events led to its discovery, and even more events would come after. Go online, research, and list five significant people or events that led to the discovery of Jewel Cave. Then, list five significant people or events which occurred after its discovery. Add your lists to the bubble diagram shown below, and show their relationships by connecting them with arrows.



Jewel's Formations

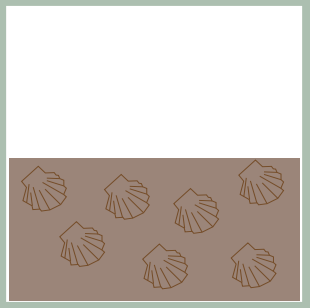
The magnificent power of water dissolved one of the world's longest caves out of solid rock over millions of years. Even more amazing are the rare and delicate formations, seen in almost pristine condition, that grew in the resulting openings.

The formation of Jewel Cave is a unique story, which began about 350 million years ago during the Mississippian Period. The Black Hills were a shallow inland sea. The sea would rise and fall a number of different times, allowing sediments and the shells of tiny sea creatures, like brachiopods, to pile up on the sea floor. Over time, chemical changes and compression solidified these shells and sediments until they formed a layer of gray limestone about 450 feet thick, known as the Pahasapa Limestone.

Gypsum spiders cling to the walls of the cave.

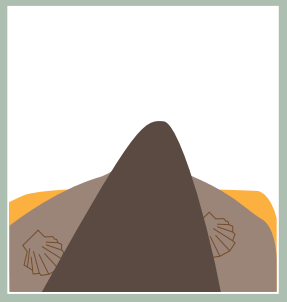
The Stages of Jewel Cave's Creation

Inland sea deposits limestone



Sea level drops, exposing limestone

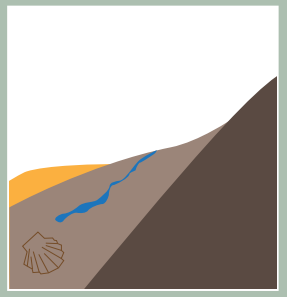
Sea level rises again and deposits sandstone



Black Hills uplifts and exposes limestone

The shallow, inland sea eventually drained. Things were relatively quiet until about 65 million years ago, when the Black Hills started to form. An igneous intrusion uplifted the overlaying limestone and sandstone layers. The cracked and eroded limestone allowed rainwater to travel into the earth. As it made its way underground, the water picked up carbon dioxide. This caused the water to turn into a weak carbonic acid. The acid would continue to flow through cracks in the limestone until it reached the water table. Slowly, the water dissolved the cracks in the limestone, making them larger and larger until they formed cave passageways. Eventually, the water drained out of the cave and left behind the passageways we witness today.

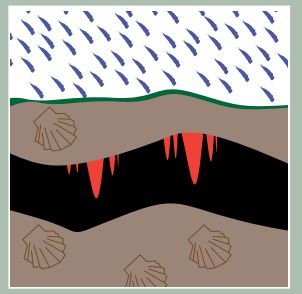
Hydromagnesite baloons hang along the Wild Caving Tour route.



Water seeps through limestone creating cave passages

Nailhead spar forms in submerged passages

Water table lowers and cave drains



Water deposits calcite as dripstones

Rocks and Their Types

Everyone has kicked a rock lying on the ground at least once in their life, but have you ever taken a closer look at it? A rock is actually a mass of material that comes from the Earth's surface, and it is made up of two or more minerals. There are three major classes of rocks, each based on how the rock was formed. The three classes are igneous, sedimentary, and metamorphic.

Igneous rocks formed from molten rock that came up from the Earth's core, then cooled and solidified. As the rocks cooled, minerals within the liquid rock (magma) formed crystals and molded together. Depending on how quickly the rock cooled, it could show either large or small mineral grains. Igneous rocks are very hard, so builders often use them as building materials.

Sedimentary rocks formed as the pre-existing pieces of other rocks, fossils, or plant material cemented together by pressure and time. Geologists classify sedimentary rocks based on size and type of pieces that compose them.

Metamorphic rocks experienced intense heat and pressure, but not to the point of melting. Instead, the heat and pressure transformed them into a new type of rock. Large amounts of pressure results in the alignment of minerals within the rock. This alignment tends to make rocks weaker and often lets them break into thin sheets.

Using the information stated above, determine which of these Black Hills rocks are igneous, sedimentary, or metamorphic.

Limestone

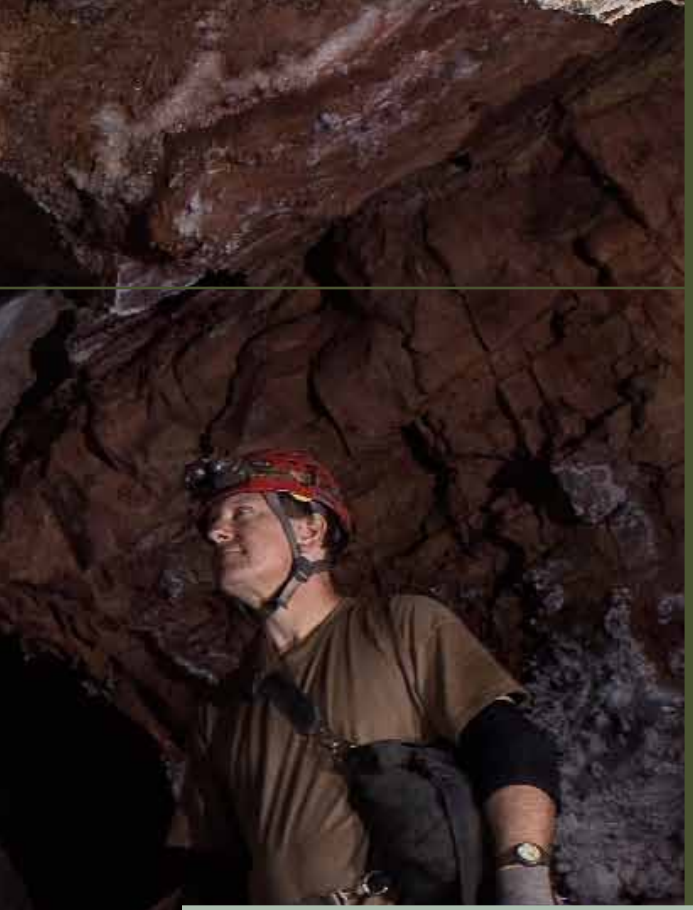
Granite

Sandstone

Schist

_____ _____ _____ _____

Rocks and Minerals



The earth may be made of rock, but have you ever considered what makes up a rock? Rocks are made of one or more minerals. A mineral is a solid, inorganic crystal with a definite chemical composition. Consider a few common rocks found in the Black Hills and fill in the lines with the names of minerals that compose them.

Limestone

Granite

Schist

Photograph of Bunyan's Foot by Dave Bunnell
Rock photographs by Joseph Hallenbeck

The Surface Above the Cave

The surface of Jewel Cave National Monument is a part of one of the most complex ecosystems in South Dakota. The Black Hills are somewhat of an anomaly among the Great Plains, rising like a dark dome over an ocean of grass. As land rises, prairie plants disappear and the land transitions into a dense ponderosa pine forest. This shift is brought about by the sudden change in elevation. The hills produce a rain shadow effect. As storm clouds move higher up, they release their moisture as sudden showers.

Pine trees are specially adapted to thrive in a dry, semi-arid climate. Their waxy needles prevent water evaporation, and a spidery root system fans out in a radius half as far as the tree is tall. As extra defenses, the tree drops its lower branches as protection against fire, and it bears seeds encased in barbed cones that discourage scavengers. Further oddities include a sap that smells like vanilla or butterscotch and needles that can be brewed to make a bitter tea.

This tree determines what else may grow within the hills, since the branches of the ponderosa shade most of the ground. The needles that fall from the trees ensure an acidic soil. As a result, the plants that carpet the Monument must adapt to survive in poor soil. This has changed in the southern part of the park, where the aftermath of the Jasper Fire allowed prairie grasses to grow in the sunlight. Like every other habitat, Jewel Cave's surface is never static, but in a constant flux.

Deer are active in the early morning or evening hours.

Life abounds within the Monument. Chipmunks weave about the rocks in search of nuts and berries, as territorial red squirrels chatter in the branches of pines overhead. Cottontails hide in the thick grasses. Porcupines climb trees, all thirty thousand quills quivering in the sun as they seek out a meal of pine needles and bark.

Lucky visitors may encounter some of the larger denizens of the Monument who periodically dwell in its boundaries as they wander. Deer are one of the most common larger mammals in the Black Hills. There are two main varieties here: mule deer and whitetail deer. The easiest way to tell them apart is in the ears and the rump. The mule deer earns its name by its almost comically enormous ears, whereas the whitetail is distinct for a large tail that flips up like a white flag to warn its peers when it runs.

Harder to find would be the Black Hills' most effective predator: the mountain lion, also known as puma, cougar, or panther. Solitary hunters, they claim huge areas of land for territory, marking several square miles of land as their own and battling any rival that would enter their turf. The lions prefer deer as prey, and they can kill one with a single bite to the neck. Other common prey includes elk, big horn sheep, rabbits, porcupines, and the occasional domestic pet.

Many overlook the smaller animals of the Monument: chipmunks and squirrels thrive in the forest.

Winged Mammals of Jewel Cave

Bats live amongst the other wildlife of the hills, sheltering within tree snags, rock crevices, and caves. At Jewel Cave, there are as many as nine different species in the summer. Many of these migrate in the winter. However, myotis, Townsend's big-eared bats, and big brown bats will shelter in the cave in the winter, where they take advantage of the 49° F temperatures. Once their metabolism slows, they enter a period of hibernation.

Over the past years, the Rangers have counted between 1100 and 1300 bats each winter. They usually find four to five hundred Myotis clustered in groups of two to sixty. By clustering together, the bats reduce their surface area and conserve heat. Seven to nine hundred Townsend's big-eared bats also hibernate in the cave. This makes Jewel Cave one of the largest hibernating locations for Townsend's big-eared bats in the world.

In the warmer summer months, the bats leave the cave to forage in the surrounding forest and meadows. Only a handful of bats will return to Jewel Cave to roost in the summer. Some species will migrate far from the cave in the summer, but pregnant Townsend's big-eared bats will go into the surrounding forest to form nursing colonies where they cluster together and rear their young. The location of the Townsend's nursing colonies remains a mystery. They prefer isolated, inaccessible caves where other animals, particularly humans, cannot disturb them.

Hiking the Monument

Now that you have learned about the ecosystem above Jewel Cave, go out and see it. Hike either the Roof Trail or the Canyons Trail. As you walk along the path, list three things that you saw in each category and sketch the one that most interests you.

Animals	Trees	Wildflowers/Grasses	Birds
1. _____	1. _____	1. _____	1. _____
2. _____	2. _____	2. _____	2._____
3. _____	3. _____	3. _____	3. _____

Food Web of the Monument

Foraging on insects, bats play an important role in the Black Hills forest. Create a food web showing the transfer of energy through eating. Include two types of bats that hibernate in Jewel Cave, their prey, and the animals that might prey upon those bats. Include at least five different animals and plants in this food web.

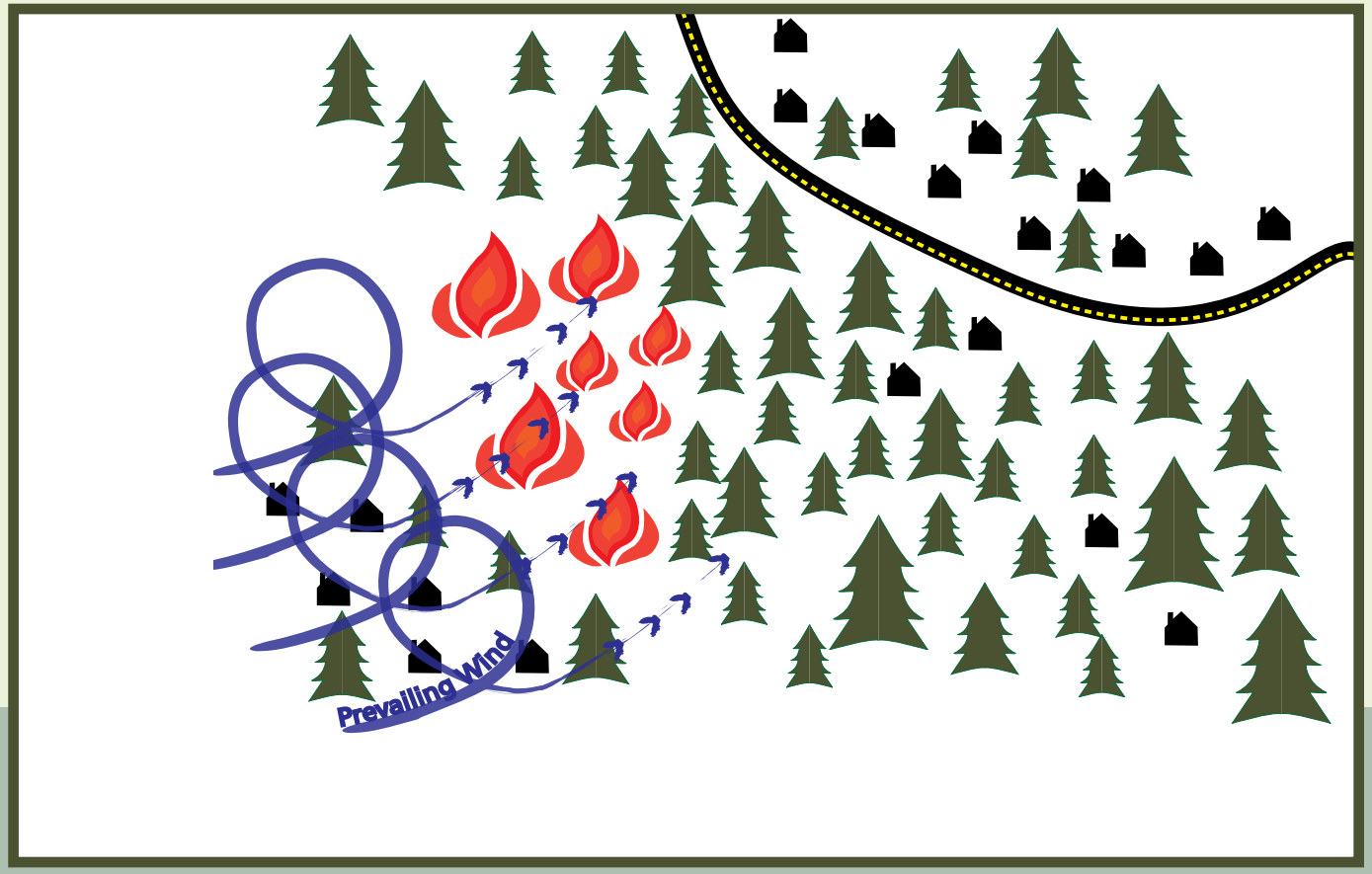
Wildfires and the Monument

The Jasper Fire is proof that hundreds of years of growth can be destroyed with one strike of a match. It started on Thursday, August 24, 2000, in the afternoon. A traveler stopped at the Forest Service road leading to Jasper Cave, lit a cigarette, and flung the match to the ground. This small event would escalate to the largest wildland fire in recorded South Dakota history.

By the following Saturday, the fire had spread at a rate of 86 acres a minute because of hot dry weather and strong winds. That is about 86 football fields a minute! Wildland firefighters worked around the clock to protect the Black Hills National Forest and Jewel Cave National Monument. The staff at the Monument was fearful for the buildings and resources in the path of the fire. Staff worked tirelessly to store valuable items in the cave for protection. Thankfully, using a foaming solution, all of the structures on the Monument were saved.

Digging the Line

Strong winds push wildfires and often determine the path that a fire will follow. Fire crews tend to dig lines in front of the advancing fire to contain its spread and keep it from encroaching on homes. To speed this process, they make use of existing breaks in the forest, such as roads and waterways. Look at the map below, and draw the line where the fire crews should dig.



Invaders in the Park

When European travelers carried feed across the ocean for their livestock, they accidentally brought the seeds of unwanted plants to the North American continent. These species out-competed the native species and quickly became a weedy blight. Today, the National Park Service works diligently to combat these weeds and to remove them from within park boundaries. Nevertheless, many of these plants are difficult to destroy.

To kill invasive species, park rangers use a mixture of three tools: mechanical, biological, and chemical controls. Mechanical control of invasive species involves hand-pulling small plots of plants and weed whacking larger plots. The plants usually regrow, but through repeated pulling, the plants will eventually die. Biological controls also weaken the plants. These involve the introduction of natural predators, such as beetles that feed upon the plants.

The limestone cave beneath the forest of Jewel Cave National Monument limits the tools available to the rangers. We can only use tools that will not damage the cave beneath. Likewise, our commitment to maintaining the original flora requires that any tool we use only kills the non-native plants while leaving the native plants alone. Because of this, chemical controls, which involves the use of herbicides to kill plant populations, are very limited.

The clingy burs of houndstongue often hitch a ride on passing hikers.

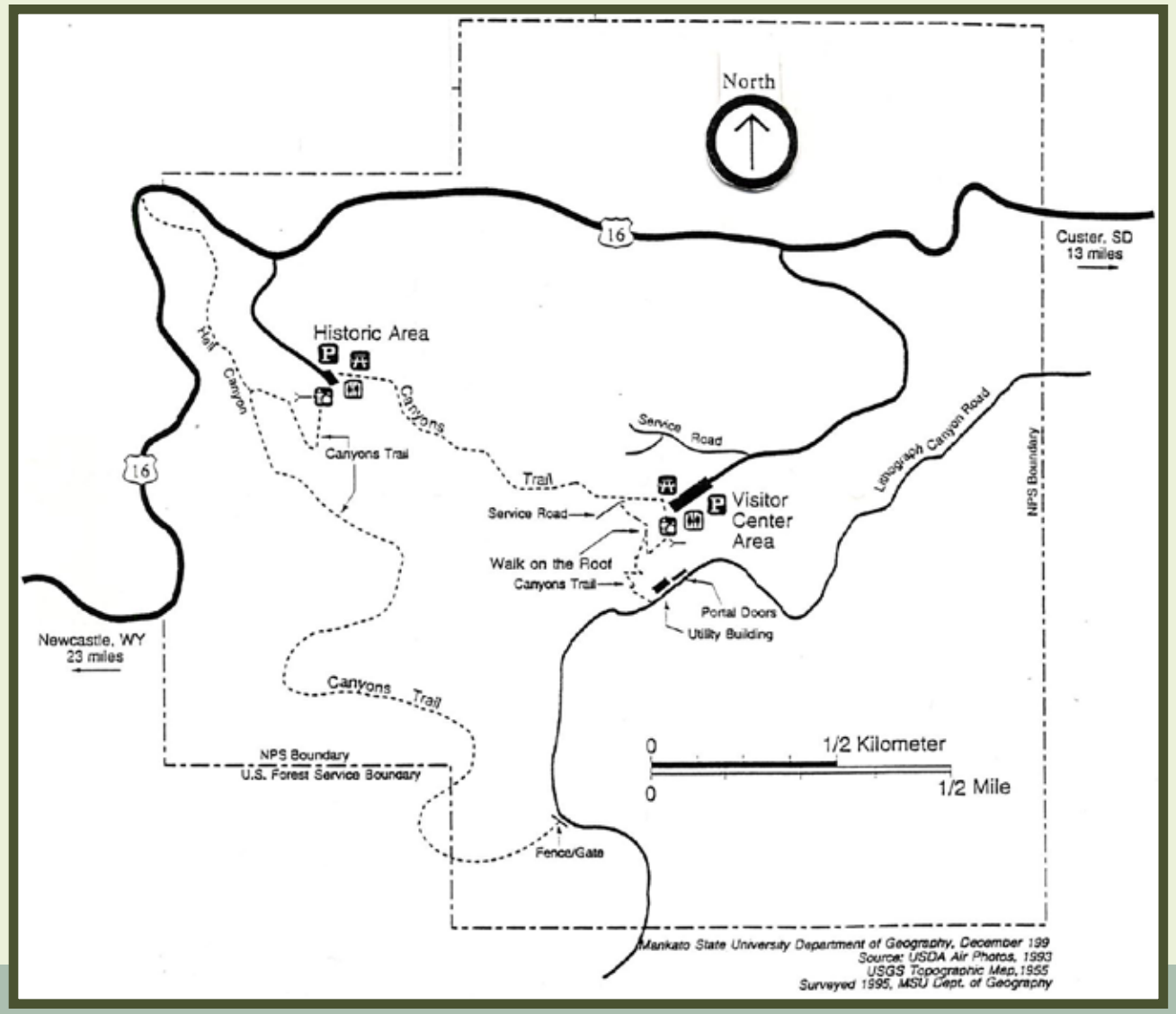
Only the herbicide Millstone fulfills these requirements. We use Millstone to kill Canada thistle within small areas. This also allows staff to monitor for the chemical in groundwater that seeps into cave pools. We limit biologic controls as well, since the beetles used to kill Canada thistle also feed upon the native wavy leaf thistle. Due to all of these restrictions, most of the weed control in the Monument relies on mechanical controls in order to remove plants. The rangers, who are responsible for the eradication of the invasive species, work long hours pulling, cutting, and mowing the weeds.

Weed control begins with the mapping of weed plots. As the rangers walk the grounds, they find new and old infestations of invasive plants. Once they find a site, they mark its location with GPS and add it to the database and map of invasive plant life. It may never be possible to remove all of the invasive species from within the Monument. Nevertheless, for the rangers and those volunteers who help them remove these damaging plants, there is hope that they will eventually slow the expanse of the invasive species.

Thistles grow in large patches along the Canyons Trail

Tracking the Invasion

As rangers hike the Monument, they use GPS to mark the locations of invasive species. Now its your turn. As you hike the trails or participate in your volunteer service project, keep an eye out for Canada thistle, bull thistle, henbane, mullin and houndstongue. When you find a plot of these plants, mark its general location on the map to the right.



Left photographs by Joseph Hallenbeck

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