United States Department of the Interior

NATIONAL PARK SERVICE
P.O. Box 168
Yellowstone National Park
Wyoming 82190

Dear Educator:

Thank you for your interest in *Expedition: Yellowstone!* Established in 1985, this program is Yellowstone National Park's residential education program for grades four through eight. A major curriculum revision occurred in 2004 and it now includes updates to present the latest research and to reflect current educational standards. Enclosed are sample pages from the curriculum showing a variety of lessons from the four units in the curriculum.

The curriculum is designed to help you teach units about Yellowstone National Park, both in your classroom and in the park. All activities are correlated to Wyoming, Montana, and Idaho education standards which can be found by selecting Education Supplements at http://www.nps.gov/yell/planyourvisit/expeditionyell.htm. The goal of the program is to introduce students to the natural and cultural resources in Yellowstone National Park, investigate current issues affecting the Greater Yellowstone Ecosystem, and to promote stewardship and preservation of ecosystems worldwide.

Expedition: Yellowstone! operates as a cost-recovery program covering instructor salaries and educational supplies. Groups are charged $40 per person, per night (adults and students included). Maximum capacity is 40 persons. Groups stay either five days and four nights (Monday through Friday) or four days and three nights (Friday through Monday). During April, May, September, and October, *Expedition: Yellowstone!* is based at the historic Lamar Buffalo Ranch in the northeast corner of the park. To participate in the spring or fall, groups are selected through a lottery. During the winter months, *Expedition: Yellowstone!* is based at the Youth Conservation Corps (YCC) facility in Mammoth. Currently, winter groups are selected on a first come, first served basis. In order to become a registered teacher and be considered for an expedition, teachers must purchase the curriculum for $60 through the Yellowstone Association. Orders may be placed by calling the association at (406) 848-2400.

Whether you use the *Expedition: Yellowstone!* curriculum in the park or in your classroom, I hope it is useful for your educational needs. If you have any questions, please contact me at P.O. Box 168, Yellowstone National Park, Wyoming 82190; email me at Bob_Fuhrmann@nps.gov; or call me at (307) 344-2256.

Sincerely,

Bob Fuhrmann
Youth Program Manager

About Expedition: Yellowstone!

Expedition: Yellowstone! **activities support the following themes:**

- **Yellowstone is the birthplace of the national park idea and was set aside by Congress in 1872 as a public park for the benefit of all people. Yellowstone's legacy of preservation continues today.**
- **Over millions of years, dynamic geological forces have molded the Yellowstone landscape. These forces are active today and will continue to shape future landforms.**
- **Yellowstone's diverse ecosystem supports a wide variety of plant and animal species.**
- **There is an inseparable relationship between Yellowstone's natural history and the cultural history of Yellowstone's Native Americans, trappers, explorers, soldiers, park rangers, and visitors.**

Welcome to *Expedition: Yellowstone!* As an educator, you are about to embark on a journey that is unparalleled in the education world—an experiential education program in Yellowstone National Park. As a teacher from Roundup, Montana, exclaimed, "This is the best outdoor educational experience I have ever experienced—or heard of—or can imagine!" And as a parent from Winnett, Montana, said, "This is the most important thing that could happen to my child during his elementary education."

Established in 1985, *Expedition: Yellowstone!* is Yellowstone National Park's curriculum-based residential program for grades four through eight. The program goals are to teach the natural and cultural histories of Yellowstone National Park, to investigate current issues affecting the Greater Yellowstone Ecosystem, and to promote stewardship and preservation in the park and in home communities.

Expedition: Yellowstone! emphasizes hands-on outdoor activities and exploration of a Yellowstone that most visitors never see. On a four or five day expedition to Yellowstone, classes engage in activities such as exploring Norris Geyser Basin, investigating Mammoth Hot Springs, tracking animals near Lost Lake, snowshoeing off-trail, building a caldera, observing evidence of Yellowstone's volcanic past and future, telling legends around the campfire, discussing habits of endangered and threatened animals, watching wildlife, role playing the geologic history of the Earth, journal writing, and examinating plant transects.

Educational Materials

Two publications comprise your purchase from the Yellowstone Association, a non-profit partner of Yellowstone National Park—the curriculum and a storybook. When you are ready to attend an expedition, you will receive a *Nuts and Bolts Guide to Your Expedition* to help you plan the logistics of your trip.

The magic of Yellowstone is preservation.

— STUDENT COMMENT AT FINAL CAMPFIRE

Expedition: Yellowstone! Curriculum

Park rangers, serving as instructors, have been using most of the activities in this curriculum for many years. This curriculum connects educational objectives with the park's resources through pre/during/post expedition activities.

We encourage you to select from the abundance of activities to tailor your class work to the school's curriculum. Please focus your efforts on preparing your students for their expedition to Yellowstone so that their park experience will be more meaningful. Inform the Education Program Coordinator which activities your students will complete prior to their expedition. Use post-activities to reinforce the concepts taught before and during their expedition.

If you are unable to attend an expedition, you can still use these materials as a valuable teaching tool in the classroom. All lesson plans are aligned with education standards and benchmarks for the states of Wyoming, Montana, and Idaho. Curriculum alignments appear on Yellowstone's official website: www.nps.gov/yell/ey

Expedition Yellowstone: A Mountain Adventure

Expeditiom Yellowstone: A Mountain Adventure is a storybook about the fictional adventures of mountain man Joshua Grimes and his discoveries in a mysterious Yellowstone dream cave. From ancient volcanoes and seas, to the creation of the world's first national park, to the present, he experiences the past which made Yellowstone what it is today.

Expedition: Yellowstone!

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Yellowstone's Legacy

Writer-conservationist Wallace Stegner once said that the national parks are the best idea America ever had, but nobody has claimed that the idea was a simple one, or that it included a clear sense of direction. Management of the national parks has always involved a lot of on-the-job training for American society.

Yellowstone was created in 1872, and fourteen other national parks followed before the National Park Service itself was established in 1916. But even the new Park Service's mission, "...to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the benefit and enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations," left a lot of questions unanswered. Conserve yet enjoy? Enjoyment without impairment? Stegner was right that it was a good idea, but each new park reminded us that good is not always easy.

And that uncertainty, for all the challenges it has caused, has been the great blessing of the parks. They have been one of our age's greatest institutional experiments, accomplishing things beyond the dreams of park pioneers a century ago. The original park idea, which leaned toward geological wonders and spectacular scenery, was soon enriched and diversified by national monuments, historic sites, battlefields, historical parks, cemeteries, birthplaces, recreation areas, and a variety of other unique sites, each with its own treasures and lessons for us.

What began as an undirected attempt to save a few extraordinary places became a mission to honor the entire natural and cultural heritage of the nation, from the wildest places that shape our view of nature to the most constrained urban settings that have been a part of our political evolution. The national parks exist to help us understand who we are, where we have been, and—once in a while—where we are going.

Core concepts:

- **Yellowstone's legacy of preservation continues today throughout the world.**
- **Regulations, laws, and acts are necessary to protect public lands.**
- **Both individuals and media play roles in generating public opinion/support/opposition.**
- **Motives for supporting an idea vary.**
- **Compromise can arise from conflict.**

There is nothing frivolous or impractical about this great enterprise of the national parks. They are vital to our society as are our museums, our stadiums, and our churches. More than any of those other essential institutions, parks constitute a great national university, in which a hundred courses of study can be pursued and a hundred debates engaged in—all aimed at advancing our understanding of our land and ourselves.

Visionary Americans have always understood the great role of the parks. In 1903, during the dedication ceremony of the north entrance arch now named for him, Theodore Roosevelt said:

> *Surely our people do not understand even yet the rich heritage that is theirs. There can be nothing in the world more beautiful than the Yosemite, the groves of giant sequoias and redwoods, the Canyon of the Colorado, the Canyon of the Yellowstone, the Three Tetons; and our people should see to it that they are preserved for their children and their children's children forever, with their majestic beauty all unmarred.*

The preservation idea, born in Yellowstone, has spread around the world. Scores of nations have preserved areas of natural beauty and historical worth so that all humankind will have the opportunity to reflect on their natural and cultural heritage and to return to nature for spiritual renewal. Of all the benefits resulting from the establishment of Yellowstone National Park, this may be the greatest.

Amy Beitel
age 14
Wyoming

Museum History Hunt

When
During and after the expedition

Disciplines
History

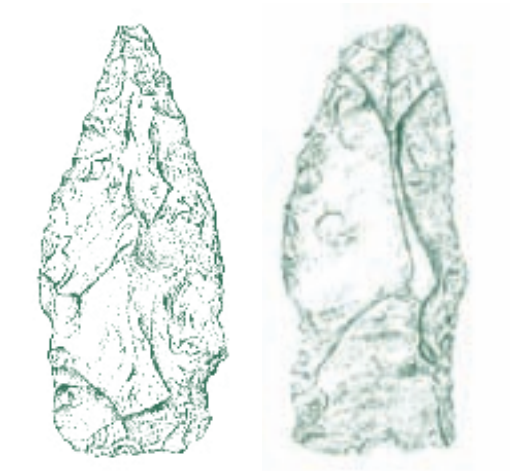
Description
By participating in a scavenger hunt in the Albright Museum, students will search exhibits to find answers to a series of questions about Yellowstone's human and natural history.

Learner Outcomes
The student will:

- Discover that museums are valuable resources for learning both human and natural histories.

Materials
During expedition: Albright Museum History Hunt handout, pencils

After the expedition: craft supplies and other presentation materials



Thomas Moran, *Lower Falls of the Yellowstone,* c. 1892.

Background
A museum is a place where works of artistic, historic, or scientific value are cared for and exhibited. The Albright Museum at Mammoth Hot Springs displays a collection of historical artifacts from Native Americans, trappers, and government explorations of the Yellowstone region, along with books and specimens that led Congress to establish Yellowstone as the world's first national park. Exhibits describe the early visitors, soldiers, and rangers. The museum also has specimens of some of the animals found in Yellowstone and hands-on exhibits about horns and antlers.

Museums often have permanent collections that are on display year-round and temporary exhibits that are on display for a limited period of time. Museum staff must decide which artifacts should be displayed, how items must be properly displayed to ensure their protection, and what information should be included. In this manner, museums interpret historical events for the public.

Suggested Procedure for Activity 1: Voices in the Museum

During the expedition, the park ranger will:

1. Facilitate a discussion on the value of exploring museums to search for information. Ask students to discuss rules for appropriate behavior while in the museum. Remind them that there are other visitors in the museum who are also looking at exhibits and reading information.
2. Distribute copies of the Albright Museum Scavenger Hunt handout. Ask students to write the answers to the questions in each square.
3. Meet with students outside the museum to discuss their answers and observations. Ask students about their overall impression of the museum. What did they like? What would they change? What would they add?
4. Explain to students that when they return to school they will design a "museum" which interprets what they learned and experienced during their expedition to Yellowstone. Explain that they will work in small groups and take their exhibits to their public—parents, other students, or community gatherings. How will they arrange their "exhibits?" What will they include? What information will accompany the exhibits? Encourage them to include at least one exhibit that describes something they learned about Yellowstone's human history and natural history at the Albright Museum.

Suggested Procedure for Activity 2: Sharing Your Expedition with Others

After the expedition, the teacher will:

1. Explain that as *Expedition: Yellowstone!* graduates they are expected to be good stewards of national parks and that one of the best ways of preserving the parks is through education. Explain that their task is to create an exhibit to help others understand and appreciate the resources of Yellowstone.
2. Organize students into small groups and have them share their favorite *Expedition: Yellowstone!* exhibits with each other. They may wish to refer to their journals.
3. Allow class time to turn their "best times" into a museum exhibit.
4. Please take pictures of the presented exhibits and send copies to the *Expedition: Yellowstone!* Coordinator. If your students create booklets and other materials, we would like to have copies, too. If your class received a tuition scholarship, we would appreciate two sets of photos/materials, so the park staff can send a copy to the scholarship donor.

Albright Museum Scavenger Hunt
Student Handout

Which group of Native Americans lived in Yellowstone until the 1880s?	Name three Native American groups that traveled through the present park area.	What was the main source of food for the Sheep Eaters?	What did the Sheep Eaters make from the horns of the bighorn sheep?	Who was the first white man to enter Yellowstone?
What did John Colter do in the Yellowstone region?	What famous trapper earned the reputation of being a "teller of tall tales?"	Who was the artist with the Hayden Expedition of 1871?	What are the names of the three waterfalls Moran painted?	Who was the photographer with the Hayden Expedition of 1871?
Why were Jackson's photographs so important in 1872?	What supplies were needed to make photographic prints in the field in 1871?	Of all the photographs here, which do you like the best and why?	Who was the first superintendent at Yellowstone?	Why was the first superintendent's job so difficult?
In 1886, what did the Secretary of War do to help protect the park?	Name three museum items the Army used while in Yellowstone.	When was the National Park Service created?	List three museum objects the early explorers used in Yellowstone.	What chemicals make up bones, the Mammoth Hot Springs, and antlers?
Name three animals with antlers that drop them each year.	Which animals have horns and thus do not lose them?	How fast can a pronghorn run?	What color is the adult wolf in the exhibit upstairs?	Which animals exhibited here have you seen during *your* expedition to Yellowstone?

Voices from the Past

Nearly 4,000 square miles have been set apart and consecrated to the highest human uses. Every railroad aims to be the medium by which to reach it. Every American must see it once before he dies. All the world dreams of it and reads about it. The best artists photograph it, copy it, and paint it. Men renew their youth in it and women become more beautiful from having breathed its air and inhaled the perfume of its flowers. Boys become wiser and girls lovelier for having visited Fairyland.

— G.L. HENDERSON, 1885

Core concepts:

- **Knowledge of past events is relevant and helpful in making present and future decisions.**
- **People approach a single issue from different perspectives.**
- **Acts and decisions always result in consequences.**
- **Understanding can lead to appreciation, and appreciation can lead to preservation.**

Voices from Yellowstone's past date back more than 11,000 years while human occupation followed environmental changes. Glaciers and an ice cap once covered most of what is now Yellowstone National Park. When they receded, they left behind rivers and valleys that people could follow in pursuit of mammals such as the wooly mammoth and the giant bison. Distinctive stone tools and projectile points indicate that the first people arrived in this region sometime before 10,000 years ago. From these artifacts, scientists believe that these early people hunted mammals and ate berries, seeds, and roots. As the climate in the region warmed and dried, people adapted their lifestyle. Small animals, such as the deer and rabbit, and plants, such as bitterroot and prickly pear, became important parts of their diet.

People seem to have increased their use of the Yellowstone area beginning about 3,000 years ago. They developed the bow and arrow to replace the atlatl and hunted more efficiently. They developed sheep traps and bison corrals.

Archeological evidence seems to indicate that fewer people may have used this region during the Little Ice Age (mid 1400s to mid 1800s). Campsites appear to have been used mostly in the summer months by small groups of people. Such a pattern makes sense in a cold region where hunting and gathering were practical for only a few months each year. Tribal oral histories indicate more extensive use during the Little Ice Age. Kiowa stories place their ancestors here from around

A.D. 1400 to A.D. 1700. Ancestors of contemporary tribes such as Blackfeet, Cayuse, Coeur d' Alene, Bannock, Nez Perce, Shoshone, and Umatilla, among others, continued to travel the park on already established trails. They visited geysers, conducted ceremonies, hunted, gathered plants and minerals, and engaged in trade.

In the early 1700s, some tribes in this region began to acquire the horse. Some historians believe the horse fundamentally changed lifestyles because tribes could now travel faster and farther to hunt bison and other animals on the plains. However, the horse does not seem to have changed the tribes' traditional use of the Yellowstone area.

Some groups of Shoshone who adapted to a mountain existence chose not to acquire the horse. These included the Sheep Eaters, or Tukudika, who used their dogs to transport food, hides, and other provisions. Sheep Eaters acquired their name from the bighorn sheep whose migrations they followed. Bighorn sheep were a significant part of their diet, and they crafted the carcasses into a wide array of tools and implements.

In the late 1700s, fur trappers traveled the Yellowstone River in search of beaver. Although Yellowstone had been thoroughly tracked by trappers and tribes, the first formal expedition was not attempted until 1860, when Captain William F. Raynolds tried to lead a military expedition but was unable to explore the Yellowstone Plateau because of late spring snow.

Formal expeditions of the park area included the 1869 Folsom-Cook-Peterson Expedition, the 1870 Washburn-Lanford-Doane Expedition, and the 1871 Hayden Expedition. The Hayden Survey brought back scientific corroboration of the earlier tales of thermal activity. The expedition gave the world an improved map of Yellowstone and visual proof of the area's unique curiosities through the photographs of William Henry Jackson and the paintings of

Henry W. Elliot and Thomas Moran. The crowning achievement of Yellowstone's explorers and artists was helping to save Yellowstone from private development. On March 1, 1872, President Ulysses S. Grant established the first national park in the world when he signed the Yellowstone National Park Act into law.

Nathaniel P. Langford was appointed to the unpaid post of park superintendent. With no salary from the U.S. Department of the Interior, he had to earn his living outside of Yellowstone. He entered the park only three times during five years in office. His task was made more difficult by the lack of laws protecting wildlife and other natural features. Political voices forced Langford's removal in 1877. Congress authorized a salary for the next superintendent and passed appropriations "to protect, preserve, and improve the Park." Philetus W. Norris was appointed the second superintendent. He constructed roads, built a headquarters in Mammoth Hot Springs, hired the first "gamekeeper," and waged a difficult campaign against poachers and vandals. When Norris fell victim to political maneuvering, he was removed from his post in 1882. The three powerless superintendents who succeeded him failed to stop the destruction of wildlife. Poachers, squatters, woodcutters, and vandals ravaged the park.

When Congress refused to appropriate money for effective park administration, the Secretary of the Interior called on the Secretary of War for assistance. On August 20, 1886, the U.S. Army took charge of the administration and protection of Yellowstone. Managing a park was not the Cavalry's usual line of work, but the soldiers successfully strengthened and enforced regulation. Troops guarded the major attractions, and cavalry patrolled the park's interior. They evicted troublemakers such as the infamous Ed Howell, who slaughtered bison in Pelican Valley. Howell received the maximum sentence and was banished from the park in 1894. Due to the public outcry, within two months, Congress passed the National Park Protection Act (the

Lacey Act). The act provided teeth for protecting Yellowstone's treasures. Although troops could protect the park and ensure access, they could not fully satisfy the visitor's desire for knowledge and were needed elsewhere to protect the country. Moreover, each of the fourteen other national parks established during this period were separately administered, resulting in uneven management, inefficiency, and a lack of direction.

Accordingly, Congress created the National Park Service in 1916. Rangers assumed sole responsibility for Yellowstone in 1918 under the park's first National Park Service superintendent, Horace M. Albright. He served simultaneously as assistant to Stephen T. Mather, Director of the National Park Service. Since the establishment of the National Park Service, many other voices have been heard.

The way the National Park Service has managed Yellowstone National Park has changed dramatically. As discussed in the first unit, the mandate of protecting the resources while providing for the benefit and enjoyment of the people has created various controversial issues. This dual mandate has been interpreted by park managers in many ways across the past century. Some examples include changes from predator control to the return of the wolf; from limiting the numbers of elk and bison to allowing for natural regulation to managing a potential disease; from keeping as many fish as you wish to limiting or not allowing the taking of any fish of certain species. Yellowstone National Park is a park of issues that concern people from varying walks of life. Yellowstone is an iconic park known for its rich natural and cultural treasures.

The lessons in this section will expose your students to a sampling of distant and more recent voices. We hope that the lesson plans will encourage your students, as stewards of our national parks, to raise their own voices.

Painting 1000 Words

When
During and after the expedition

Disciplines
History, fine arts, and language arts

Description
Students examine historic Yellowstone artwork and discover the influential "voices" of painter Thomas Moran and photographer William H. Jackson. Students then give voice to their own Yellowstone experiences through watercolors and photographs.

Learner Outcomes
The student will:

- Identify Thomas Moran as an artist and William H. Jackson as a photographer who accompanied the Hayden Survey of 1871.
- Recognize the importance of watercolor sketches and photographs in the creation of Yellowstone as the world's first national park in 1872.
- Express his/her Yellowstone experience by creating paintings and/or photographs.

Materials
5"x 8" blank index cards, journals, pencils, colored pencils, watercolor paints and brushes, sponges, water, writing implements, Moran/Jackson/Haynes prints, cameras and film (must be supplied by school or individual student), watercolor/drawing paper

W.H. Jackson, *Nathanial P. Langford on Mammoth Terraces,* 1871

Background
In 1871 scientists, technical personnel, and artists comprised Dr. Ferdinand Hayden's Geological Survey of 1871. These men devoted the summer to exploring the Yellowstone region. William H. Jackson accompanied the expedition to photograph Yellowstone and Thomas Moran came along to paint what he saw. The beauty they captured through photographs and paintings helped inspire members of Congress, who had never seen the area, to pass legislation to protect Yellowstone "as a public park or pleasuring-ground for the benefit and enjoyment of the people." President Ulysses S. Grant signed the bill into law on March 1, 1872, thereby creating the first national park.

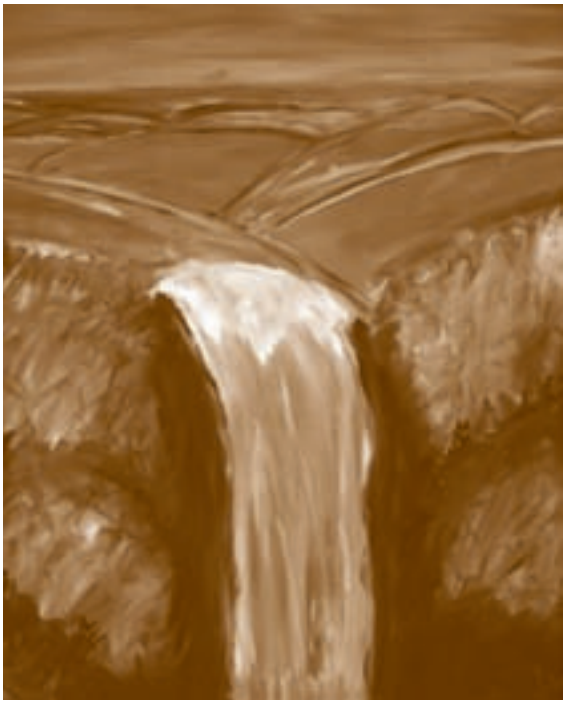
Moran's watercolors beautifully portray Yellowstone's remarkable scenery and grandeur. But at times even Moran was overwhelmed by its display of beauty. It is said that when he first gazed upon the canyon known now as the Grand Canyon of the Yellowstone, he remarked that its beautiful colors "were beyond the reach of human art." Nonetheless he proceeded to record the scene as best he could with his watercolors, just as Jackson recorded what he saw with his camera.

Art continues to influence protection of Yellowstone and other national parks by bringing the beauty of the parks to people who may never be able to visit them.

Suggested Procedure

The teacher will:

1. Discuss Thomas Moran and William Henry Jackson and the roles they played in the Hayden Survey of 1871. Explain how their watercolors and photographs contributed to the establishment of Yellowstone National Park.
2. Visit the Albright Visitor Center and allow students to explore the exhibits relating to Moran and Jackson. Students may wish to record details about the paintings and photographs in their journals.
3. Explain to students that they will have an opportunity to create a work of art based on the day's activities.
4. Proceed to a scenic location (Tower Fall, Wraith Falls, or other location) for an exploration of the Yellowstone landscape.
5. Discuss the Haynes/Schwatka Expedition during the winter of 1887.



Paige Saunders
age 12
Montana

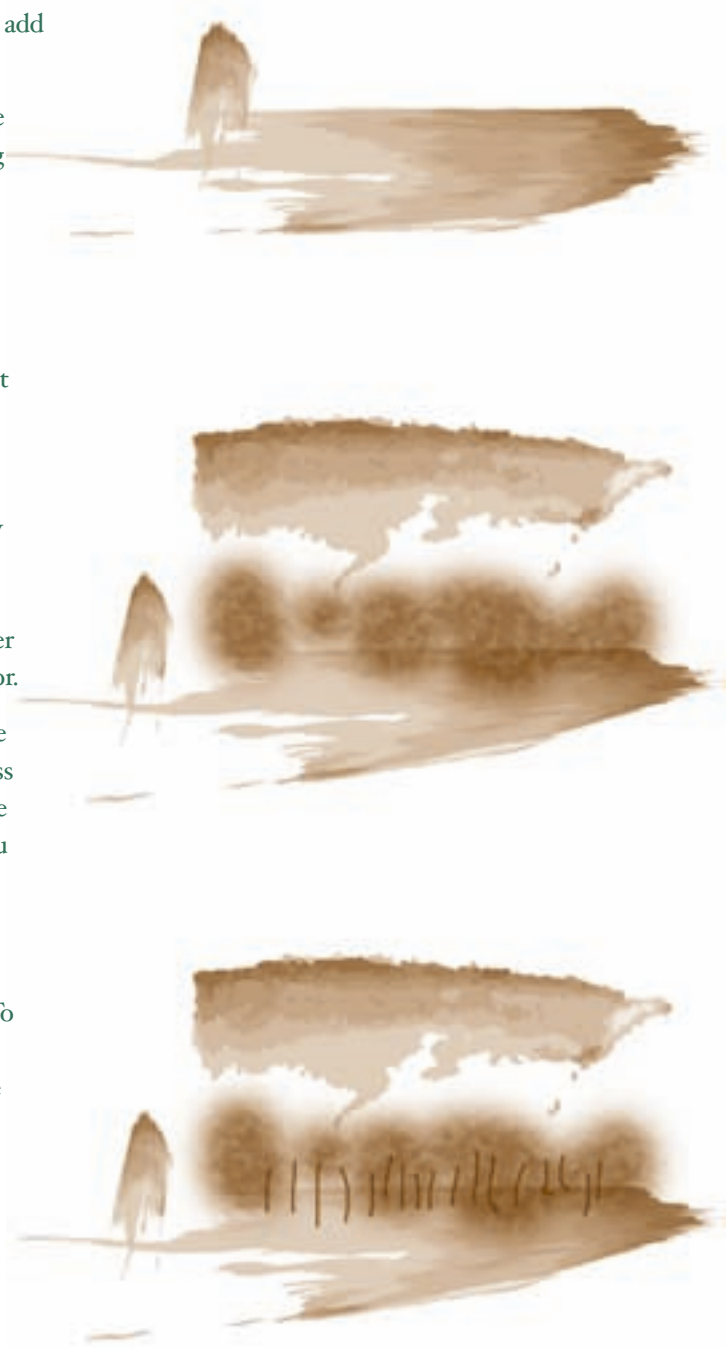
Thomas Moran, *Yellowstone Cañon,* 1871

6. Distribute art materials. Ask students to select a view that they would like to reproduce. Allow students 20 minutes to sketch what they see on the 5"x 8" cards. Explain to the students that they will add colors at a later time as Moran did, and that they should make notes in their journals concerning the colors to be added.
7. Redistribute art supplies in the classroom, and allow students 20 minutes to add color to their sketches.
8. Ask students to write a few sentences on the back of the cards explaining how their work could be used to promote Yellowstone National Park and the idea of preservation.
9. Ask students to share their artwork with the group. How do they think these watercolor sketches could be used to convince a group that they needed to protect this area?
10. Suggest to the students that they develop their film and use some of their photographs and paintings to create an *Expedition: Yellowstone!* bulletin board at their school.

Suggested Art Techniques

There are many ways students can capture what they see with watercolors. Depending on the experience of each group, it may be best to demonstrate to students how to make a wash, make trees with sponges, and add detail before going into the field.

- Paint the sky first. (Watercolors may need to be softened with a little water.) Each student, using a small piece of sponge, should dip it into the water and squeeze out the excess. With what is left on the sponge, they should apply it to the paper only where they want sky. This is called a "wash." Now ask the students to use their brushes to wet the color they choose and draw it across the wash. The color should run and be fluid. The students may streak the color across the wash, leaving unpainted portions to provide hints of cloud. Remind students that the beauty of watercolors is the water, so they can let the water do a lot of the painting for them. If their colors are too dark, tell the students to add water with their brush to distribute or lighten the color.
- Suggest to students that they allow a small space between the sky and ground. Repeat the process now for the ground below the horizon line. Give watercolors a chance to dry somewhat while you discuss the scenery they will be adding to their paintings.
- The students might wish to add trees or sagebrush with another small piece of sponge. To do this, dip the sponge into the water and squeeze out most of the water. With the sponge still squeezed between their fingertips, dip the sponge into a watercolor. The pattern on the sponge should leave its imprint on the paper, depicting leafy trees.
- Ask students to make trunks with brushes or pens. With brushes, add details of rocks, cliff edges, and snags.



Geologic Wonders

This entire country is seemingly under a constant and active internal pressure from volcanic forces, which seek relief through the numberless springs, jets, volcanoes, and geysers exhibited on its surface, and which , but for these vents, might burst forth in one terrific eruption and form a volcano of vast dimensions.

—NATHANIEL LANGFORD,
SCRIBNER'S MONTHLY, JUNE 1871

Core concepts:

- **Geology is dynamic.**
- **Landforms are created and reformed across time by major geologic events.**
- **Geology largely determines habitat, and habitat determines biological diversity.**
- **Understanding the waters of Yellowstone is a window into the global water system.**

Yellowstone National Park was established because of its unique array of geologic features and processes. The park has more than 300 active geysers, which is the largest concentration in the world, equalling about half of all geysers known. But the geysers represent only three percent of the 10,000-plus hydrothermal features in the park. Repeated volcanic eruptions over the ages have left behind large quantities of petrified trees. One of Yellowstone's volcanic eruptions left a caldera measuring 30 by 45 miles. The eruption is estimated to have been 2,400 times the size of the 1980 Mount Saint Helens eruption.

Volcanic and seismic energy (approximately 2,000 earthquakes annually) power the geysers and related hydrothermal features, create mountains and canyons, and generate the unique ecosystems that support Yellowstone's diverse wildlife. Truly, geology is at the heart of Yellowstone's biocomplexity!

Yellowstone's wild geologic beauty has humbled people for generations. Early people used these thermal areas for medicinal and ceremonial purposes. The first Europeans perceived the Yellowstone area to be where "hell bubbled up" and where "petrified birds sang petrified songs on the limbs of petrified trees." Even today, park visitors and employees stand in awe before the landscape, some with a timid respect and others with extreme reverence.

This unit provides a basic knowledge of Yellowstone's geology: plate tectonics, volcanoes, hydrothermal features, earthquakes, glaciers, sedimentation, erosion, and fossils.

Revealing eight major geological events in the park's history, initial lessons and activities in this unit are designed to help students place Yellowstone in geologic time. During their expedition, students will test the waters of Yellowstone, experiment with forces of erosion that continue to shape the landscape, and measure stream flow in the cooler waters.

Sara Hoover
age 16
Ohio

Through the Ages

When
Before and during the expedition

Disciplines
Geology, math, and language arts

Description
Students read Chapter 1 (Dream Cave) of *Expedition Yellowstone, A Mountain Adventure.* Before their expedition, students create posters illustrating one of the geologic events Joshua Grimes portrayed in cave paintings. They will use math skills to create a 40-foot time line of the geologic events in Yellowstone's history. During their expedition, students experience a "time machine" to reinforce the eight major geologic events in Yellowstone's history. During their journey back in time, students observe a demonstration of a caldera being formed.

Learner Outcomes
The student will:

- Identify major geologic events in Yellowstone's history through illustrations.
- Identify major geologic events in Yellowstone's history by using math skills to create a 40-foot timeline.
- Record the geologic events in Yellowstone's history via a time machine.
- Witness and understand the formation of a caldera through a model.

Materials
Before the expedition: *Expedition Yellowstone, A Mountain Adventure;* poster boards; art supplies; 40-foot rope with distances marked with colored tape; Geologic Event Cards; journals

During the expedition: murals, rectangular plastic tub, dirt, sand, small pebbles, squirt bottle, small balloons, 3-foot-long flexible tubing with diameter just large enough to fit inside the lip of the balloon, rubber band or tape, bicycle pump, large relief map of Yellowstone National Park

Background
The oldest rocks found in Yellowstone are 2.7 billion years old. Through periods of erosion, sedimentation, uplift, volcanic eruptions, and glaciation, the Yellowstone area has changed over time to the landscape seen today. The following time line and event cards render more details.

Time Line

# of Years Ago	Event	Distances marked on rope; 1"=10,000,000 year
4.6 billion	Earth formed.	**0' 0"**
2.7 billion	Oldest rocks found in Yellowstone. Only lifeforms capable of survival were primitive plants. Atmosphere was mostly carbon dioxide. Observed rocks are igneous and metamorphic—no fossils.	**12' 3"**
570 million	First Paleozoic seas reached Yellowstone. Little change in next 500 million years. Examples: Cambrian (Buffalo Plateau trilobites, sponges, and worms); Cretaceous (Mt. Everts—leaves, ferns, clams, shark teeth)	**33' 6"**
100 million	Mesozoic marine reptiles—plesiosaurs and ichthyosaurs—appeared. (Later Paleozoic seas)	**37' 6"**
75 million	Laramide Orogeny (mountain building) began and lasted for 20 million years.	**37' 8"**
55 million	Absaroka volcanics began. Buried forests. Quietness and explosive volcanic eruptions occurred over the next 15 million years.	**37' 10"**
40–10 million	Relatively quiet, hot, dry climate characterizes this period of thirty million years. It was populated by primitive camels, elephants, and horses.	**38'**
10–2 million	Regional uplift took place, and the Yellowstone Plateau gained much of its elevation. The Teton Range and Gallatin Mountains uplifted across this period.	**38' 3"**
2 million	Caldera period began.	**38' 3-13/16"**
640,000	Youngest Yellowstone caldera was formed.	**38' 3-15/16"**
640,000–70,000	Post caldera lava flows.	**38' 3-15/16"**
70,000-14,000	Last major glaciation (Pinedale); glacial erratics deposited; thermal activity.	**38' 3-15/16"**
Present Day	Yellowstone as it is today.	**38' 4"**

Suggested Procedure for Activity 1: Dream Cave

Before the expedition, the teacher will:

1. Read aloud Chapter 1 of *Expedition Yellowstone, A Mountain Adventure.*
2. Divide the class into work groups and assign each group a geologic event described by Joshua Grimes.
3. Give each group a poster board for illustrating their event.
4. When groups have completed their illustrations, instruct them to work collaboratively to assemble their posters in chronological order to form a mural along a classroom wall. This step will serve as an assessment. If posters are not placed in the proper order, have the groups continue to work together until they succeed.

Holly Spriggs
age 13
Wyoming

Suggested Procedure for Activity 2: Time Line

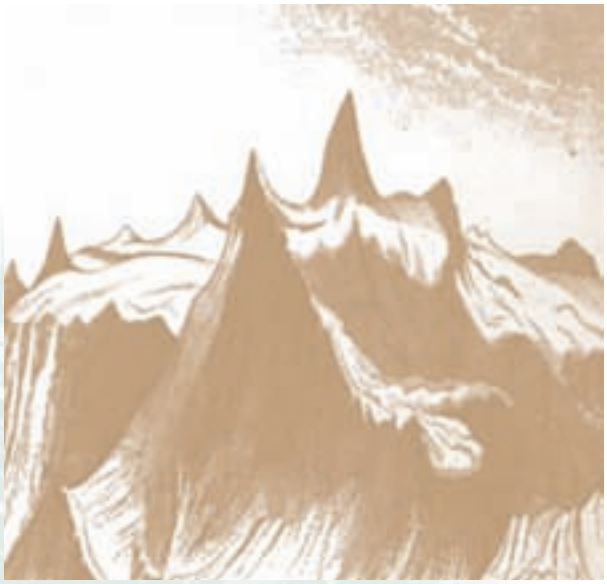
Before the expedition, the teacher will:

1. Explain to the students that they will make a time line to review the major events in Yellowstone's geological history and to visually demonstrate the time between these events.
2. Allow students to assist in marking the rope with a piece of colored tape to represent the eleven events described on the Event Cards. Explain the math—one inch equals ten million years. (Events toward the end are relatively close together. Colored string may be used to mark those events.)
3. Divide students into eleven groups and give each an Event Card. Instruct them to study the event on their card.
4. Have a volunteer from each group stand along the rope matching his or her event with the correct mark on the rope. After volunteers are at the proper locations, have a second student from each group read the event card aloud beginning with the earliest event.
5. Pose the problem—If you were to walk back in time at the rate of one century per step, the first step would return you to the early 1900s. But to return to the oldest event in Yellowstone's geologic history (2.7 billion years ago) you would walk about halfway around the world. Calculate how many miles you would have to walk back to arrive at 2.7 billion years ago, given that each step you took measured 3 feet. (Solution: X feet divided by 2,700,000,000 years equals 3 feet divided by 100 years. Then, X feet equals 3 feet multiplied by 2,700,000,000 years divided by 100 years would equal 81,000,000 feet. Then X miles divided by 81,000,000 feet equals 1 mile divided by 5,280 feet. X miles would then equal 81,000,000 feet divided by 5,280 feet. The answer is 15,341 miles.)

Suggested Procedure for Activity 3: Time Machine

During the expedition, the park ranger will:

1. Cover windows with prepared murals chronologically, representing eight different events in Yellowstone's geologic history. Lower shades to cover the murals. (Students should not be in the room when this step is taken.)
2. Set up the caldera activity next to the caldera mural. On that shade, tape a sign that reads, "Danger! Do not raise heat shield!"
3. Begin class by asking the students what they like about Yellowstone National Park. Make a list of their responses. Ask if they think the park always looked like it does today. Ask how they might go back in time to see firsthand what Yellowstone looked like millions of years ago. Then offer them the chance of a lifetime—travel back in time in a time machine!
4. Ask students to keep a Time Travel Log before activating the machine. Journal entries should describe each of eight stops. They should record the entries in two columns—one to identify "number of years ago" and the second to describe what Yellowstone looked like. (Modification: Students may illustrate, rather than use words, to describe the events.)
5. Explain that the time machine takes everyone swirling through space and time, and that it allows them to look at each event only when the light and heat shields are removed. Explain that for their safety, you will guide them through the millions and millions of years.
6. Have students begin their time travel by closing their eyes: "Only while your eyes are closed can you travel in the time machine. This first trip is the longest. Before you enter the time machine take one last look at the Yellowstone you know. Rose Creek next to your cabins is clear and sparkling. You watch it running down to the Lamar River. There you see a grizzly as you glide by. You're beginning to lift high over the Lamar Valley, and you clearly notice how the last glacier carved out the valley. You're skimming the tops of the trees over the ridge, above petrified forests. Then you begin to see things no one has seen. You're going so fast that everything blurs together—glaciers, volcanoes, and oceans. You're hurling through time as you fall to Earth; you open your eyes. You can't believe what you see."
7. Begin with the first mural and guide the students in a description of that event. Ask students to write/draw in their journals. Continue with each mural. Remember to turn off the lights and have students make time machine noises in order to enter the next time period.
8. Follow the procedures outlined for the demonstration when you arrive at the caldera mural.
9. After describing the last mural, bring students back to the present by having them close their eyes and imagining that they are flying over the forests, trees, Lamar Valley, Rose Creek, and right back to the classroom.



10. Facilitate a discussion about the landscape of today's Yellowstone by referring back to the list the students generated earlier in this activity concerning what they like about Yellowstone. What is the relationship between items on the list and the geologic events in Yellowstone's history? What evidence remains of these major geologic events? How can they investigate these events? Do they think Yellowstone will always look like it does now? Why? Emphasize that geologic forces in Yellowstone are DYNAMIC. What they see today may not be here tomorrow. What they cannot see today may be visible tomorrow. Or what they see today may look different tomorrow.

11. Explain to the students that throughout the expedition you will help them find various pieces of geological evidence.

Suggested Procedure for Activity 4: Caldera Collapse Activity

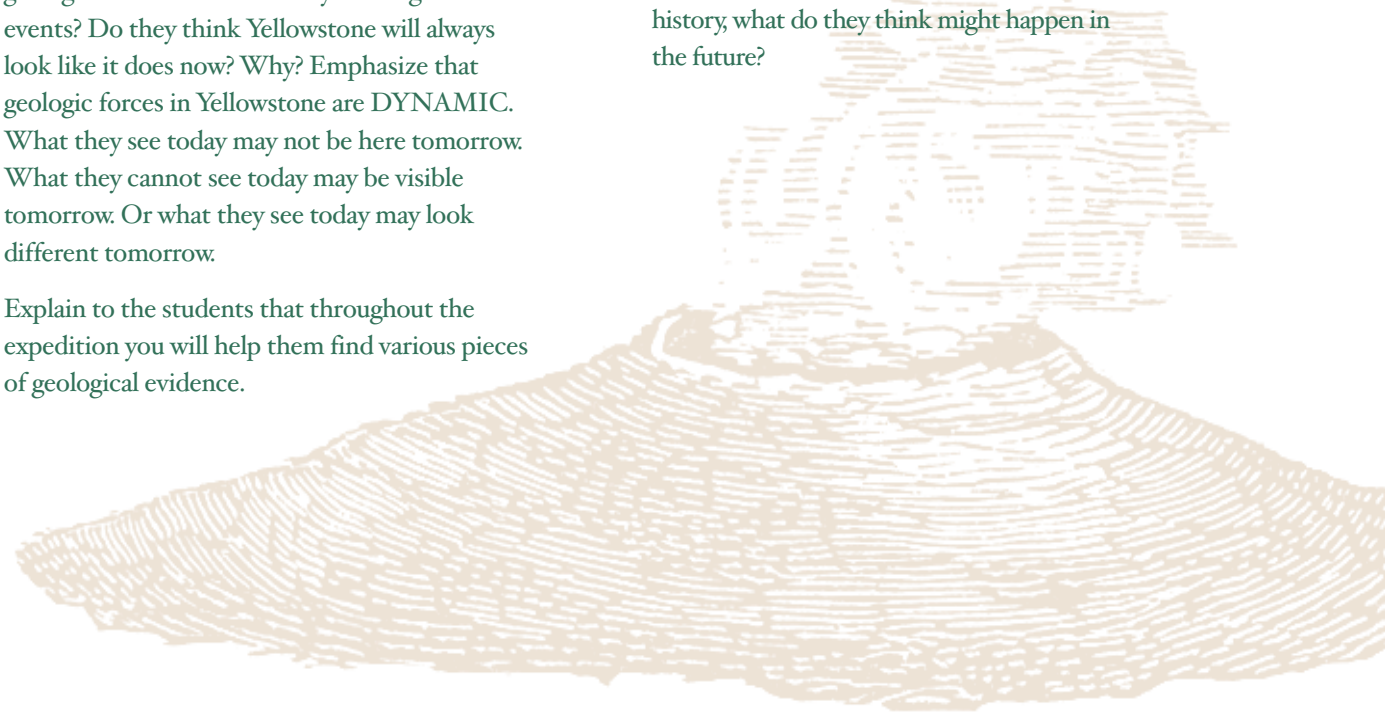
During the expedition, the park ranger will:

1. Prepare the demonstration prior to the *Expedition: Yellowstone!* class session by pouring a small quantity of flour into a balloon and attaching the balloon to tubing with a rubber band or tape. Lay the balloon under the soil mixture within the plastic tub. Then run the tube out of plastic tub and attach to the bicycle pump.

2. Facilitate a discussion about Yellowstone's volcanic history. Encourage students to explain the importance of Yellowstone's major caldera.

3. Have students sit a few feet away from the demonstration. Begin to pump the balloon. Can the students explain what is happening? As you continue to pump, ask the students what will eventually happen. Using a pin, pop the balloon. Encourage students to explain how the caldera collapsed and how lava continued to flow and refilled the crater after the eruption.

4. Outline the caldera on the relief map of Yellowstone. Discuss the size of the caldera and its location in relation to where the students are staying during their expedition. Based on what they know about Yellowstone's geologic history, what do they think might happen in the future?



Geologic Event Cards
Student Handout

2.7 billion years ago

Approximately 2.7 billion years ago, the oldest geologic event in Yellowstone's history occurred and resulted in rocks so crumpled and changed by heat and pressure that their original form is unknown. These rocks, which came from even older rocks, are thought to be the foundation of Earth's landforms and are called "basement" rocks. At this time, there was little oxygen in the environment, but there was bright sunlight.

570 million to 75 million years ago

Yellowstone's landscape had been reduced by erosion to a flat, barren plain that soon was flooded by a shallow sea moving inland from the west. These early seas laid down layers of sand, silt, clay, and mud. Later they hardened into sandstone, shales, and limestones called sedimentary rocks. These early seas also brought the earliest signs of abundant life—trilobites (extinct creatures resembling crabs and spiders), sponges, and worms. Algae appeared and then marine reptiles and dinosaurs. The land grew tropical jungles and forests. The seas advanced and retreated across the Yellowstone region at least a dozen times over the 500 million-year period.

75 million to 55 million years ago

This is the time of Laramide Orogeny (Orogeny means mountain-building). Great underground forces bent and cracked the Earth's crust to create huge uplifts and downfolds. As these pressures increased, rock layers broke and were shoved over one another along great reverse faults. As the land was uplifted and contorted, it began to erode. Rock was eroded from the tops of uplifts and carried by streams into low basins in the form of sand and gravel. This extensive disturbance of the landforms in Yellowstone prepared the land for the great volcanic periods that followed.

Geologic Event Cards
Student Handout

55 million to 40 million years ago

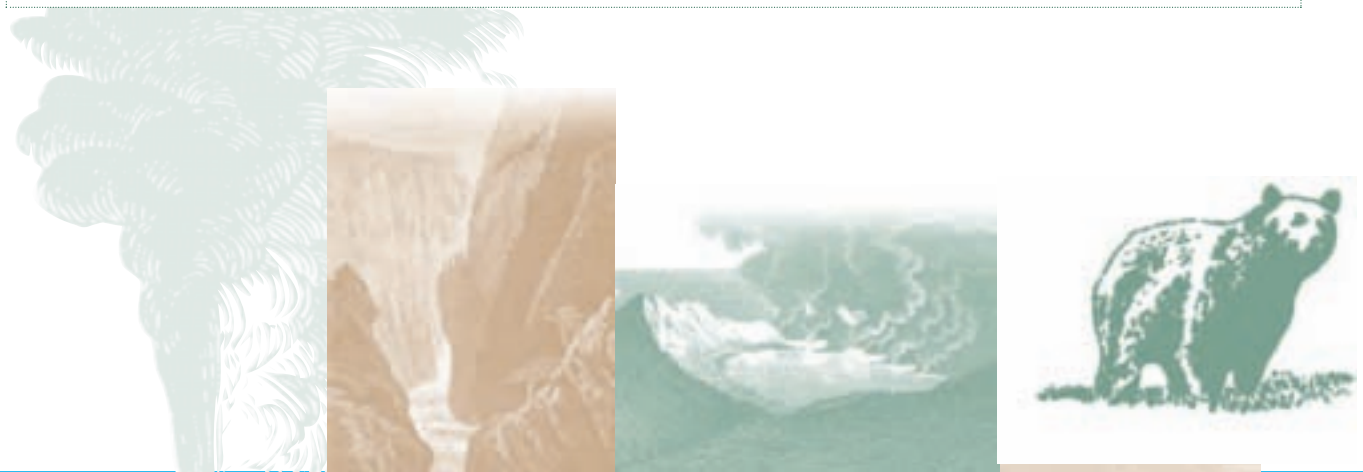
Several large volcanoes erupted in and near Yellowstone (Absaroka Volcanics). The eruptions were periodic and primarily spewed molten rock. Rain followed and caused mud and broken rock to stream down the mountainsides. At times the volcanoes were violent and covered the countryside with rocks, cinders, and ash. Sometimes the entire Yellowstone region was covered with volcanic debris. Between eruptions, there were often long periods of quiet, long enough for forests to grow. These forests were later covered by volcanic eruptions, causing the petrified forests seen on and near Specimen Ridge. Mt. Washburn and Bunsen Peak are examples of Absaroka Volcanics. At the end of this volcanic activity, all of Yellowstone lay buried under several thousand feet of volcanic material. The land must have appeared as a rolling plateau with some streams and some volcanoes appearing above ground.

40 million to 10 million years ago

It must have been geologically quiet and very dry during these years in Yellowstone. No rocks of this age have been identified in the park. If they ever existed in Yellowstone, they were eroded away or buried by younger volcanic rocks. Animals, such as camels, short rhinoceroses, giant pig-like animals, and early horses, grazed on the plentiful grasslands.

10 million to 2.1 million years ago

The entire region was uplifted to several thousand feet above its previous level. Great forces pulled the region apart and broke parts of it into enormous blocks, creating large faults that extended many miles. Both the Gallatin and Teton mountain ranges were uplifted. This tremendous rise in elevation and the subsequent breaking of the region into fault blocks increased erosion. Gentle streams became running rivers, cutting deeply through Yellowstone's plateaus. Over two million years ago, Yellowstone was covered with mountains, basins, and canyons.



Geologic Event Cards
Student Handout

2.1 million years to 640,000 years ago

Once more, a vast quantity of molten rock (magma) that had accumulated deep within the Earth produced two violent volcanic eruptions in the Yellowstone region. The first, 2.1 million years ago in the central part of Yellowstone, formed the first caldera in the area. It is thought that a dome was formed as pressure increased from the magma chamber below. Lava flowed from cracks in the dome. Finally, a violent eruption occurred, spewing hot pumice, rock, and ash across the countryside. As the molten rock was suddenly spewed from the volcano, the roof of the volcano collapsed, creating a huge crater, or caldera. Today, remnants of this volcano can be seen on Mt. Everts, Tuff Cliffs, and Golden Gate. Most of the volcanic remnants, however, were covered by subsequent eruptions. A second smaller eruption occurred 1.3 million years ago just southwest of Yellowstone and contains evidence of the oldest possible glaciation in the region.

640,000 years ago

This is the geologic event that shaped much of today's Yellowstone. Hot molten rock, or magma, in two chambers beneath Yellowstone created a huge volcanic dome. After spewing small amounts of lava through the cracks in the dome, a violent explosive eruption occurred, spreading volcanic debris—hot pumice, rock, and ash—over thousands of square miles. The dome collapsed and a huge crater, or caldera, appeared. The caldera extended 30 miles by 45 miles and was probably several thousand feet deep. Inside this crater is where we find many of Yellowstone National Park's natural wonders. For example, heat from the magma chamber still sustains the thermal features. Also the thick lava flowing within the caldera after the violent eruption created the plateaus in the central part of the park. Closely related to this violent volcanic activity are the carving of the Grand Canyon of the Yellowstone and the creation of the basin forming Yellowstone Lake.

Geologic Event Cards
Student Handout

640,000 to 70,000 years ago

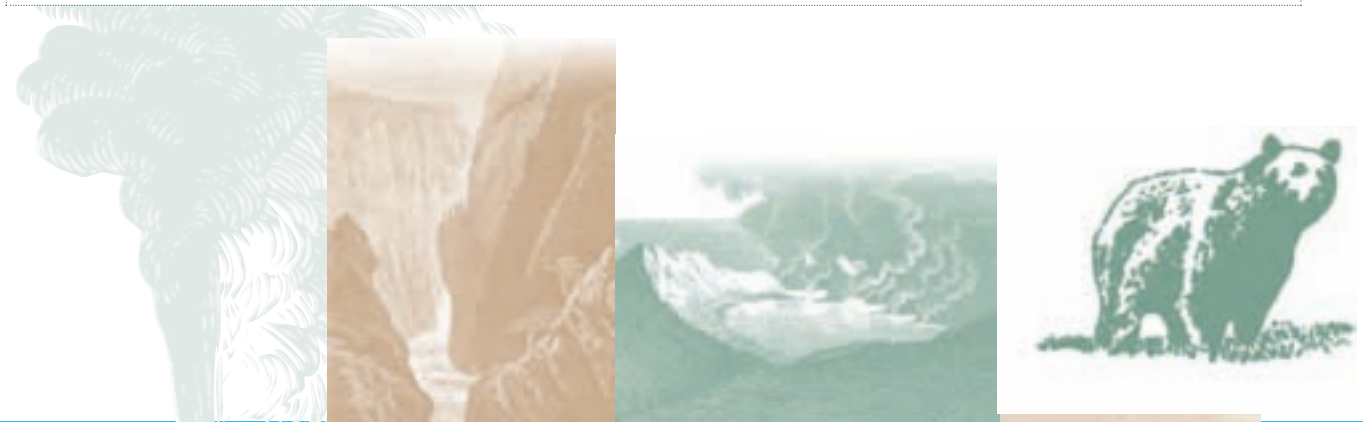
After the violent eruption 640,000 years ago, molten rock again began to build under a dome within the caldera. This time the lava poured out quietly from many openings. The lava flowed mainly into the caldera, but sometimes it flowed over the caldera rim and hardened into ridges and plateaus. The first lava flows occurred about 600,000 years ago, and the last ones occurred about 70,000 years ago. This time, no violent eruption followed. An additional caldera-forming event occurred about 150,000 years ago. It produced a smaller caldera that is now filled by West Thumb of Yellowstone Lake. At the end of this volcanic activity, it seemed volcanism in the Yellowstone region was finally quiet. What remains today is the hydrothermal activity. Could volcanoes become active again in Yellowstone? What do you think?

70,000 to 14,000 years ago

Glaciers form when more snow accumulates in the winter than is melted during the summer. If this happens over centuries, the snow becomes ice. Expansive ice fields grow and begin moving downward under their own weight. This action carves U-shaped valleys. The most recent glaciation, called the Pinedale Glaciation, occurred from about 70,000 to 14,000 years ago with its maximum extent 25,000 years ago. It was during this period that many huge ice masses flowed into and out of Yellowstone and covered about 90% of the region. The ice mass over the Yellowstone Lake basin grew to be as much as 4,000 feet thick.

14,000-8,500 years ago

By about 14,000 years ago, these glacial ice masses had melted from most areas except for mountain valleys where glaciers existed until 8,500 years ago. As the glaciers began to melt, they left behind rock debris that the glaciers had gouged from landforms and carried along with them as they moved. They also dropped huge boulders, called glacial erratics, and left behind glacial or kettle ponds. Even though a few snowfields exist throughout Yellowstone during the summer, there are no longer glaciers in the park today. Could this change? If so how?



Ecological Communities

The outstanding scientific discovery of the 20th Century is not television, or radio, but *rather the complexity of the land organism.*

—ALDO LEOPOLD, 1948

Core concepts:

- **All living and nonliving things are connected in every ecosystem.**
- **Wildlife and plants cannot be studied apart from geology.**
- **Diversity of plants and animals is essential for species survival.**
- **Many plants have adaptations that allow them to live in fire-dependent environments.**
- **Change is an inevitable, necessary, and often unstoppable force in nature.**

Cycles and processes are the building blocks in the foundation of the Greater Yellowstone Ecosystem, just as they are in any ecosystem. Photosynthesis, predation, decomposition, climate, and precipitation facilitate the flow of energy and raw materials. Living things absorb, transform, and circulate energy and raw materials and release them again. Cycles and processes provide the essential connections with the ecosystem.

In Yellowstone, life is active at all levels. Microbes beneath Yellowstone Lake thrive in hydrothermal vents where they obtain energy from sulphur instead of the sun. Plants draw energy from the sun and cycle minerals such as carbon, sulphur, and nitrogen, through the system. Herbivores, ranging from ephydrid flies to bison, feed on the plants and, in turn, they provide food for predators such as coyotes and hawks. Decomposers—bacteria, fungi, other microbes—link all that die with all that is alive. This biological diversity, one of the benchmarks indicating the health of an ecosystem, is measured by richness (the number of different species) and evenness (the abundance of each species).

The Greater Yellowstone Ecosystem comprises more than 18 million acres and is basically intact. With the exception of the black-footed ferret, the region appears to have retained and restored its full historic complement of vertebrate wildlife species—a truly unique attribute for wildlands in the contiguous 48 states. With more than 60 different species, Yellowstone National Park is home to the largest concentration of mammals in the lower 48 states. The park's wildlife also includes seven species of native ungulates, 319 recorded species

of birds, 16 species of fish, six species of reptiles, four species of amphibians, three threatened species (bald eagle, grizzly bear, and lynx), and one endangered species (gray wolf).

Two main forces determine vegetation types in Yellowstone—precipitation and rock type. Most precipitation falls as snow, which is held on top of the soil for much of the year and then released in a short period during spring and early summer. The two major types of bedrock in Yellowstone—the Absaroka Volcanics (andesites) and the Yellowstone Volcanics (rhyolites)—differ in their mineral content, especially in the amount of calcium. Andesites contain two to eight times more calcium than rhyolites. Rhyolites are low in some of the other minerals essential to plant growth. The major vegetation types in the park include sagebrush-steppe, lodgepole pine forests, spruce-fir forests, Douglas-fir forests, and hydrothermal communities.

The vegetation in the Greater Yellowstone Ecosystem has adapted to fire and in some cases is dependent on it. Some plant communities depend on the removal of the forest canopy to become established; they are the first to inhabit sites after a fire. Other plants growing on the forest floor are adapted to survive at a subsistence level for long periods of time until fires open the canopy.

Lessons and activities in this section will help students understand the biocomplexity of the region including the interconnections between living and nonliving things, wildlife issues of the Greater Yellowstone Ecosystem, predator-prey relationships, role of fire in the ecosystem, and wildlife and plant identification.

Wild Wapiti

When
During or after the expedition

Disciplines
Ecology and mathematics

Description
Wild Wapiti is an active game that uses the elk and wolves of Yellowstone to teach the basic ecological concepts of habitat components, carrying capacity, natural fluctuations of populations, and predator/prey relationships. Students assume the role of elk, habitat components, and wolves to simulate different years in the lives of elk in Yellowstone National Park.

Learner Outcomes
The student will:

- State the components of a habitat necessary for the survival of a species.
- Understand that quality of habitat is the most critical limiting factor for Yellowstone's elk population.
- State the effects of predators on a prey species, specifically wolves on elk.
- Identify limiting factors determining the carrying capacity of a habitat.
- Observe through experience that fluctuations in populations are natural.
- Analyze a population graph and write a summary of findings with hypotheses.
- Use observation skills to make hypotheses.

Materials
Wild Wapiti graph, Northern Range Elk Count Graph and questions, journals, pencils

Background
Elk *(Cervus elaphus)* are the most abundant large mammal found in Yellowstone and are the major prey species of the wolves, returned to Yellowstone in 1995. Elk populations in Yellowstone fluctuate from season to season and from year to year. About 30,000 elk in seven or eight different herds inhabit Yellowstone during the summer months. About half that number winter in the park, while the rest migrate outside the park.

Elk in Yellowstone live in mountain meadows and forests. They feed on grasses, forbs, shrubs, and trees. They prefer bunchgrasses, snowbrush, serviceberry, aspen, and willow.

The term habitat describes where an animal species can live within a specific environment. The components of habitat—food, water, shelter, and space—must be accessible and must be adequate in terms of quantity and quality. When a component of the habitat is deficient, the wildlife populations decline.

Carrying capacity is defined as the number of animals a particular habitat can support at a given time. Habitat factors that influence the carrying capacity of Yellowstone's habitat for elk include climate (drought years, wet summers, mild winters), fire (opening up forest areas for more ground cover growth), and availability of winter range outside the park's borders. Climate appears to be the primary factor affecting habitat and influencing elk populations in Yellowstone. Other factors that influence elk populations in the park include: calf mortality during winter; yearling and adult bull mortality; summer predation on elk calves by grizzly bears, coyotes, black bears, and wolves; predation by mountain lions and wolves; and hunting outside the park. In winter, a single pack of wolves will kill an average of 9 to 14 elk per month.

Suggested Procedure

The teacher or park ranger will:

1. Explain the term "wapiti." Discuss Yellowstone's elk populations. If students have seen elk during their expedition ask: Where have they observed elk? Why were they in that area? What time of day was it? What were they doing? What were they eating? Did you notice water nearby? Did they have shelter? If in an elk habitat, point out some of the plants that elk prefer. Depending on the season, discuss the value of plants.
2. Review essential components of habitat: food, water, shelter, and space in a suitable arrangement. This activity emphasizes three of those components–food, water, and shelter. Space requirement is assumed to be sufficient.
3. Divide students into two groups, one about a quarter of the size of the other. Have them form two lines, 20 yards apart and facing each other. Instruct the students to stand shoulder to shoulder without touching.
4. Teach the symbols of the habitat components. The water symbol is hands over mouth. The food symbol is hands over stomach. And the shelter symbol is hands forming a tent over head.
5. Explain that the line with fewer students represents elk. They must find food, water, or shelter to survive. They can choose to look for any one of the components during each round. They cannot change, however, in the middle of a round. Each round represents one year of life.
6. Explain that the line with the greater number of students represents the habitat components. They decide which component they will represent for each round. They can change between rounds but not during a round.
7. If students take their hands down as they walk or run, they will experience a natural disaster, perishing and becoming a habitat component.
8. Instruct students to turn with their backs to the students in the other line.
9. Ask all students to make their signs without looking at the other line.
10. Have students turn and face the students in the other line.
11. Tell the elk to move toward the habitat components and the habitat components to stand still and wait to be chosen. The elk's habitat component needs to match the one they have chosen.
12. Instruct the elk to return with their habitat back to the elk side. (Elk should maintain physical contact with their habitat component all the way back.) The habitat component then becomes an elk and joins the elk side.
13. Instruct students that if an elk does not find a habitat component, it perishes and becomes a resource, and joins the habitat line.
14. Begin recording each "year" on the graph after one practice demonstration.
15. Introduce a drought at some point in the game. No habitat components are water. Note the drought on the graph.
16. Introduce a predator such as a wolf. Note this on the graph for later discussion.

17. Explain one of the options for the wolf rules: The wolf stands in the middle of the playing field. One foot must remain glued to the ground, but the wolf can reach and pivot on that foot. The wolf can tag an elk only as the elk crosses to retrieve a habitat component. When tagged, that elk becomes a wolf. Another option is that the wolf stays on the sidelines. The wolf must hop or skip to catch the elk on its way toward the habitat component. If the wolf tags the elk, the wolf escorts the elk back to the sideline, and the elk becomes a wolf for the next round. There would then be two wolves. Graph the wolf population as well.

18. Limit the number of wolves by increasing wolf mortality. Explain factors that limit wolf populations such as viruses that kill wolf pups, wolves killing other wolves, vehicle accidents, injuries sustained from elk during hunts, management practices, and illegal shooting.

19. Review the graph at the conclusion of the activity. What happened to the elk population before wolves were reintroduced? What happened to the elk population during the drought? Describe the fluctuations in population. Does this happen in the "real world?"

20. Discuss the impact of predators on wildlife populations and the role predators play in keeping wildlife populations and habitat healthy.

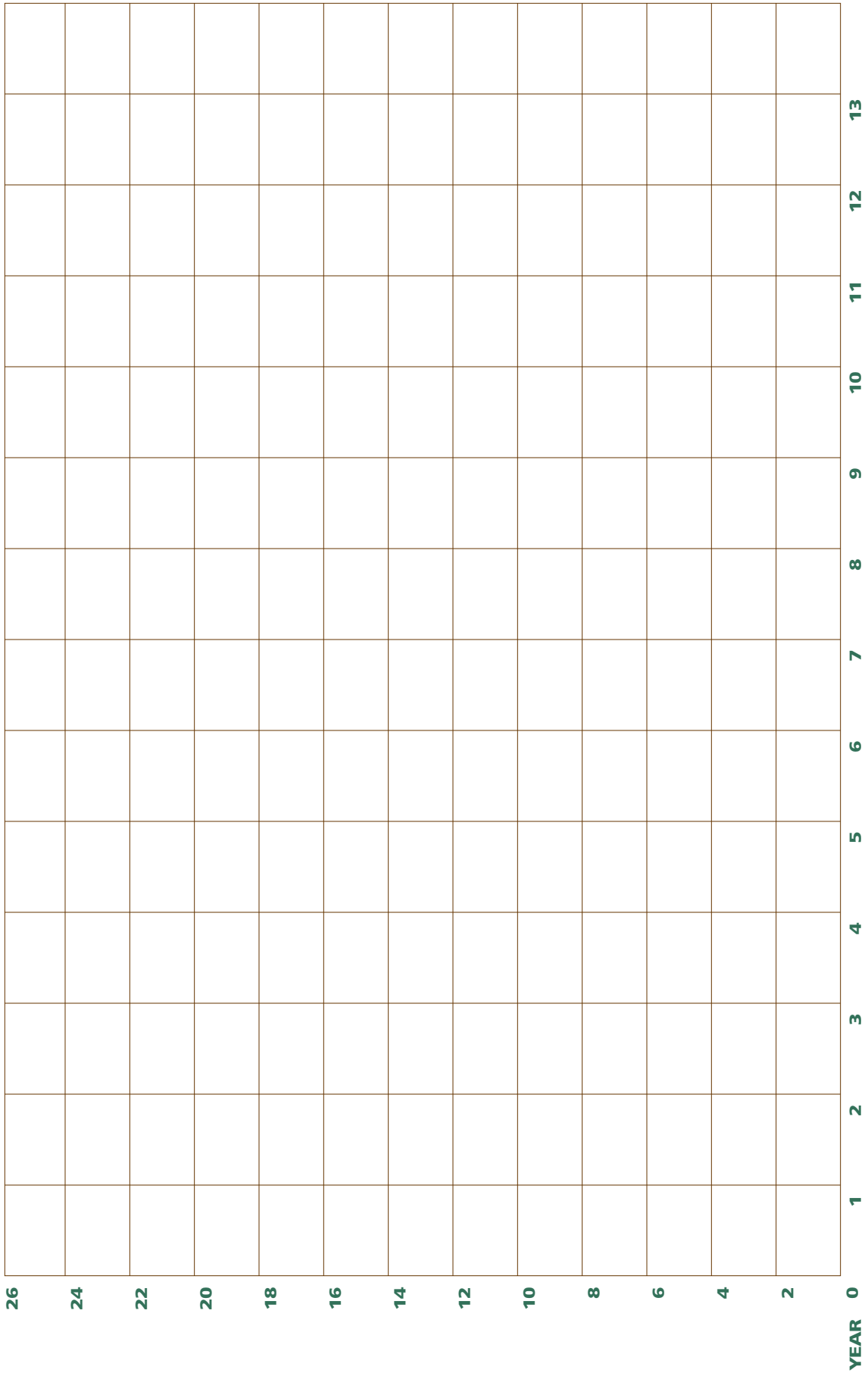
21. Ask students how other animal species could take the place of elk in this activity. How would it change the activity? What would remain the same?

22. Discuss threatened and endangered species. Which animals in the Yellowstone ecosystem are threatened or endangered? What are their limiting factors? How have they become threatened or endangered? How will they be able to increase their populations to a sustainable level? What role do people have in this process?

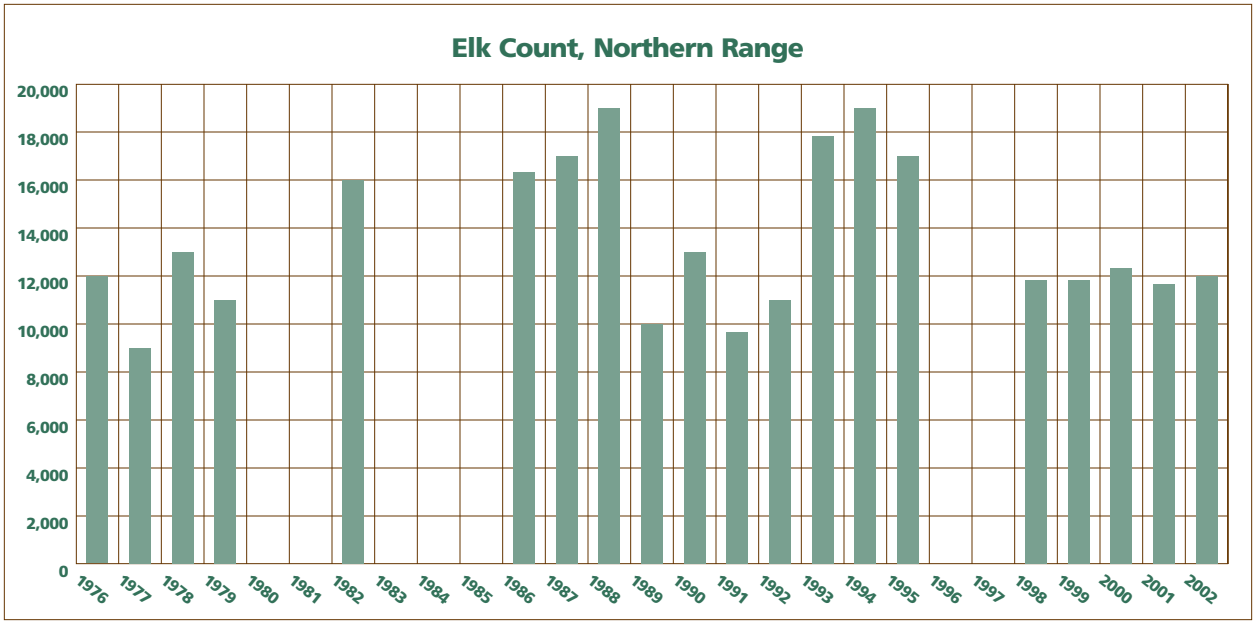
23. Distribute copies of the Northern Range Elk Count Graph. Students should use the questions listed below the graph to analyze the graph and correlate historical occurrences with the population variations such as the Yellowstone fires of 1988, the reintroduction of wolves in 1995 and 1996, and the drought years of 1999, 2000, 2001, and 2002.

NOTE: For safety, if this activity is done on uneven ground, allow students to walk fast rather than run. Walking also makes it easier to monitor the elk and habitat components for "honesty."

Wild Wapiti Population Graph
Student Handout



The Northern Range Elk Count
Student Handout



1. Why do you think there are blank years?

2. What components of a habitat are necessary to support a population of animals?

   a. b. c. d.

3. Look at the population numbers for the years 1988 and 1989. How might you explain the change in elk numbers for those years?

4. Between 1999-2002, there were four years of drought. How has this affected the elk population? What other factors might affect the elk population for the years 1999-2002?

5. What would you predict for the next five years? Give reasons for your predictions.

A thousand Yellowstone wonders are calling,
"Look up and down and round about you!"

— JOHN MUIR, 1885

Expedition: Yellowstone!
National Park Service
PO Box 168
Yellowstone National Park, WY 82190
Phone: (307) 344-2256; Fax (307) 344-2323