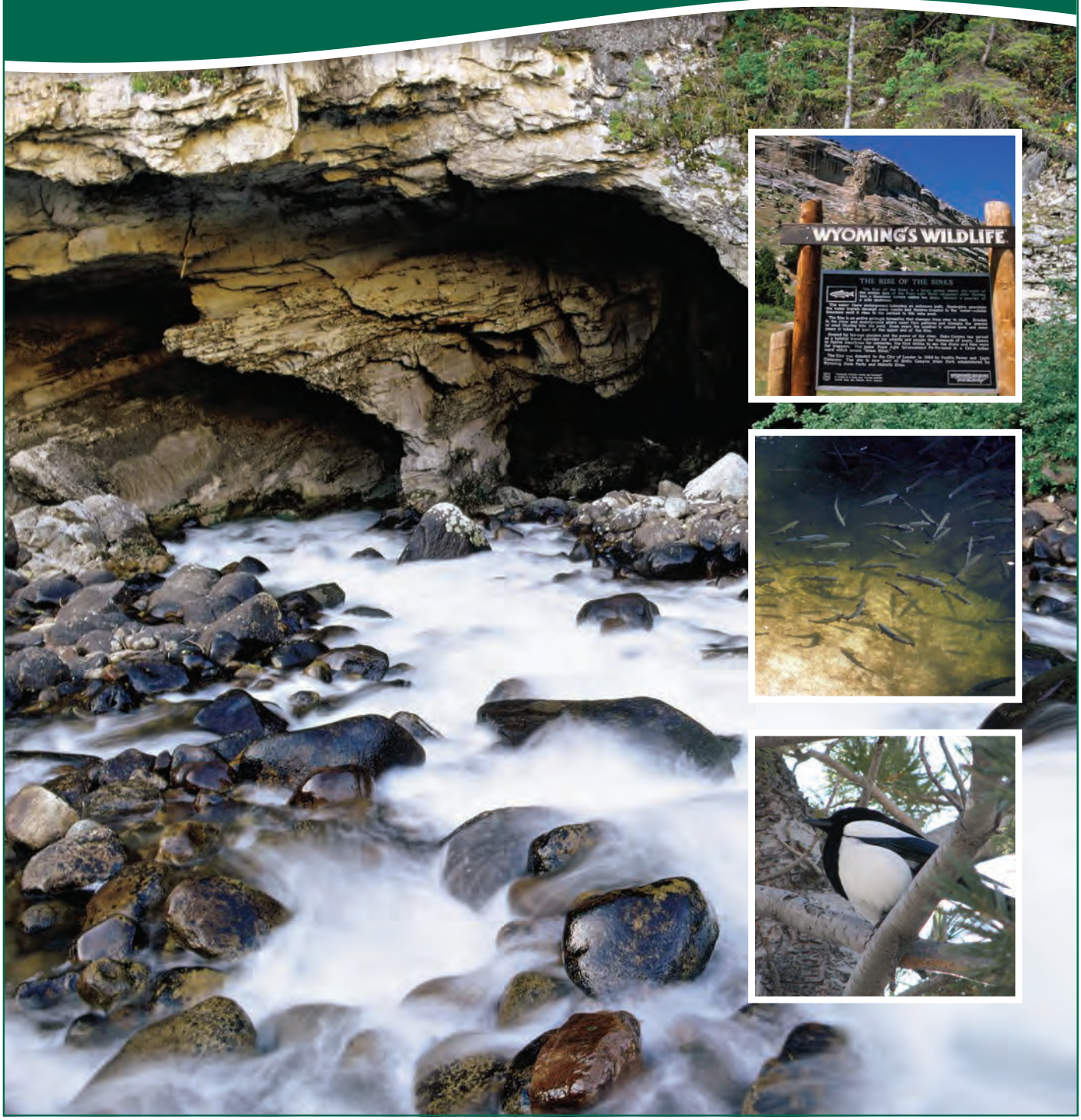
Wyoming State Parks, Historic Sites and Trails

A Journey of Wind and Water:

An Educator's Guide to Sinks Canyon State Park



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Welcome to *A Journey of Wind and Water: An Educator's Guide to Sinks Canyon State Park*.

The Sinks

The Rise

About Sinks Canyon State Park

Sinks Canyon State Park (The Park, SCSP) sits at the gateway to Sinks Canyon, a geologic wonder formed by the weight of glaciers eroding, carrying, and depositing rock during recent ice ages. As great masses of compacted ice carved into the sedimentary rock that now makes up the towering cliffs in the canyon, a broad u-shaped valley was formed. This valley serves as a travel corridor and has facilitated movements of people, plants, and animals for thousands of years.

The Popo Agie River (pronounced po po zshuh) travels through the canyon to the Sinks, where it disappears into a cave, flows underground, and reappears at the Rise, giving the canyon its name. With seasonal weather changes, wildlife migrate to higher and lower elevations through Sinks Canyon and feed off the lush vegetation along the Popo Agie River. Down-sloping winds along the Continental Divide assist in the erosion and weathering of the landscape and help disperse plants' seed and pollen. Up-sloping winds carry moisture and provide the canyon with large amounts of precipitation as those winds rise and cool.

Prehistoric inhabitants used the canyon corridor for hunting and, as evidenced by archeological finds, as a site for tool making. More recently in the 19th century, people traveled the canyon seeking resources needed to build the then fledgling town of Lander. Present day recreationists and travelers still journey through, and stop and stay in, the canyon. With this activity guide, Sinks Canyon will provide a path to discovery and ultimately

Welcome to *A Journey of Wind and Water*: An Educator's Guide to Sinks Canyon State Park continued ...

stewardship for educators and students who explore its uniqueness and travel its paths.

About *A Journey of Wind and Water: An Educator's Guide to Sinks Canyon State Park*.

This guide is the result of a cooperative effort between Wyoming State Parks, Historic Sites and Trails (WY SPHS&T) and Fremont County School District #1 teachers, with the goal of:

- encouraging teachers to take students outside to learn,
- facilitating the use of Sinks Canyon State Park as an educational resource by more teachers
- providing examples and information for educators to use before, during, and after a site visit to Sinks Canyon State Park.

The ultimate goal of bringing students to the park for learning and discovery is to develop a sense of ownership of the park as a local community center, a place where residents enjoy the outdoors, and a place where residents feel they have a stake in its care and well-being. Additionally, by encouraging learning in the outdoors and demonstrating physical activity, the activities in this guide provide a foundation of health and wellness for our students by suggesting physical activity and time spent in the outdoors as life-long skills.

This guide is intended to provide:

1. Information for educators about the resources found at Sinks Canyon State Park in one easily accessible location
2. Suggestions for activities that educators can use before, during, and after a visit to Sinks Canyon State Park .

The activities included in this guide are hands-on, to encourage authentic learning by actively involving students and encouraging them to be creative, to problem-solve, and to experiment within safe parameters. The activities in this guide are intended to provide experiences that will be novel to many students, providing the opportunity to enhance their vocabulary and to make connections to more familiar experiences.

Activities in the guide are focused in 5 basic content areas;

1. Geology
2. Habitats and Ecosystems
3. Human History
4. Plants
5. Stewardship

Within those content areas, activities are designated as "Before Visit"- those activities to use at school to prepare students for their visit to Sinks Canyon State Park, "During Visit"- activities which utilize the park's resources as teaching sites, and "After Visit"- activities intended as follow-up to help students understand and use the information they have learned. Each activity lists the content standard it addresses by grade level.

Templates for student journals are included with the activity guide and educators are encouraged to use these to build students' observational skills, to have students practice being aware of their surroundings, and to capture in writing or drawing, their observations and experiences while at Sinks Canyon State Park.

Welcome to *A Journey of Wind and Water*: An Educator's Guide to Sinks Canyon State Park continued ...

What to Expect

When preparing for a visit to Sinks Canyon State Park, please consider the time of year and encourage students to dress appropriately, with the ability to add or remove layers as necessary. Close-toed shoes are recommended for walking and hiking the park's trails.

It is the goal of the Sinks Canyon State Park staff to greet all school groups, especially those visiting for the first time, and to help educators feel confident and comfortable teaching in the out-of-doors. Please contact the park staff prior to your visit to discuss your educational goals.

Educators are encouraged to visit the park prior to their fieldtrip to familiarize themselves with locations of trails and resources. Please take time to experience the park, both with and without your students. Plan time during your fieldtrip to slow down and to experience the natural beauty of the canyon and the park. Please plan a minimum of 2 hours to accomplish any of the on-site activities.

Sinks Canyon State Park is home to an abundance of wildlife and many plant species. When visiting, please be respectful of the animals and plants by leaving everything in its place and leaving little evidence of your presence. Do not remove anything from the park and do not destroy things that you encounter. The best way to see wildlife at Sinks Canyon State Park is to use quiet voices while out on trails and, please do not approach wildlife, regardless of the species. Each visitor to Sinks Canyon State Park, and all of Wyoming State Parks, Historic Sites and Trails, has the responsibility to help protect the resources in order to provide experiences for future visitors. Please be observant and pay attention to slopes and un-even terrain as you travel on paved and unpaved trails. Be aware that Wyoming State Highway 131 passes through The Park and some activities require students to cross Highway 131. Please use caution with students when crossing this road and encourage students to be aware and observant.

Helpful practices when teaching students in the outdoors:

- Students should wear name tags, especially if you plan to ask Park Staff to teach the group
- Students walk single-file in most places, especially on trails
- An adult should always be in the front of the group; do not let students take off on their own to a destination
- Pick-up any trash and do not leave any trash
- Groups should yield to individual trail users

Helpful Strategies to address student questions that you may not know the answer to:

- Reason out loud and encourage students to join in
- Go through the process of how you might find the answer by suggesting resources
- Consult field guides to look-up answer
- Write down questions to research later or to ask an expert
- Turn the question back to the group and encourage brainstorming and hypothesizing

Getting to Know Sinks Canyon State Park

Activity to be completed: during trip to Sinks Canyon State Park.

Essential Question:
What makes Sinks Canyon State Park a unique environment?

Goal:
Introduce students to the geology and ecology of Sinks Canyon State Park.

Standards:

K-4th Grade:
SC.4.1 Concepts and Processes
In the context of unifying concepts and processes, students develop an understanding of scientific content through inquiry. Science is a dynamic process; concepts and content are best learned through inquiry and investigation.

5th-8th Grade:
SC.8.1 Concepts and Processes
In the context of unifying concepts and processes, students develop an understanding of scientific content through inquiry. Science is a dynamic process; concepts and content are best learned through inquiry and investigation.

Activity #1
A Visit to the Sinks and The Rise

Materials:
Students' journal or a notebook from school.

Procedure:
1. Call the Sinks Canyon State Park staff to set up a time to bring students to the visitors' center.
2. Before arriving at Sinks Canyon State Park, watch the introductory video on the home page of the Sinks Canyon State Park website: http://www.sinkscanyonstatepark.org/
   Students should answer the following questions in their journals:
   - Name three ecosystems found in the canyon
   - Names five plants and five animals found in the canyon
   - How was Sinks Canyon formed?
   - What makes the canyon a unique place?
3. Walk to the Sinks from the Visitors' Center parking lot and follow the path to the Rise. Signs along the path may help students answer the questions in #2.

Writing Activities:

1. How are the Sinks and the Rise connected?
2. Make a list of five unfamiliar vocabulary words

Assessment:

1. Student journals
2. Debrief with the students about what they learned on the trip.

Activity #2
The History of Sinks Canyon

Materials:

Notebooks, pencils, copies of each of the following Primary Source Analysis Worksheets:

1. Written Document Analysis Worksheet
2. Photograph Analysis Worksheet
3. Poster Analysis Worksheet

These worksheets can also be found at the National Archives Experience website at www.archives.gov/nae/education/tool-box.html.

Procedure:

1. Travel to Sinks Canyon State Park Visitors' Center to learn about the many uses of Sinks Canyon over time.
2. Divide your class into small groups of three to four students.
3. The staff at the visitors' center will provide placards with primary resources about a particular topic that will include photos, newspaper articles, brochures, and other documents.
4. Give each student a copy of the three Primary Source Analysis Worksheets.
5. Ask the students to complete the forms using the materials in the placard.
6. Ask the student work-group to share with the rest of the class what they learned from analyzing the primary sources.

Writing:

1. Students write a newspaper article about one of the events that occurred in Sinks Canyon.

Assessment:

1. Groups share the information that they learned.
2. In pairs or in small groups, students make a double time line of the events that occurred in Sinks Canyon State Park and major events that happened at the same time in American history or in the students' home community. (Sinks Canyon History on the top and US history/ community history on the lower section of the time line).
3. Groups re-enact the historical events in 1-2 minutes skits.

Getting to Know Sinks Canyon State Park continued ...

Activity #3
Sinks Canyon Junior Ranger

Materials:
Canyon Junior Ranger Books (cost $3/student), pencils

Procedure:
1. Sinks Canyon Junior Ranger books are available at the Sinks Canyon State Park Visitors' Center. Signs along the Sinks-to-Rise Trail provide answers to the questions in the Junior Ranger book.
2. After students complete their Junior Ranger book, return to the visitors' center to have the book stamped.

Writing:
1. Ask each student to write a question about Sinks Canyon State Park as you travel to The Park. While at The Park, students should work to find the answer to their question.
2. After their fieldtrip, ask students to write the answer to their question.

Assessment:
- Completed Sinks Canyon Junior Ranger book.
- Ask the students what they learned by asking about the information from the Junior Ranger booklet.

Written Document Analysis Worksheet

1. TYPE OF DOCUMENT (Check one):

☐ Newspaper	☐ Map	☐ Advertisement
☐ Letter	☐ Telegram	☐ Congressional Record
☐ Patent	☐ Press Release	☐ Census Report
☐ Memorandum	☐ Report	☐ Other

2. UNIQUE PHYSICAL CHARACTERISTICS OF THE DOCUMENT (Check one or more):

☐ Interesting Letterhead	☐ Notations
☐ Handwritten	☐ "RECEIVED" stamp
☐ Typed	☐ Other
☐ Seals	

3. DATE(S) OF DOCUMENT:

4. AUTHOR (OR CREATOR) OF THE DOCUMENT:

   POSITION (TITLE):

5. FOR WHAT AUDIENCE WAS THE DOCUMENT WRITTEN?

6. DOCUMENT INFORMATION (There are many possible ways to answer A-E.)

   A. List three things the author said that you think are important:

   B. Why do you think this document was written?

   C. What evidence in the document helps you know why it was written? Quote from the document.

   D. List two things the document tells you about life in the United States at the time it was written.

   E. Write a question to the author that is left unanswered by the document:

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Photo Analysis Worksheet

Step 1. Observation

A. Study the photograph for 2 minutes. Form an overall impression of the photograph and then examine individual items. Next, divide the photo into quadrants and study each section to see what new details become visible.

B. Use the chart below to list people, objects, and activities in the photograph.

People	Objects	Activities

Step 2. Inference

Based on what you have observed above, list three things you might infer from this photograph.

Step 3. Questions

A. What questions does this photograph raise in your mind?

B. Where could you find answers to them?

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Poster Analysis Worksheet

1. What are the main colors used in the poster?

2. What symbols (if any) are used in the poster?

3. If a symbol is used, is it
   a. clear (easy to interpret)?
   b. memorable?
   c. dramatic?

4. Are the messages in the poster primarily visual, verbal, or both?

5. Who do you think is the intended audience for the poster?

6. What does the poster creator hope the audience will do?

7. What purpose(s) is served by the poster?

8. The most effective posters use symbols that are unusual, simple, and direct. Is this an effective poster?

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Getting To Know Sinks Canyon State Park, activity #1

1. Name 3 ecosystems or habitats found in Sinks Canyon.

2. Name 5 plants and 5 animals found in Sinks Canyon.

3. How was Sinks Canyon formed?

4. What makes Sinks Canyon a unique place?

Geology of the Canyon
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Geologic History of the Earth

Activity to be completed: before trip to Sinks Canyon State Park

Essential Question:

How can we better understand the geological history of Sinks Canyon State Park by knowing geological eras?

Goal:

Students will understand geological timeframes.

Standards:

K-4th Grade:

SC.4.1.4 Properties of Earth Materials: Students investigate water, air, rocks, and soils to compare basic properties of earth materials.

5th-8th Grade:

SC.8.1.8 The Structure of the Earth System: Students examine the structure of the Earth, identifying layers of the Earth, considering plate movement and its effect, and recognizing landforms resulting from constructive and destructive forces.

SC.8.1.9 The Earth's History: Students systematize the Earth's history in terms of geologic evidence, comparing past and present Earth processes and identifying catastrophic events and fossil evidence.

Websites:

http://www.enchantedlearning.com/subjects/Geologictime.html

http://www.cotf.edu/ete/modules/msese/earthsysflr/geotime.html

http://faculty.clintoncc.suny.edu/faculty/michael.gregory/files/bio%20102/Bio%20102%20lectures/History%20of%20Life/history.htm

Vocabulary:

Era, geologic history, crust, mantle, core, continental activity

Materials:

"Geologic History of the Earth" at http://www.english-online.at/science/geologic-history-of-the-earth/geologic-eras-of-the-earths-history.htm
large paper for students to make a chart or timeline

Activity Procedure:

1. Either as a class or in pairs, students read, "Geologic History of the Earth."
2. Ask students to read for these main ideas which they will turn into a detailed timeline:
   a. Name of Era or time period

   b. When each era or time period occurred
   c. Life forms present during each era or time period
   d. Continental activity during era or time period
   e. Other significant facts about era or time period
3. Ask students to develop a chart or timeline to present the information from the reading visually (example follows).

Writing Activity:
Note taking based on content of reading; encourage students to pull out main points and state those in clear, concise language

Assessment:
Students' chart or timeline with information specified and complete ideas for each point.

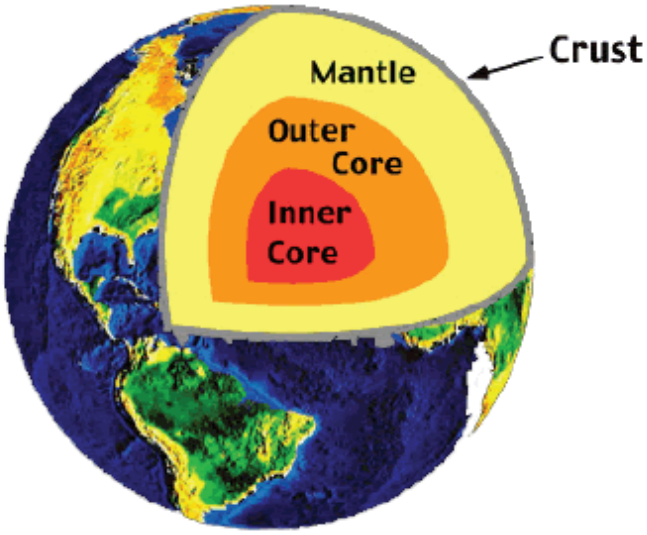
Follow-up Activity:
Students illustrate their chart or timeline with representations of what era or time period may have looked like.

Geologic History of the Earth

http://www.english-online.at/science/geologic-history-of-the-earth/geologic-eras-of-the-earths-history.htm

Geologists are scientists who study the structure of rocks and the history of the earth. By looking at and examining layers of rocks and the fossils they contain they are able to tell us what the earth looked like at a certain time in history and what kind of plants and animals lived at that time.

Scientists think that the earth was probably formed at the same time as the rest of our solar system, about 4.6 billion years ago. The solar system may have begun as a cloud of dust, from which the sun and the planets evolved. Small particles crashed into each other to create bigger objects, which then turned into smaller or larger planets. Our earth is made up of three basic layers. The center has a core made of iron and nickel. Around it is a thick layer of rock called the mantle and around that is a thin layer of rock called the crust.

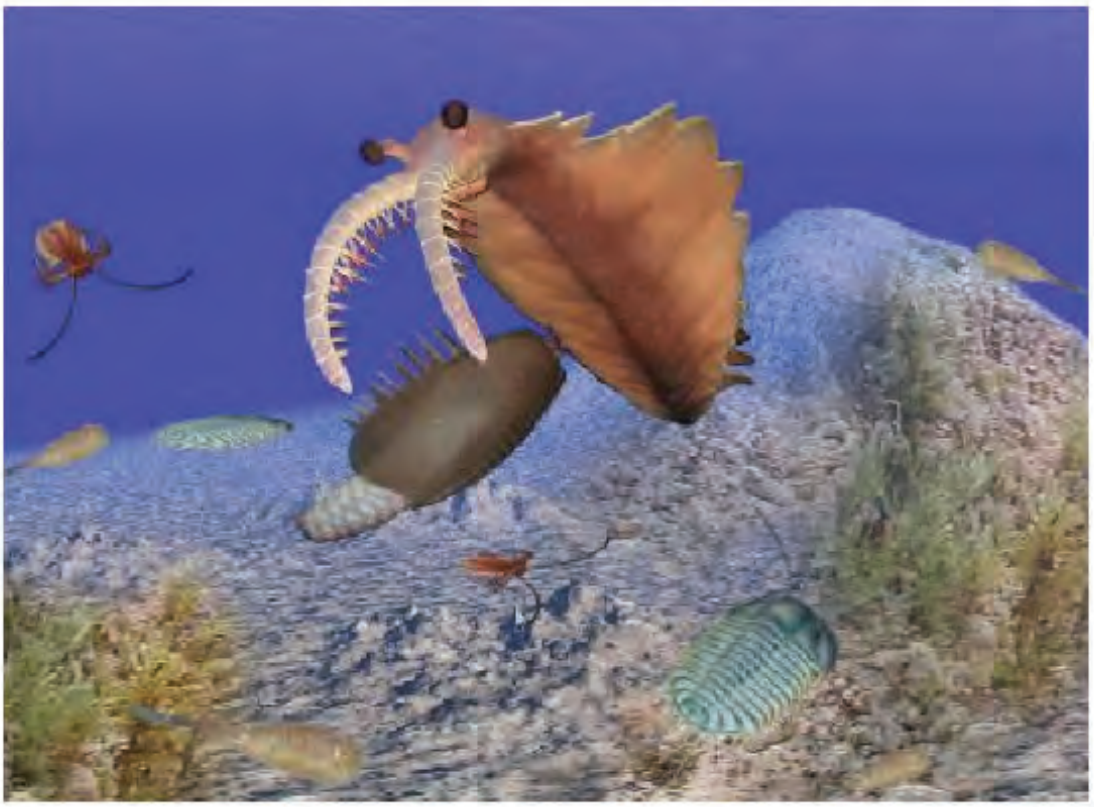


When the earth formed over 4 billion years ago it was totally different from the planet we live on today. There were no plants or animals, only rock, desert, water and ice. The atmosphere probably consisted of carbon dioxide and steam with almost no oxygen to breathe.

The Precambrian Time

The oldest period of the earth's history lasted from the beginnings four and a half billion years ago to about 600 million years ago. At first simple forms of one-celled life developed in the oceans. Later on bacteria and algae evolved. Towards the middle of the Precambrian, about 2 billion years ago, more complex organisms, sponge-like creatures and soft-bodied animals lived in the seas. During this time there was no life on land because there was not enough oxygen to breathe.

As the Precambrian came to an end the oceans were full of life. Plants started absorbing the carbon dioxide from the atmosphere and turned it into oxygen. Early continents formed, but they looked quite different than they do today.



An artist's drawing of what life may have looked like during the Precambrian

The Paleozoic Era

The Paleozoic Era lasted from about 600 million to about 240 million years ago. Geologists divide this era into six periods**.** From the earliest to the latest these are the Cambrian, Ordovician, Silurian, Devonian, Carboniferous and the Permian.

Although most animals and plants still lived in the oceans, life started to develop on land and by the end of this era there was life in both the sea and on land. The earliest living things on land were simple plants and mosses, the first creatures to appear on land were animals that looked like spiders, scorpions and insects.

The middle of the era was dominated by all sorts of fish and invertebrates. Early amphibians, animals that could live on land and in the water, appeared. During the Carboniferous period the first reptiles evolved and insects grew to an enormous size.

The end of the era was the time of big forests and swamps. The earth got hot and wet. Plants and big trees died and were buried in sediments.

Over millions of years they turned into gigantic coal deposits which we find in the eastern United States, Europe, Russia and China.

During the Paleozoic era the land masses were constantly moving and by the end of the era they joined together to become a single continent called Pangaea. As these land masses collided several mountain chains, like the Appalachian and Ural Mountains emerged.

*Millions of years ago there was one continent, Pangaea. The borders of today's continents show how they **probably** looked like. Later on they started **drifting** apart into today's **location***

The Mesozoic Era

The Mesozoic era lasted from about 240 million to about 65 million years ago. At the end of the Paleozoic about 90 % of all living creatures on earth died out. We don't really know what caused this to happen but many scientists think that our climate started to change dramatically. Maybe a big volcanic eruption thrust gas into the earth's atmosphere or maybe a large asteroid hit the earth and dust blocked out sunlight for many years.

The Mesozoic era is often called the age of dinosaurs because they dominated the earth's land masses. Reptiles were the most powerful and fearsome creatures of that time. The archaeopteryx was a flying reptile, probably the first bird on earth. Some dinosaurs, like the Tyrannosaurus Rex, were meat eating predators; others only ate plants and leaves. The 30 meter long brontosaurus was the largest land animal that ever lived. During the Mesozoic era the first mammals also appeared on earth but they were very small and could not match the size and greatness of dinosaurs.

In this era, Pangaea started breaking up and land masses formed the continents we know today. They started moving in all directions. By the end of the Mesozoic era South America had separated from Africa; Australia and Antarctica was one continent and North America had started to move away from Eurasia. Just like the Paleozoic era before it, the Mesozoic also ended abruptly. About 65 million years ago 75 per cent of all animals on earth, including the dinosaurs, died out. Geologists are pretty sure that a large asteroid hit Mexico and sent dust into the atmosphere that blocked out sunlight for years. It killed off many plants and animals could not survive without food.

The Cenozoic era

The Cenozoic era started about 65 million years ago and continues on into the present. It is divided into the Tertiary period which ended about 1.8 million years ago and Quaternary period.

After the death of the dinosaurs and other reptiles, mammals started to dominate life on earth. In the early Cenozoic era, horses, rhinoceroses, pigs, camels, deer and cattle started to evolve. As time went on, mammals got bigger and bigger. Elephants and mammoths roamed the plains and forests.

The Wooly Mammoth

About 2 to 4 million years ago, apelike creatures lived in Africa. Apes that looked like humans appeared 2 million years ago, but the first real humans came to earth much later, maybe even less than 200,000 years ago.

During the Cenozoic era continents continued to move and crash into each other. Layers of rock folded and moved upward. During this era, the biggest mountains of the world, the Alps, Himalayas, Rocky Mountains and Andes have taken shape. In the last 2 million years large parts of the earth have been covered by huge ice sheets. In four Ice Ages, which were separated by warmer periods, glaciers moved across the northern hemisphere. The surface of the seas sank by about 100 meters and turned many shallow parts of the oceans, like the North Sea, into land. Great Britain, for example, was a part of the European mainland and became an island when the ice melted about 20,000 years ago. The glaciers built up huge deposits of rock and reshaped mountains and valleys into today's form. On the southern continents it rained a lot and turned these areas, like the Sahara desert, into green forests and grasslands.

Geologic History of the Earth Timeline

Name of Era or Time Period	Number of Years Ago	Life Forms Present	Continental Activity	Other Significant Facts
Precambrian Archean Era Proteroic Era	4.5 billion to 600 million years ago	-Simple, one-celled life in the ocean -Then, bacteria and algae -Then, sponges and soft-bodied sea animal -End of era: sea plants which absorb CO2 and release O2	Early continents formed	CO2 and steam in atmosphere, no O2
Paleozoic Era	600 million to 240 million years ago	-Animals and plants mostly found in the ocean; life starts to develop on land -Then, life in both sea and land; on land- simple plants and mosses, spiders, scorpions, insect-like creatures -Early amphibian and first reptiles	-Continents moving to form Pangaea -Mountain-building as a result of continental collisions	6 Periods 1. Cambrain 2. Orodovician 3. Silurian 4. Denovian 5. Carboniferous 6. Permian -Earth got hot and wet during last period -Large die-off of life at end of era
Mesozoic Era	240 million to 65 million years ago	-90% of all living creatures had died off at end of previous era -Earth dominated by dinosaurs, both plant and meat-eating -first mammals appear	Pangaea breaks-up to form present-day continents	Large die-off of life at end of era
Cenozoic Era	65 million years ago and continuing to present	-mammals dominate -apes that look like humans present 2 million years ago	-Continents moving, much mountain-building	4 ice ages

Canyon Carver I

Activity to be completed: before trip to Sinks Canyon State Park

Essential Question:
How do rivers and glaciers form canyons?

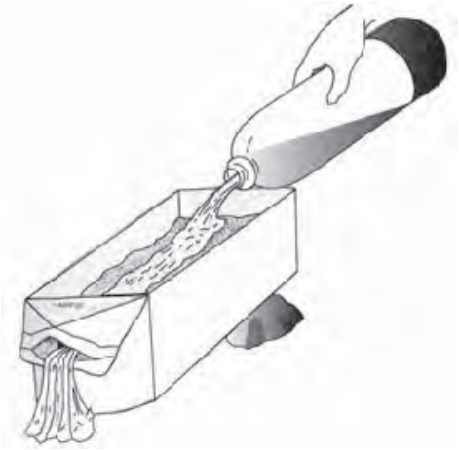
Goals:
Students will describe the canyon-carving ability of water and ice after observing a scale model demonstrating each.

Standards:

K-4th Grade:
SC.4.1.4 Properties of Earth Materials: Students investigate water, air, rocks, and soils to compare basic properties of earth materials.

5th-8th Grade:
SC.8.1.8 The Structure of the Earth System: Students examine the structure of the Earth, identifying layers of the Earth, considering plate movement and its effect, and recognizing landforms resulting from constructive and destructive forces.

SC.8.1.9 The Earth's History: Students systematize the Earth's history in terms of geologic evidence, comparing past and present Earth processes and identifying catastrophic events and fossil evidence.



Lesson Overview:
Students will demonstrate the process of *erosion* (transportation of sediment by water or wearing away of earth's surface by forces of water, glaciers, winds, or waves) using a milk carton and plastic bottle.

Goal
Students will learn the basics of *erosional* processes and how they create a landscape of river canyons such as the Grand Canyon.

Materials
- 1.9-L milk carton
- 2.0-L (water) bottle
- sediment (sand or potting soil)
- ruler
- scissors
- source of water
- garden trowel

Canyon Carver I continued ...

Vocabulary:

Sediment, glacier, erosion, weathering

Background

Students often know that rivers such as the *Colorado River* can be muddy. But they may not know that some of the sediment (sand, silt, and clay) that makes the river muddy comes from the riverbed itself and is a result of the river's cutting or carving action. The canyon, and all of the formations within it, resulted directly from weathering and erosion in various forms. The Grand Canyon is one of the world's greatest examples of arid land erosion through layers of stratified rock.

Procedure

Preparation:

1. Use scissors to cut out the side panel of the empty milk carton under the spout, leaving the spout intact.
2. (You may wish to continue this activity outside; don't forget all the necessary materials.) Lay the carton on its side with the cut out panel facing up. Fill the container about half full with the sediment, and smooth the surface.

Demonstration:

3. To simulate the gravitational change of a flowing river, set one end of the carton approximately 1-cm higher than the other end, using something to prop it up such as a rock or piece of bark. Be sure the lower end of the carton is the one with the spout.
4. Ask students to make predictions about what might happen when water is added. Place the mouth of the bottle containing water on the higher end and slowly pour the water out. The water should flow steadily down and out the spout end. Remember, the water flow will be directly affected by your sediment choice and degree of its saturation.
5. Continue repeating steps 2-4, but raise the elevated end a cm or two at a time. What happens as the elevated end gets higher, or the grade of the river becomes steeper? Why? (The water or river is flowing faster as grade increases.) Discuss the various depths and formations created.
6. At each stage of the experiment, ask students to draw what occurs.

Before adding water	At 1 cm elevation	At 2 cm elevation

Canyon Carver II

Activity to be completed: before trip to Sinks Canyon State Park

Essential Question:

How are glacial canyons formed?

Goal:

Students will learn the basics of *erosional* processes and how they form the landscape of glacial canyons, such as Sinks Canyon.

Standards:

K-4th Grade:

SC.4.1.4 Properties of Earth Materials: Students investigate water, air, rocks, and soils to compare basic properties of earth materials.

5th-8th Grade:

SC.8.1.8 The Structure of the Earth System: Students examine the structure of the Earth, identifying layers of the Earth, considering plate movement and its effect, and recognizing landforms resulting from constructive and destructive forces.

SC.8.1.9 The Earth's History: Students systematize the Earth's history in terms of geologic evidence, comparing past and present Earth processes and identifying catastrophic events and fossil evidence.

Materials

- long (at least 24 inches) plastic container at least 6 inches deep.
- 2.0-L bottle containing water
- sediment (sand with small gravel)
- freezer
- scissors
- source of water
- garden trowel

Vocabulary:

Sediment, erosion, lateral moraine, terminal moraine, glacier

Procedure:

Preparation

1. Before students arrive, fill and freeze 2-liter plastic container half full of water, lying horizontally. Leave frozen until just before students arrive, then cut away plastic container.
2. Fill long, plastic container with sand gravel mix. Elevate one end.

Demonstration:

3. Ask students to make predictions about what might happen when ice block is added and as it melts. Place ice block on elevated end of container with sand/ gravel mix. Let gravity slide the ice block downhill, simulating a glacier as it inches downhill. Lateral and terminal moraines

Canyon Carver II continued ...

should be created as the ice moves through the sand/gravel mix. It's best if a hole is drilled in the lower end of the plastic container of sand and gravel so that melted ice can drain out. Throughout the day, students should check on the progress of the glacier as it melts. What effect does the glacier have on the "land surface?"

4. Ask students to draw what occurs and label lateral and terminal moraines.
5. Ask students to write a paragraph explaining the difference between what happened with the water and ice experiments and similarities (and differences) to how rivers and glaciers erode canyons.

Canyon-Carving Force: River

Activity to be completed: before trip to Sinks Canyon State Park

Essential Question:
What forces have formed the Grand Canyon?

Goals:
Students will describe how canyons can be formed by rivers, using the Grand Canyon as an example.

Standards:

K-4th Grade Science:
SC.4.1.4 Properties of Earth Materials: Students investigate water, air, rocks, and soils to compare basic properties of earth materials.

5th-8th Grade Science:
SC.8.1.8 The Structure of the Earth System: Students examine the structure of the Earth, identifying layers of the Earth, considering plate movement and its effect, and recognizing landforms resulting from constructive and destructive forces.

SC.8.1.9 The Earth's History: Students systematize the Earth's history in terms of geologic evidence, comparing past and present Earth processes and identifying catastrophic events and fossil evidence.

Materials:
Computers with Internet access, Canyon-carving Force: River worksheet, students' removable storage device to store all work and bookmarks.

Vocabulary:
Erosion, geology, sedimentary, igneous, metamorphic, land forms

Website:
http://www.kaibab.org/geology/gc_geol.htm

Procedure:
1. Students will complete the previous knowledge section of the Canyon-carving Force: River worksheet independently.
2. Working in pairs, students log-on and go to www.kaibab.org/geology/gc-geol.htm, and cooperatively complete the Canyon-carving Force: River worksheet with information from the website. Each student is responsible for recording his/her own notes and answers and each student should take a turn navigating the web-site.

Evaluation:
The worksheet will include a student self-assessment. Information gathered from this field trip can be included on a Geology Unit test.

River-formed Canyon continued ...

Students may give a short five minute presentation demonstrating what they have learned. Casual observation by the instructor will determine whether the students are on task.

Follow-up Activity:

Students may make a PowerPoint or other type of media presentation on the topic or related topics and present it to the class. Some students may wish to go to the Sinks Canyon and make a photographic or video account of their expedition then, compare their photos to what they learned about the Grand Canyon from their web investigation.

Canyon-Carving Force: River

Worksheet for virtual field trip- www.kaibab.org/geology/gc_geol.htm

What do you already know about how the Grand Canyon was formed?

_____

_____

_____

1. What was the primary force that created the Grand Canyon?_____
2. Is the soil in the Grand Canyon (A) moisture rich and absorbs water easily OR (B) dry, hard, and does not hold water well? Choose A or B.
3. Fill in the blanks: Water seeps into cracks in rocks, _____, expands,

   _____the_____ _____ and eventually the rocks fall off the edge of the rim.
4. What has constrained (limited) the erosive activity of the Colorado

   River?_____
5. Before the Colorado River was dammed, it moved (A) quicker OR (B) more slowly. Choose A or B.
6. The Earth's crust is formed by _____ which float on molten (liquid) rock.
7. Since these _____ are moving, they collide into one another. What

   happens when they collide?_____
8. What happens when plates buckle?
9. Why do so many sedimentary rock layers exist in the Grand Canyon?_____

---

10. The Grand Canyon is made-up of many layers of rock. Each time the _____ moved in, sediment was deposited and formed a new layer which then became rock.

Investigate the Rocks of Sinks Canyon State Park

Activity to be completed: during trip to Sinks Canyon State Park with State Parks Staff

Essential Question:
What rocks are found at Sinks Canyon State Park?

Goals:
Students will identify and classify rocks found in Sinks Canyon State Park.

Standards:

K-4th Grade:
Properties of Earth Materials: Students investigate water, air, rocks, and soils to compare basic properties of earth materials.

5th-8th Grade:
The Structure of the Earth System: Students examine the structure of the Earth, identifying layers of the Earth, considering plate movement and its effect, and recognizing landforms resulting from constructive and destructive forces.

The Earth's History: Students systematize the Earth's history in terms of geologic evidence, comparing past and present Earth processes and identifying catastrophic events and fossil evidence.

Materials:
Student journals, pencils, photos of examples of different rock types (available from the visitors' center)

Vocabulary:
Geology, rock cycle, igneous, sedimentary, metamorphic

Activity Procedure:
1. Drive to the Sinks Canyon State Park Visitors' Center where you may choose to meet a staff member.
2. Students observe examples of the rocks located in front of the Visitors' Center, noting the characteristics of each rock.
3. Students compare photos with the actual rock and read the description on each corresponding card.
4. Students then visit various locations in the park to find as many of these examples of rock as possible.
5. If students have cameras, take photos of each example of rock to create a PowerPoint presentation or similar project to display their collection of rock images.

Investigate the Rocks of Sinks Canyon

Name and describe the different types of rocks outside of the Sinks Canyon State Park Visitors' Center and those that you found on a hike at Sinks Canyon.

Geology of Sinks Canyon

Activity to be completed: during trip to Sinks Canyon State Park with State Park Staff

Essential Question:

What makes the geology of Sinks Canyon unique?

Goals:

Students will identify the geological forces that created the canyon.
Students will identify the unique features of the canyon.

Standards:

K-4th Grade:

Properties of Earth Materials: Students investigate water, air, rocks, and soils to compare basic properties of earth materials.

5th-8th Grade:

The Structure of the Earth System: Students examine the structure of the Earth, identifying layers of the Earth, considering plate movement and its effect, and recognizing landforms resulting from constructive and destructive forces.

The Earth's History: Students systematize the Earth's history in terms of geologic evidence, comparing past and present Earth processes and identifying catastrophic events and fossil evidence.

Materials:

Student journals, pencils.
Optional: camera to take photos of geologic features.

Vocabulary:

Glacier, sedimentary, igneous, metamorphic, glacial moraine, sinks, rise, limestone, feldspar, quartz, hornblende, intrusive, extrusive, minerals, Ten Sleep sandstone, Laramide Uplift, desert varnish, cirque, Madison limestone.

Activity Procedure #1:

1. Drive to the Sinks Canyon State Park Visitors' Center where you may meet a SCSP staff member (please arrange for this prior to your field trip.)
2. Staff will share the geological history of Sinks Canyon.
3. The group will walk to the Sinks and Rise.
4. Students take notes and draw the features they observed.

Activity Procedure #2:

1. Hike the Nature Trail (accessible from the Popo Agie Campground) to an elevated area where a cross-section of the canyon is visible.
2. In their student journals, students draw the cross-section and describe its shape.

Geology of Sinks Canyon continued ...

3. On their drawings, students label geological features, for example glacial moraine, glacier erratic, etc.
4. Students describe how the canyon was formed based on the shape of their drawings.

Writing Activities:

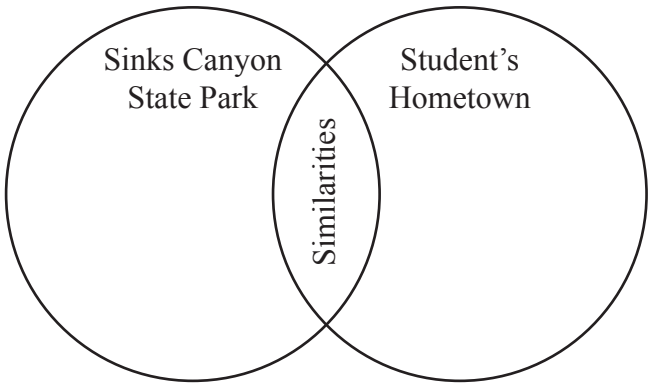
1. (Before visit) Students write a prediction of how the canyon was formed and what unique features they may discover on the field trip.
2. (During) Students will write notes as the Sinks Canyon State Park staff member discusses geologic features in the canyon.
3. (After) Students write a reflection and include three new things they learned on the field trip.

Assessment:

1. Students write a reflection about what they learned.
2. Geology I Have activity (located after the Geology of Sinks Canyon II activity) can be used as a review and assessment.

Extension of activity:

1. Ask the students to compare the geology of where they live to that of Sinks Canyon State Park by completing a Venn diagram.



Geology of Sinks Canyon

Record three new ideas you learned about The Sinks.

_____

_____

_____

Draw The Sinks.

Record Three new ideas you learned about The Rise.

_____

_____

_____

Draw The Rise.

Geology of Sinks Canyon continued

From a high-point on The Nature Trail, draw the canyon, describe its shape, and describe how the canyon was formed.

_____

_____

_____

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_____

_____

_____

Geology of Sinks Canyon II

Activity to be completed: after trip to Sinks Canyon State Park

Essential Question:

What makes the geology of Sinks Canyon unique?

Goals:

Students will identify the geological forces that created the canyon.
Students will identify the unique features of the canyon.

Standards:

K-4th Grade:

Properties of Earth Materials:Students investigate water, air, rocks, and soils to compare basic properties of earth materials.

5th-8th Grade:

The Structure of the Earth System: Students examine the structure of the Earth, identifying layers of the Earth, considering plate movement and its effect, and recognizing landforms resulting from constructive and destructive forces.

The Earth's History: Students systematize the Earth's history in terms of geologic evidence, comparing past and present Earth processes and identifying catastrophic events and fossil evidence.

Materials:

Student journals, pencils, Geology "I Have" cards
Optional: camera to take photos of geologic features.

Vocabulary:

Glacier, sedimentary, igneous, metamorphic, glacial moraine, sinks, rise, limestone, feldspar, quartz, hornblende, intrusive, extrusive, minerals, Ten Sleep sandstone, Laramide Uplift, desert varnish, cirque, Madison limestone.

Activity Procedure (may be done on the return trip or after returning to school):

1. Use the "Geology 'I Have'" cards master to create a set of cards to distribute to students.
2. Distribute the cards to students
3. Students proceed through the questions until all are answered correctly. Ask any student to begin with his/her question. When the student with the card containing the correct answer to that question answers, he/she then asks the question on his/her card and so on until all students have asked a question.

Geology of Sinks Canyon II continued ...

Writing Activities:

1. Students write a prediction of how the area where they live was formed.
2. Students will write notes as they research the geology of their home area
3. Students write a reflection, create a poster or multi-media presentation comparing both geologic locations- Sinks Canyon and their home.

Assessment:

1. Student reflection about what they learned can be used as an assessment tool.

Extension of activity:

1. Have the students compare the geology of where they live to Sinks Canyon State Park by completing a Venn diagram.
2. Ask a local geologist to come and talk to the class about local landforms and geology.

“I Have” Cards

I have glacier. What type of rocks form the “Sinks”?	I have the rock cycle. How many years ago was the most recent glacier present in Sinks Canyon?
I have sedimentary rock: limestone. What forms a v-shaped valley?	I have 10,000 years ago. About how many years ago were the Rocky Mountains formed?
I have river. What are the three types of rock?	I have 135,000,000 years ago. The upper-most cliffs of Sinks Canyon are made from what kind of rock?
I have igneous, metamorphic, and sedimentary. What are the common minerals that form granite?	I have Ten Sleep sandstone. What is the name of the major geological event that created the Rocky Mountains?
I have mica feldspar, quartz, and hornblende. What are the deposits left behind after glaciers retreated?	I have the Laramide Uplift. What is a geological uplift?

“I Have” Cards

I have moraines. What is the type of igneous rock that cools beneath the surface of the Earth?	I have upward movement of the Earth’s crust. What is a force that shaped Sinks Canyon?
I have intrusive igneous rock. What are particles that make up rocks called?	I have the ice age or glaciers. What is the name of large granite boulders carried from higher locations in the mountains by glaciers and deposited on lower surfaces of a different material?
I have minerals. What is the type of igneous rock that cools on the surface of the Earth?	I have glacial erratics. What caused the red and black streaking on the high Ten Sleep sandstone cliff faces?
I have extrusive igneous rock. What is the process during which rock can change from one form to another?	I have oxides of iron and magnesium called “desert varnish.” What are steep-walled bowls at the head of glacial valleys?
I have Madison Limestone. What caused the u-shaped valley to form?	I have cirques? What geological formation are the “Sinks” and “Rise” located?

Habitats and Ecosystems
Table of Contents

What Do You Already Know?

Activity to be completed: before trip to Sinks Canyon State Park

Essential Question:

What are some food chains and food webs found at Sinks Canyon State Park?

Standards: Standards could vary according to topic chosen by teacher.

K-4th Grade Science:

SC4.1.3 Organisms and Their Environments: Students show connections between living things, their basic needs, and the environments.

5th-8th Grade Science:

SC8.1.6 Interrelationships of Populations and Ecosystems: Students illustrate populations of organisms and their interconnection within an ecosystem, identifying relationships among producers, consumers, and decomposers.

Activity Procedure:

Students create a Know-Wonder-Learn Chart before viewing the Sinks Canyon State Park website video. Students can write what they know about Sinks Canyon State Park. After discussion, have students write questions or items they wonder about the canyon and the park. View the video and see how many of the students' "I wonders" were discovered from the video. These discoveries can be added to the Learn section of the students' charts. Students can continue to add new ideas and facts, especially after they have visited Sinks Canyon State Park.

Materials:

Pencil, Know-Wonder-Learn chart worksheet

Website:

www.sinkscanyonstatepark.org

Vocabulary:

Producer, consumer, decomposer, carnivore, herbivore, energy pyramid, predator, prey

LEARN	
WONDER	
KNOW	

What's Here?

Activity to be completed: before visit to Sinks Canyon State Park

Essential Question:
How is my school yard different and similar to Sinks Canyon State Park?

Goal
Students use sight and hearing to make observations.

Standards:

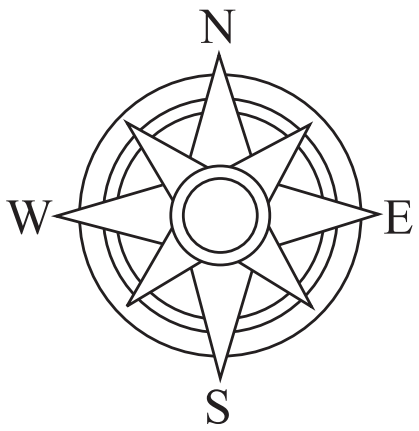
K-4th Grade:
SC4.1.3 Organisms and Their Environments: Students show connections between living things, their basic needs, and the environments.

SC4.2.2 Students use the inquiry process to conduct simple scientific investigations.
- Collect and organize data.
- Use data to construct simple graphs, charts, diagrams, and/or models.
- Draw conclusions and accurately communicate results, making connections to daily life.
- Pose or identify questions and make predictions.
- Conduct investigations to answer questions and check predictions.

5th-8th Grade:
SC8.1.6 Interrelationships of Populations and Ecosystems: Students illustrate populations of organisms and their interconnection within an ecosystem, identifying relationships among producers, consumers, and decomposers.

Vocabulary:
observe, human-made, nature-made or natural

Activity Procedure:
There are several activities that you can use to compare your school yard environment to Sinks Canyon State Park.



1. Ask students to create a sound map by sitting apart from one another and drawing a compass rose on their paper. Students sit quietly and either draw or list the sounds they hear on the compass rose, corresponding to the direction from which they heard the sound. Ask students to indicate if the sound was human-made or nature-made.

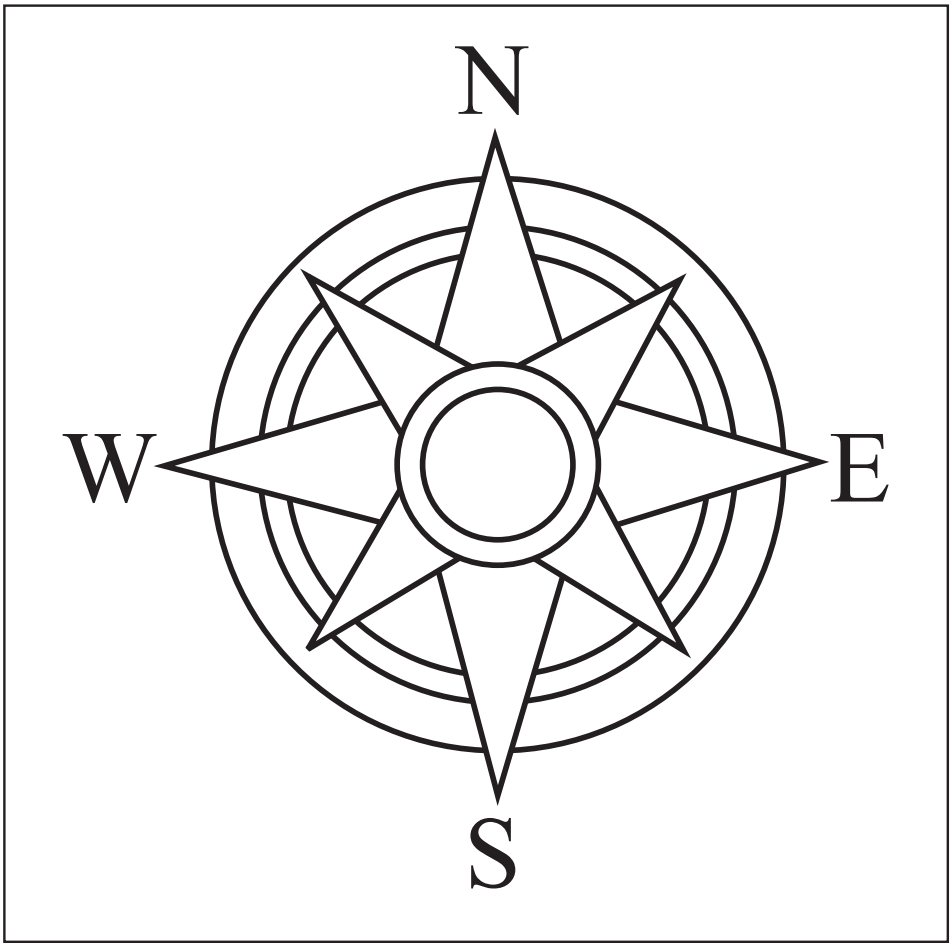
   When you first arrive at Sinks Canyon State Park, create another sound map and ask students to classify the sounds as

School Yard Observation continued ...

human-made or nature-made. Compare the human-made and nature-made sounds from the two locations.

2. Do an ABC Observation Walk around your school yard and have students find as many observations of nature and human-made items for each letter of the alphabet. Students can use the ABC list worksheet to record their observations. Do the same activity at Sinks Canyon State Park. Classify which items are created by humans or nature. With older students, add a descriptive adjective beginning with the same letter to each item.

3. Tape-down a large sheet of white paper outside the night before you leave school and in the morning check to see if any critters happen to walk across the paper and what sign those critters left behind. Or, find home habitats around the school yard like webs and nests in trees. Other examples to look for are the four components of habitat: food, water shelter, and space.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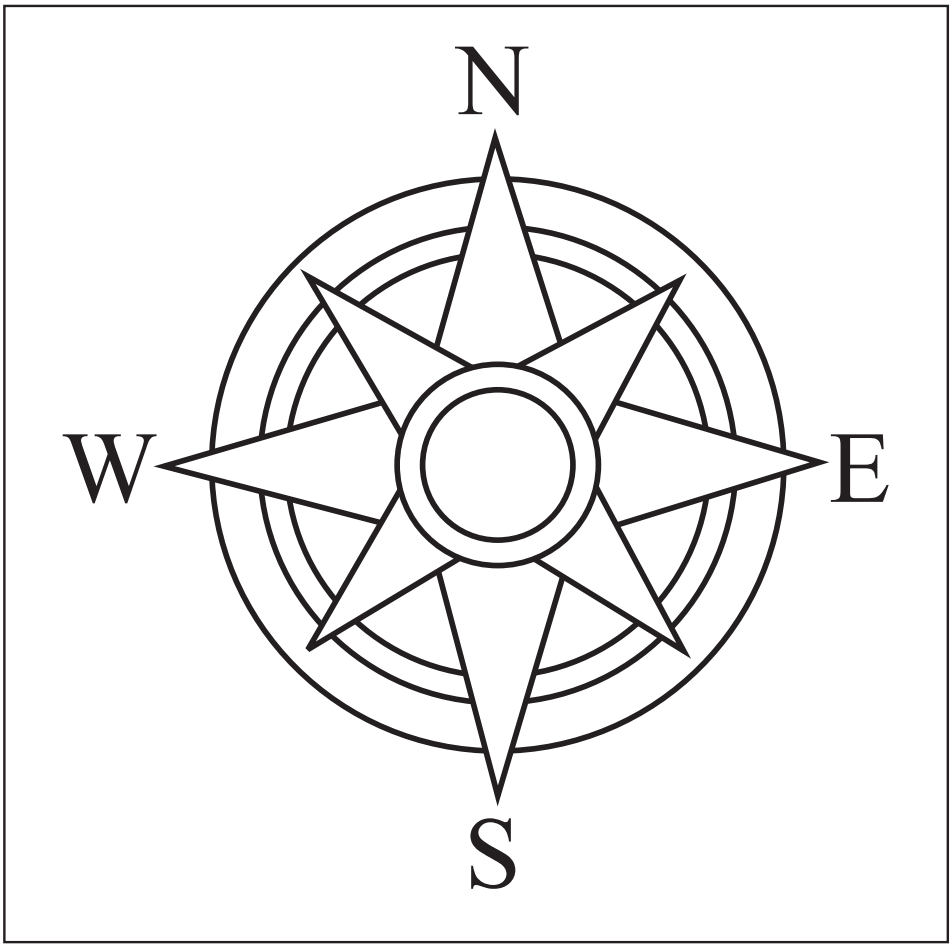
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Name_____

Observation Walk

A _____

B _____

C _____

D _____

E _____

F _____

G _____

H _____

I _____

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L _____

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8 _____

9 _____

10 _____

Watch Where You're Hiking!

Activity to be completed: during trip to Sinks Canyon State Park

Essential Question:
How can we identify the components of a habitat or ecosystem?

Goals:
Identify signs of food, water, shelter, and space while hiking at Sinks Canyon State Park

Standards:

K-4th Grade Science:
SC4.1.3 Organisms and Their Environments: Students show connections between living things, their basic needs, and the environments.

5th-8th Grade Science:
SC8.1.6 Interrelationships of Populations and Ecosystems: Students illustrate populations of organisms and their interconnection within an ecosystem, identifying relationships among producers, consumers, and decomposers.

Materials:
ABC Observation Walk worksheet, Animal Signs Worksheet, pencil, tracks and scat field guides available from the Sinks Canyon State Park Visitors' Center on-loan.

Vocabulary:
producer, consumer, decomposer, herbivore, carnivore, energy pyramid, predator, prey, adapt, ecosystem, habitat, space, riparian, conifer, sagebrush

Activity Procedure:
Drive to the Popo Agie Campground to access the Nature Trail. Before setting out on the trail, ask students to identify four elements that plants and animals need for survival.

Walk along the Nature Trail and look for signs of food, water, shelter, and space available for producers, consumers and decomposers in Sinks Canyon State Park. Use all five senses to find as many items (observations) as possible to fill in the ABC Observation Walk worksheet. Also, ask students to complete the Animal Signs worksheet

Extension of activity:
Identify and label: producer, consumer, decomposer next to each item on the ABC Observation Walk worksheet.
Draw a food web including producer, consumer, decomposer found while at Sinks Canyon State Park.
Create a new animal and explain why you think it could live in this environment. Be sure to use terms learned during this activity.

Assessment:
Write a paragraph reflection to answer, "How can we identify the components of a habitat or ecosystem?"

Name_____

Observation Walk

A _____

B _____

C _____

D _____

E _____

F _____

G _____

H _____

I _____

J _____

K _____

L _____

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W _____

X _____

Y _____

Z _____

1 _____

2 _____

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4 _____

5 _____

6 _____

7 _____

8 _____

9 _____

10 _____

Animal Signs Worksheet

Find and draw three signs of animals. Label each drawing by indicating the animal that left it.

Find and draw three different animal scats. Use the Scats and Tracks of the Rocky Mountains guide to identify the scats' creator and label each drawing with the animal's name.

Find and draw three animal tracks. Use the Scats and Tracks of the Rocky Mountains guide to identify the track's creator and label each drawing with the animal's name.

Habitats Scavenger Hunt

Activity to be completed: during trip to Sinks Canyon State Park with State Park Staff

Essential Question:

What are the components of a habitat found at Sinks Canyon State Park?

Goal

Students observe and identify habitat components and the interrelationships found in ecosystems.

Standards:

K-4th Grade Science:

SC4.1.3 Organisms and Their Environments: Students show connections between living things, their basic needs, and the environments.

5th-8th Grade Science:

SC8.1.6 Interrelationships of Populations and Ecosystems: Students illustrate populations of organisms and their interconnection within an ecosystem, identifying relationships among producers, consumers, and decomposers.

Materials:

Scavenger Hunt Worksheet, pencil, I Have Who Has Habitat cards

Vocabulary:

producer, consumer, decomposer, carnivore, herbivore, energy pyramid, predator, prey

Activity Procedure:

1. On the Nature Trail or around the Visitor Center, look for signs of plants, animals and decomposers living at Sinks Canyon State Park and draw representations of each on Scavenger Hunt worksheet.

2. After students have filled in their Scavenger Hunt worksheet, ask them to choose one item from their list and stand next to someone that has chosen an item that relates to their own item. For example, an insect relies on animal scat for necessary minerals or, a producer (plant) relies upon something from the sky (sun) to produce chlorophyll or, a plant shorter than three inches might grow on a rock and would be decomposing the rock. Make a circle and discuss how components of a habitat rely on each other for survival.

3. As a review of concepts, play the I Have Who Has Habitat game. Use the I Have Who Has Habitat card master to create a set of cards to distribute to the students.

4. Distribute the cards to the students. Ask a student to begin with his/her question. When the student with the card containing the correct answer to that question answers, he/she then asks the question on his/her card and so on until all students have asked a question.

Scavenger Hunt - Draw and Label Observation

Something Growing on a Rock	**Animal Home**	**Deciduous Tree**	**Scavenger**
Animal Scat	**Animal Track**	**Sign of Animal**	**Producer**
Evergreen Plant	**Something that needs water**	**Decomposer**	**Predator/Prey**
Plant with berries	**Something From the Sky**	**Sagebrush**	**Pine Cone**
A Smooth Rock	**Clouds or Sun**	**Insect**	**Plant Shorter than Three Inches**

I Have, Who Has Habitat Cards

I have an animal that hunts, kills, or eats other animals. Who has the definition of **producer**?	I have a plant that uses photosynthesis to make its own food. Who has the definition of a **consumer**?	I have an organism that eats other organisms for survival. Who has the definition of **decomposer**?	I have organisms that decay dead plants and animals. Who has the definition of a **food chain**?
I have the transfer of food energy from plants through a variety of animals. Who has the definition of **food web**?	I have the complex and interlocking of food chains. Who has the definition of a **riparian area**?	I have land areas adjacent to aquatic habitats. Who has the definition of **montane habitat**?	I have mountain (conifer-evergreen) forest. Who has the definition of **upper grassland**?
I have a habitat with grasses, forbs and shrubs. Who has the definition of an **herbivore**?	I have an animal that eats only plants. Who has the definition of **carnivore**?	I have an animal that eats only meat. Who has the definition of **omnivore**?	I have an animal that eats both plants and animals. Who has the definition of **habitat**?
I have an area that has food, water, shelter, and space for a species. Who has the definition of **biotic**?	I have a living factor within an ecosystem. Who has the definition of **adaptation**?	I have the process by which plants and animals change to survive in their environment. Who has the definition of **abiotic**?	I have the non-living factors in an ecosystem such as sun and water. Who has the definition of **ecosystem**?
I have a system of living organisms and their interactions with the environment. Who has the definition of **biodiversity**?	I have the variety and abundance of living organisms in an environment. Who has the definition of **organism**?	I have any living thing. Who has the definition of **wetlands**?	I have areas that are usually covered with standing water. Who has the definition of **predator**?

Unique with Similarities

Activity to be completed: after field trip to Sinks Canyon State Park

Essential Question:
How is my school yard similar to and different from Sinks Canyon State Park?

Goals:
Identify similarities and differences between the school yard and Sinks Canyon State Park

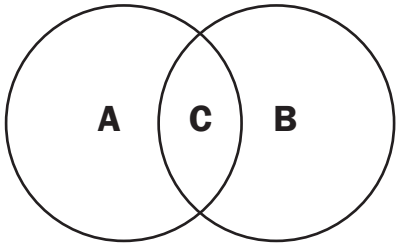
Standards:

K-4th Grade Science:
SC4.1.3 Organisms and Their Environments: Students show connections between living things, their basic needs, and the environments.

5th-8th Grade Science:
SC8.1.6 Interrelationships of Populations and Ecosystems: Students illustrate populations of organisms and their interconnection within an ecosystem, identifying relationships among producers, consumers, and decomposers.

Materials:
Notes from field trip, Know-Wonder-Learn-Compare & Contrast worksheet

Activity Procedure:
1. Review vocabulary from "Scavenger Hunt Habitats" activity.
2. With students working in groups or individually, ask them to create Venn Diagrams identifying similarities and differences between Sinks Canyon State Park and the school yard habitat. Encourage students to first complete the "Know, Wonder, Learn, Compare, Contrast" worksheet to organize their ideas and concepts. Then, ask students to draw two circles which overlap in the middle. One circle represents Sinks Canyon State Park and the other circle represents the school yard habitat. Where the circles overlap, ask students to list those things that both sites have in common. Where the circles do not overlap, students should list the things that are unique to each individual site.



Assessment:
Completeness and accuracy of Venn diagrams.

Extension:
Introduce a third location such as a local park or city natural area.

Complete the What Do You Already Know" activity first. Use the compare and contrast for post trip discussion with class after your field trip.

KNOW	WONDER	LEARN	COMPARE	CONTRAST

People of the Canyon
Table of Contents

A Historical Time-line of Sinks Canyon

Activity to be completed: before trip to Sinks Canyon State Park

Essential Question:

How has Sinks Canyon been used over time?

Goal:

Students will identify the groups of people who have used the canyon.
Students will create a time-line depicting the years and groups of people who have used the canyon.

Standards:

K-4th Grade Social Studies:

SS4.3.2 Students describe different ways that people earn a living in the local community and in Wyoming.

SS4.4.3 Students describe the chronology of exploration, immigration and settlement of Wyoming.

SS4.5.4 Students describe relationships among people and places, and the environmental context in which they take place.

5th-8th Grade Social Studies:

SS8.2.2 Students describe cultural diversity and the interdependence of cultures.

SS8.3.1 Students communicate how economic considerations influence personal, local, state, national, and international decision-making.

SS8.4.1 Students identify people, events, problems, conflicts, and ideas and explain their historical significance.

SS8.4.3 Students analyze the impact of historical events and people on present conditions, situations, or circumstances.

SS8.5.2 Students apply the themes of geography to topics being studied.

Materials:

Primary Source Analysis Worksheets:
1. Written Document Analysis Worksheet,
2. Photograph Analysis Worksheet, pencils, newspaper articles, large sheets of paper for constructing timelines.

Vocabulary:

NOLS, quarry, immigration, Civilian Conservation Corp (CCC)

Activity Procedure:

1. Students will use the Primary Source Analysis Worksheets to identify the groups of people who have visited Sinks Canyon and how it has been used throughout history, gathering information from photos, newspaper articles, and other primary sources

A Historical Time-line of Sinks Canyon continued ...

2. Students share the information they learn from reading the primary sources.
3. Students create a timeline showing who has used the canyon, how it was used, and when each event occurred.
4. Compare the history of Sinks Canyon to events in your area or in the nation at the same time.

Writing:

Students will write a summary of the information from the primary sources.

Assessment:

- Students will present what they learned from assessing the primary source documents.
- Students will create a timeline of the historical uses of Sinks Canyon.
- Students will compare the history of Sinks Canyon to where they live.

Written Document Analysis Worksheet

1. TYPE OF DOCUMENT (Check one):

☐ Newspaper	☐ Map	☐ Advertisement
☐ Letter	☐ Telegram	☐ Congressional Record
☐ Patent	☐ Press Release	☐ Census Report
☐ Memorandum	☐ Report	☐ Other

2. UNIQUE PHYSICAL CHARACTERISTICS OF THE DOCUMENT (Check one or more):

☐ Interesting Letterhead	☐ Notations
☐ Handwritten	☐ "RECEIVED" stamp
☐ Typed	☐ Other
☐ Seals	

3. DATE(S) OF DOCUMENT:

4. AUTHOR (OR CREATOR) OF THE DOCUMENT:

   POSITION (TITLE):

5. FOR WHAT AUDIENCE WAS THE DOCUMENT WRITTEN?

6. DOCUMENT INFORMATION (There are many possible ways to answer A-E.)

   A. List three things the author said that you think are important:

   B. Why do you think this document was written?

   C. What evidence in the document helps you know why it was written? Quote from the document.

   D. List two things the document tells you about life in the United States at the time it was written.

   E. Write a question to the author that is left unanswered by the document:

Photo Analysis Worksheet

Step 1. Observation

A. Study the photograph for 2 minutes. Form an overall impression of the photograph and then examine individual items. Next, divide the photo into quadrants and study each section to see what new details become visible.

B. Use the chart below to list people, objects, and activities in the photograph.

People	Objects	Activities

Step 2. Inference

Based on what you have observed above, list three things you might infer from this photograph.

Step 3. Questions

A. What questions does this photograph raise in your mind?

B. Where could you find answers to them?

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SAWMILLS

The first sawmill was located on Mill Creek in 1868, by Charles Decker, three sawmills were installed in 1869 on Slate Creek, Willow Creek, and Rock Creek respectively. These mills furnished the lumber for the building in South Pass, Atlantic City, Miners Delight, Lewiston and Fort Stambaugh. In 1885 Emil Granier installed the sawmill ahead of Rock Creek, with which he cut all the lumber ~~needed~~ used for the flumes and buildings on the Granier ditch.

In 1876 Samuel Fairfield constructed a sawmill on Big Popo Agie (Middle Fork) on what is now called the Fair field hill. Another sawmill was located on North Fork in 1880 by A. T. Wilson. These two mills supplied Lander, North Fork and Fort Washakie.

The sawmills on Baldwin Creek, Squaw Creek, Sawmill Creek and Dickinson Park are of a later date.

The first sawmill on Upper Wind River was installed by the Gold Mining Co. in 1895 at the Clarks Mines. This was a whipsaw and was worked until 1898.

In 1898, Olney Green established a sawmill at Sheridan Creek driven by water power.

Asa Stringer constructed the first steam driven mill at Little Warm Spring in 1910 and worked it about 5 years. In 1911, C. E. Shippen started a sawmill in Lime Kiln Draw, this was later moved to Horse Creek.

Electricity came to Lander early

Photo credit American Heritage Center, Laramie

This was Lander, probably in the spring of 1889, or possibly the fall. By the summer of 1890, an addition to the east side of the mill had been built to accommodate steam boilers. The addition does not appear in this photo.

Little did the pioneer residents of Lander know that when the flour mill was built at the east end of Main Street, it would soon lead to electric power. The focus was really on flour and the cost of hauling it from a railhead 150 miles away. The energy it took to grind and mill the flour was a secondary consideration, and it was far from anyone's mind that that energy could be put to other uses.

Following a few difficulties in getting the ditch right-of-way, the builders had the flume in place. It wasn't the most satisfactory power source but water did turn the mill stones. Then came the cold weather, the months of winter, and the water froze. It was most inconvenient; the water turned to ice in the flume.

Given the cosmopolitan background of Eugene Amoretti and the resourcefulness of J. D. Woodruff, both of whom were involved in the flour mill, it wasn't long before they realized there had to be a better way. They turned to steam power. Coal was readily available from the mines near present-day Hudson and was already being hauled into Lander for heating. Later, it seemed even more feasible to haul oil in from Dallas and burn it.

By September 26, 1890, *The Fremont Clipper* noted that the whistle at the mill could be heard in the morning air. It was noted that the mill was using oil for fuel on October 24, but by December 5, the paper said the mill had gone back to coal.

A column written by a Miles Cannon in 1892 said, "We visited a flour mill that stood on the bank of the creek in Lander to see what was mentioned as a curiosity - burning oil to make steam, instead of wood or coal. Every few days a wagon rigged with a tank and drawn by four mules would come into the mill with a load of crude oil from some springs out in the hills. No particular value was attached to the oil at that time and thousands of acres of what was to become the richest oil-bearing land in the state could then have been bought for a song. Grass, land and the ever-prevailing feud between the sheep and cattle men contained the only thrill in those days."

The *Clipper* noted on May 5, 1893, that, "The flour mill started up Monday and the old familiar sound of the steam whistle is again heard mornings and evenings."

Electricity was probably shared with the townspeople in late 1892 or early 1893. *The Fremont Clipper*, December 29, 1893, said that Lander had an "electric light plant." A 1933 *Wyoming State Journal* photo caption under a photo of the early light plant said Lander was one of the first towns in Wyoming to have electric lights. This was of some note because Thomas Edison's first electric light plant had only begun operation in New York City in 1884.

Ace Wilson's sawmill in 1883, located just downstream of today's Popo Agie campground.

April 25, 1919

RIVER TO FURNISH POWER FOR LANDER

Long Cherished Dream to be Realized by Lander People This Year ==Work Will Start Soon

PROPOSITION IS FINANCED LOCALLY

This is to be Purely a Lander Enterprise, All the Capital Being Furnished by Local People

E. D. Edwards and C. O. Beardsley have worked out and financed a plan to harness the waters of the Big Popo Agie in the canon near the Sinks to furnish light and power to Lander and the surrounding country. Estimates and plans have been prepared and submitted and bids have already been received for most of the work and supplies needed.

All of the capital necessary has already been subscribed by local people and the Lander Electric Light & Power Company is ready to contract for current sufficient to supply the town as soon as the plant and transmission lines can be completed which will probably be about September 1st this year.

The complete plant which will be built upon the unit plan will cost about $100,000 and the contract with the local lighting company will pay a fair rate of interest upon this sum. As the town grows, the power plant can be added to to supply the increased demand.

The local company is to be congratulated upon securing the most logical site for the economical development of all the power that will be needed here for years to come and upon its entrprise in developing a plan that has been dreamed of for many years.

Photo courtesy Frank Meredith - Pioneer Museum

This 1920 photo shows E. D. Edwards standing on the newly constructed dam across Middle Fork of the Popo Agie River above The Sinks. The dam was built to divert water from the river to the powerplant located at The Rise of the Sinks. The pipeline seen at lower left corner carried the water one-half mile down to the penstocks and the turbines which turned the generators. The dam is still visible although slowly deteriorating; the buildings of the powerplant are still at The Rise. All of the installation is now in Sinks Canyon State Park.

Sinks Canyon Power House, 1925

1933

TWO HUNDRED RELIEF WORKERS WILL ARRIVE FRIDAY MORNING

First Camp Popo Agie Will Be Engineered Thursday in Readiness for First Contingent of Forest Workers

Two hundred unemployed men of the great army of millions being mobilized over the nation will arrive in Lander Friday morning at five o'clock by special train of three baggage and five pullman cars to be transported to the site of Camp Popo Agie (F9 Wyo.) near the Middle Fork ranger station eleven miles south of Lander. Twenty-one local men selected for their special abilities along the lines of leadership in camp life and out-of-doors work will mobilize at the same time and be ready to receive their orders from the army officers.

Tomorrow the contingent of army officers from Ft. Francis E. Warren, Cheyenne, will arrive to lay out the camp and have the preliminary arrangements ready for receiving the men from the south.

In the baggage cars will be the tents, cooking equipment, bedding, clothing and other supplies. Rations will be purchased locally.

It will be an interesting sight to see these men unload under the direction of army officers, take up the work of loading the equipment and getting to the camp perhaps in time for breakfast.

It is hinted that the men may be colored. It is known that there are men of that race mobilized there. The local forest force feels that from such a group they will probably get more real work than from boys from the cities and would not be at all disappointed should they draw the negroes.

The Dubois camp at Sheridan Creek ranger station will be established ten days later and will be transported from Lander.

Both camps will have Capt. J. S. Cooks as supply officer. Dr. L. H. Wilmoth has signed a contract as medical officer of Camp Popo Agie and it is expected that Dr. Paul Holtz will establish a recuperation camp for himself in the upper country and be in charge of the medical work there. Dr. Holtz is expected home from Wheatland in a few days where he underwent a major operation.

Relief Work Head

Photo shows Harry L. Hopkins New York state administrator of relief, who was nominated by President Roosevelt to be federal emergency administrator under the Wagner $500,000,000 relief act. His salary will be $10,000 a year, meaning a loss of $5,000 to him, as he was paid $15

June 7, 1933

OKLAHOMA BOYS HAVE GOOD TIME NEW DEAL JOBS WITH UNCLE SAM

Building of Roads and Fences on Forest Gets Started Today after Building Camp City of Tents on Popo Agie

Happy in a new camp in the mountains of the Wind River range eleven miles south of Lander 185 officers and men of the reforestation army got down to work yesterday with a group taking the stones from the road from the Sinks to the Bruce's camp site preparatory to the widening of the road, another crew working on line fences for the Forest and another strating on the road over the big hill to Louis lake where a road is to be built for the protection of the forest at the south end where there is a large body of merchantable timber.

"Are you happy up here?" asked the Journal reporter. "You betcha, sure thing!". chorused the gang that gathered about.

"How's the feed?" Lots of it! Mighty good!"

"Anything wrong?" "Mister, could you spare us a blanket?" Inquiry developed that these boys have four army blankets under them and three on top and still they shiver. It's from a hot country they come. Down in old Oklahoma where they fry steaks on a sawblade and sweat is used for irrigation purposes, the chill nights strike to the center of their thin blooded circulation and they shake with the cold.

One bright-eyed lad who looked like he had had a marcel in the improvised barber shop told about what fun they were having. The work isn't hard, the hours are short and it's a real vacation for us, he said. The officers are good sports and are adjusting their army methods to meet the new conditions.

Captain M. W. Wilson of Ft. Sill in charge of the camp is a prince of a chap, ready to do his part and more, "This is a new job for us," he said. "They offered it to the department of agriculture and they turned it down, the forest department has a full schedule without it and so they put it over onto the army," he continued.

August 11, 1933

MAN KILLED BY ROCK BLASTED HALF MILE FROM C. C. C. CAMP

Struck by 20-pound Missile While Working In Blacksmith Shop; Men in Camp Given Warning

Death accidently came last Thursday to Allen C. C. C. camp.

Working in the blacksmith shop as helper to Charles Robeson, Johnny Casey was killed by a 10-inch, 20-pound niggerhead rock, heaved nearly half a mile from the newly-constructed road above camp on the mountain side.

After 4:30 the powder gang began shooting to break thru the impregnable granite, thru which much of the new road climbs from Bruce's camp. The blacksmith shop is open on south and east sides and Mr. Robeson and Johnny who had been warned could see the charges as they were fired. Several times during the afternoon rocks were thrown in the vicinity of camp, but men were keeping heads up. Johnny had gone out side the shop an hour before the fateful time at 6:15 in the evening to sit on a nearby tractor and take pictures of the shots.

When the fatal shot of dynamite came Johnny was standing by a heavy work bench. Mr. Robeson standing nearby and looking out between the two-by-fours to the southeast up on the mountain where the workers were, saw the shot and saw the rock flying toward the shop. He yelled and ducked.

The next instant the missile tore thru the flimsy roof, meant only to shade and keep off showers, tearing a 12x14-inch hole, and struck Johnny to the ground. Paralyzing him for a while, it mangled his right arm. An enormous black bruise showed where it hit his side.

Doctors believe the rock pinched him against the heavy bench in front of which he was standing. The right kidney was completely crushed, the top of the pelvic bone was broken and muscles thruout the region were mashed. Capt. John G. Cook secured a truck immediately to rush the injured man to Lander ordering word sent to Benson-Coolidge ambulance to meet the truck. However, the truck brought him to the hospital to save time and Dr. L. H. Wilmoth was called to assist. In spite of medical aid it took four

(Continued on Page Five)

WARNING! Blasting in Canyon

Blasting will be done in the vicinity of the Middle Fork ranger station Mondays, Tuesdays, Thursdays and Fridays between the hours of 5 p.m. and 7 p.m.

Cars should not enter the area west of the forest boundary during the hour stated above.

HOLLIS W. HIGBY,
C. C. C. Camp Supt.

PREPARE REQUESTS FOR WATER STORAGE

Applications are being prepared this week by various ditch companies and by the Lander chamber of commerce for financing of water storage projects in the upper reaches of the Popo Agie, Little Popo Agie, Squaw creek and the Wind river, under the provisions of the Public Works Administration loans.

Plans are being made for dams at the mouth of several lakes in the mountains to conserve spring run-off water and to make the supply of water available for irrigation greater in the later months of the summer.

The projects will be urged both as water storage measures and for purposes of flood control.

Senators Robert D. Carey and John B. Kendrick will furnish valuable advice to organizations making application when they are here during the Legion convention.

1934

CCC Boys Look Forward to Pioneer Days With Its Thrills of Wild West Contests

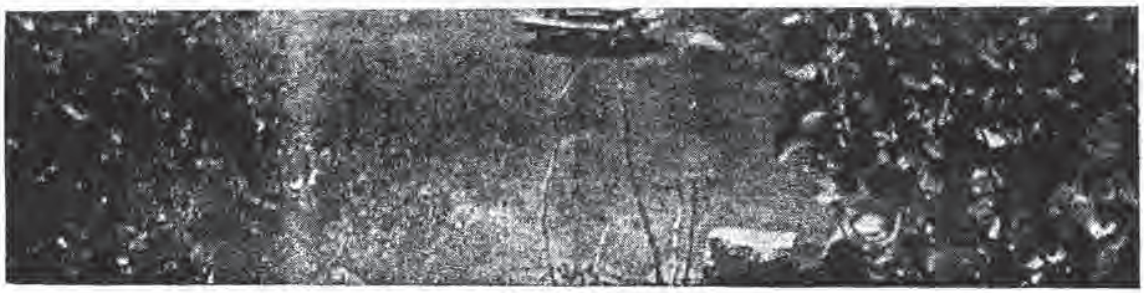
Smiles on the faces of the CCC boys may be due to one of two things and mayhap both. There are new floors in all the tents which keep down the dust and enables them to do real housekeeping in their forest homes, and in the coming week are the Pioneer Days with two days of vacation and a lot of thrills for all of the boys, none of whom have seen anything like they expect to see when the first bronc and his rider is poured out of the chute.

The food is better too. What would you think if the menu included such things as new turnips, ripe tomatoes, cucumbers, lettuce and the other fresh things on the market? We have 'em and boy, they sure taste good. It was thought that it would be beans and bacon with spuds three times a day, but now that the camp is organized in full swing, there is everything anyone could wish and plenty, too.

By the way, we have a real town now since a business district has arisen in our midst. It has no show windows or pretty girl clerks at the ribbon counter, but our boys can walk up to the counter and have a bar of "choclit," the makin's, a bottle of dope that will make his hair shine like a Negro's heel, or even a bottle of three-point-two or some other liquid refreshment of more pleasing taste and less gas to come back to blow off the tip of your nose.

The new commissary is located in the recreation tent with the library, writing tables and other conveniences. This popular place is the center of all activities and the boys are enjoying it immensely, especially since the new floor was put in.

Not only has this store a generous stock of things the boys need and enjoy, but strange to say, they can have their purchases charged up to the amount of the cash pay due them to date. Rob Angelo who comes from Cherokee, Okla., is the official storekeeper.



Just this side of the National Forest boundary in Sinks Canyon, is this inviting picnic area, recently built by the Lander Rod and Gun Club.

Much-Needed Addition

Many Volunteers Helped Build New Sinks Canyon Campground

A new campground has been completed in Sinks Canyon. Located just below the Forest boundary on land owned by the Game and Fish Commission, it is a much-needed addition to local recreation areas.

The campground was made possible through the efforts of the Lander Rod and Gun Club and with the cooperation of local businessmen and the contractor, Vern Miller.

In an effort to improve and expand the local camping and picnicking areas, the Rod and Gun Club asked the Game and Fish Commission for permission to improve the area. The Commission agreed to pay the expense of installing sanitary facilities and gave the club the go ahead for any other improvements it wished to make.

Mr. Miller, vice-president of

DONATED MUCH

the club, got the bid for sanitary facilities. He volunteered to donate all the labor, use of machinery, and such material as could be salvaged from scrap, so that all the money coming from the state could be used to buy other materials for further improvements.

Volunteer labor by friends and members of the Rod and Gun Club dug holes, made forms, poured cement and installed the two toilets supplied by the Commission.

The money which Mr. Miller received from the state was used to buy native lumber with which the volunteers made six picnic tables. Fireplaces were built and installed at the campground. Another table was donated by Roy Lathrop, which made a total of seven table and fireplace combinations intended strictly for public use.

PLAN IMPROVEMENTS

The local fish crew painted and had handles put on several barrels for use as garbage cans.

The last thing to be installed was the sign marking the area and dedicating the campground to public use.

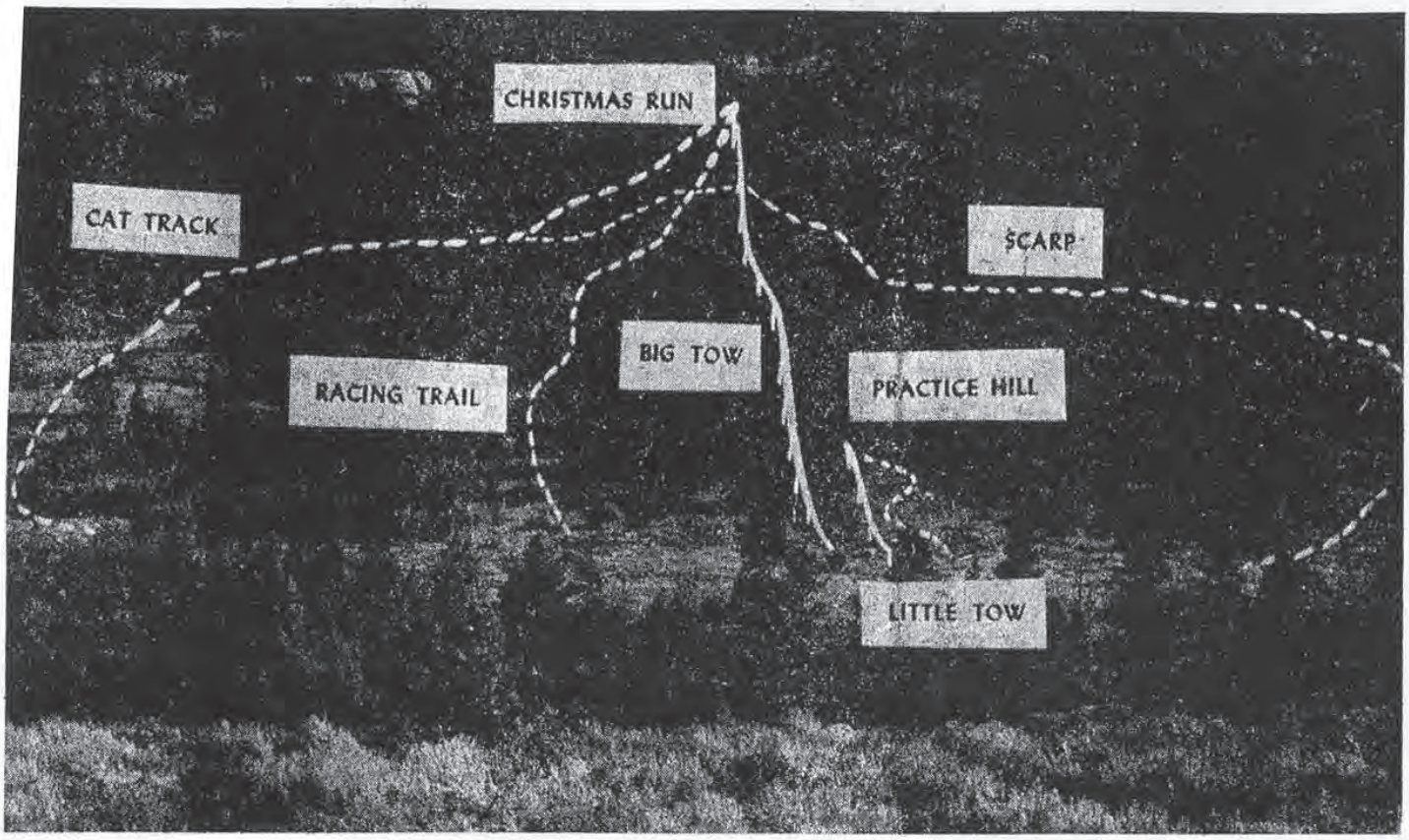
Further improvements planned include improvement of the road leading to the area, enlarging of the parking area, and with the cooperation of the local fish crew, periodic planting of the stream with catchable fish. Improvement of the road has been volunteered by the county and state in connection with the improvement of the main Sinks Canyon road.

WANT TO DOUBLE SIZE

It is hoped that next year the size of the campground can be at least doubled. The facilities are badly needed, and if the state can be persuaded to help finance the project, the Rod and Gun Club and other interested individuals have promised to donate time and busted thumbs to getting it done.

The present facilities would cost about $1,200 to $1,400 to duplicate if done on a cost-of-material-plus-labor basis. The bid which Mr. Miller submitted to the state was less than $150. This was the total cost to the state. All other materials and all the labor were donated by local people.

Local business houses donating material were the Noble Lumber, Farmers Supply, Fremont Truck and Implement, Raecke and Scott, Boise Payette Lumber, Roper Paint Store, Dick's Welding, Fremont Motor, A. J. Hardendorf, Gamble's Store, Lander Hardware, Buddy Miller's Cabinet Shop, Betts Barber Shop and Mr. Miller. If we have left anyone out of this list, please call Harvey Betts so we can give everyone credit for participating in this very worthwhile project.



Two New Runs--One for Better Skiers and One for Beginners--Added at Sinks Canyon

Skiers next Winter will find something new has been added at the Sinks Canyon ski area.

There are two new ski runs.

One which was cut through the trees this Summer is the Racing Trail, a steeper course just at the left of the big tow.

The little tow was moved up from where it was last year and an area cleared for a practice hill. It's called "Lookout Run" because that's where you hear beginners holler "Lookout!"

The other runs were there last year.

They include the top one, Christmas run, so named because the trees cut from there were sold at Christmas-time by the Ski Club and the Girl Scouts.

It joins the Cat Track, which got its name because that is where the caterpillar went during the first year of building the tow.

At the right is the other run which was opened last year, called the Scarp, because it runs along an escarpment.

There are quite a few side trails running into and out of these main trails.

Sinks Canyon Skiers Wonder What to Do

Get Snow-making Machine, Move or What?

The lack of skiing in Sinks Canyon is causing much discussion among Ski Club members, who want to know what other skiiers think about it too.

Sunday evening, Ski Club directors elected Paul Petzoldt as president; Nick Golder, vice president; Charlotte Jones, secretary; and Dr. Harry Tipton, treasurer.

"Skiing conditions at the Sinks Canyon Ski Area have been uncertain for some time," Petzoldt said.

"Last winter the snow was adequate. For a few years previous to that it was erratic. This year there has been no skiing at all.

"As a result, there has been a great deal of discussion about possible remedies that would provide a dependable ski area. Listed here are same of the ideas:

"1 — Continue to operate the Sinks Canyon Area, making improvements on slopes and equipment as possible or necessary.

"2 — Install a snowmaking machine at the Sinks Canyon Area.

"3 — Establish a new ski area at a higher location where there is more snowfall. Mt. Fairfield and Fossil Mountain are possibilities that have been and are being scouted.

"4 — Abandon the present area and use the equipment, where possible, in a new area.

"5 — Establish a new area while continuing to operate the present beginners area.

"6 — Establish a new area while operating both tows on the present area.

"7 — Pray for snow!"

In order to better learn the thinking of the majority, ski - minded people are urged to express their ideas in writing and mail them to: Sinks Canyon Ski Club, 310 Canyon Street, Lander.

"If you have ideas and comments other than those listed above, be sure to include them," Petzoldt said.

After the response is in, a general meeting will be held for everyone interested. Advantages and disadvantages of the more favored solutions will be presented, with a question - and - answer period following.

"The response given this request will be a great help in deciding what action will be taken to improve skiing in this area," Petzoldt pointed out.

Little More Snow Needed For Skiing at Sinks Canyon Area

The Sinks Canyon ski area needs about 4 more inches of snow for excellent ski conditions, City Recreation Director Jim Davison reported Monday.

The beginners' area is covered now, but a little more snow is needed for safe skiing.

The Beginners' Hill was groomed by members of the ski club. All rocks, logs, and debris were removed. The Recreation Department built a new tow shack on the small tow, poured concrete foundations under the tow shacks, installed large window panes in the warming house, and ordered a new rope for the practice hill.

Lawrence Anesi, club president, has spent his days off, building a beautiful stone fire place in the warming house. Lawrence has been hauling rock, hammering, and working at the project for a year now.

The electric motors have been rewired and the tows are in perfect operating conditions.

The area will operate on Saturdays and Sundays with a well trained ski patrol present during operating hours. The ski school will operate Saturdays and Sundays.

Creating Sinks Canyon State Park

Activity to be completed: before trip to Sinks Canyon State Park

Essential Question:

Who were the people responsible for the creation of Sinks Canyon State Park?
Was there a single visionary responsible for the creation of Sinks Canyon State Park?

Goal:

Students will identify the events that occurred to make Sinks Canyon a state park.
Students will list the reasons why the area became a state park.

Standards:

K-4th Grade Social Studies:

SS4.3.2 Students describe different ways that people earn a living in the local community and in Wyoming.

SS4.4.3 Students describe the chronology of exploration, immigration and settlement of Wyoming.

SS4.5.4 Students describe relationships among people and places, and the environmental context in which they take place.

5th-8th Grade Social Studies:

SS8.2.2 Students describe cultural diversity and the interdependence of cultures.

SS8.3.1 Students communicate how economic considerations influence personal, local, state, national, and international decision-making.

SS8.4.1 Students identify people, events, problems, conflicts, and ideas and explain their historical significance.

SS8.4.3 Students analyze the impact of historical events and people on present conditions, situations, or circumstances.

SS8.5.2 Students apply the themes of geography to topics being studied.

Materials:

Copies of the newspaper articles reporting on the events that created the state park.

Vocabulary:

Conservation, preservation, habitat, ecosystem, visionary, proposal

Activity Procedure:

1. Using the newspaper articles, students create a time line of the process to create the state park.
2. Discuss the reasons why the area was preserved.
3. Look at the Sinks Canyon State Park website (www.sinkscanyonstatepark.org) and discuss who might have used the

Creating Sinks Canyon State Park continued ...

area in the past and who continues to spend time there today.

4. What important events were happening in your home town at the time that Sinks Canyon was becoming a state park?

Writing:

1. Students write a summary that explains the reason Sinks Canyon State Park was created.
2. Students write about a place that they would want to preserve forever and explain why it is an important place.
3. Students write about the type of development they think is important (if any) at Sinks Canyon State Park or at the place they proposed to preserve (from the previous question.)
4. Working in small groups, ask half of the class to propose reasons why a natural area should be developed while the other half will propose reasons to keep the preserved area undeveloped. Ask students to present their reasons and debate the pros and cons. Encourage students to be respectful and polite, allowing each other to talk uninterrupted and never make derogatory or offensive comments.

Assessment:

Students present what they learned about the process to make Sinks Canyon a state park from assessing the primary documents.

January 7, 1971

Guest editorial

G-F comments on Sinks canyon proposal . . .

About a year ago the Wyoming Game and Fish Commission and the Wyoming Recreation Commission entered into an agreement whereby lands owned by the department could be developed by the State Recreation Commission for recreational uses if these uses did not substantially interfere with the basic objectives the Game and Fish Department had for purchasing the lands. At this time we feel there is a definite need to provide adequate facilities for the public to see and use the Sinks Canyon area by an agency which will not only provide minimum facilities but arrange for routine clean-up and maintenance. We feel the State Recreation Commission is in the best position toprovide this service to the public through establishment of this area as the Sinks Canyon State Park.

Most of the bottom land between themouth of Sinks Canyon and the Forest Service boundry line was purchased with Game and Fish Department funds a number of years ago. This purchase was made to assure continued use by wintering big game animals and public access to fishing on the Popo Agie River. Approximately 13 acres around the "Rise of the Sinks" including the buildings belongs to the City of Lander.

Along with this purchase, a unique geological formation, the Sinks and Rise of the Popo Agie River was reserved for continued public ownership and enjoyment. The Game and Fish Department does not feel justified in expending money collected from hunter and fishermen license sales to improve facilities and provide routine maintenance of the area for people visiting the site for purely recreational and sightseeing purposes.

Over the years, various groups including the Lander Rod and Gun Club, the Kiwanis Key Club, the Wyoming Highway Department, the National Outdoor Leadership School, Pacific Power and Light Company and undoubtedly unnamed others have helped provide some minimum facilities and maintenance for public use of this area. The very uniqueness of this area and word of mouth has resulted in greater and greater numbers of visitors who not only bring interest and curiosity but their inevitable effects on the landscape and beauty including trash and litter.

The Sinks Canyon is a highly scenic area but actually quite small in total acres which would proclude extensive road, parking and camping developments. Adequate facilities and maintenance are needed to preserve this unique site from ever increasing visitors.

William Crump, Game Div. Sup.
Wyoming Game & Fish Department.

Sinks Canyon Plan. . .

By JAN JIBBEN
Staff Writer

State park proposal 'four-pronged effort'

(Editor's note: This is second in a series of articles on the proposed development of the Sinks into a State Park).

Under a proposed bill permitting Sinks Canyon to be designated a state park, this area of natural wonders will be shared--and saved--for the enjoyment of generations to come.

Little has been publicized about the Sinks, either by state or local organizations, yet this site already attracts nearly 100,000 visitors each year.

According to Randy Wagner, chief of the planning division of Wyoming Recreation Commission, "With use of the canyon growing at the rate is now is, proper planned development has become a must. The fact that the area lies in the 'one-day from Yellowstone', belt also is a must factor for park planning."

(Please turn to page 8)

The Sinks Canyon area is an almost perfect site as far as utilization and proper maintenance is concerned, because its physical aspects enable good control of human use and pose few problems in upkeep. Also, as Wagner indicated, "The Sinks Canyon Plan can be properly developed without costing taxpayers an arm and a leg!"

ESSENTIALLY, the proposal (which will be introduced by Harold Meier in the House of Representatives during this year's state legislative session) calls for a four-pronged program:

1. **Signs** - Four signs are suggested, each with a short description of the area. One will be placed at the main turn-off in Lander, at the Sinks, at the Rise of the Sinks, and one at the now-designated Rod and Gun Club campground explaining the geology of the area and marking the beginning of the Nature Trail.

2. **Nature Trail** - About a mile long, the proposed trail will begin at the present Rod & Gun Club campground and end at the Rise of the Sinks. Along the way various geological formations and flora and fauna varieties, peculiar to this area, will be described through small signs.

The trail will be shored up, where there is danger of erosion, with materials which will blend in with the surroundings.

Also the overlook, affording a fantastic view of Rainbow trout at the Popo Agie's reappearance, will be reconstructed. At present a series of rotting log handrails and cement steps lead to a shaky wooden platform which is adequate for three viewers, safe for five or six, but often can be found supporting a crowd of 12 to 15.

3. **Visitors Center** - Described in an earlier article printed in the JOURNAL, the Visitors Center will be a focal point of interest. A very small building, only a thousand square feet, it will house a display room, a small office for the summer naturalist, and supply room.

Object of the Visitors Center primarily is to acquaint both tourists and residents alike with unique features to be seen in Sinks Canyon.

4. **Campground** - The Rod and Gun campground, in disrepair for the past few years, will be renovated under this proposal to include not only picniking sites but camping facilities for trailers and tents.

Adequate parking and drinking water facilities will be made available, as well as tables and cooking grills. Vault-type toilets will be installed to eliminate the probability of polluting the Popo Agie. A footbridge across the river will be built to provide access to a few camping spots on the other side, as well as to provide better fisherman access.

THE STATE park proposal for Sinks Canyon has been developed through cooperation of Wyoming Recreation Commission, Bureau of Land Management and Wyoming Game & Fish Department (the latter agency supervises nearly all the land under consideration for state park status).

Any construction or utilization of this land will be designed affect only minimally the fish and wildlife values for which Wyoming Game & Fish originally acquired the area, and in addition will greatly enhance conservation and maintenance efforts now in effect.

January 25, 1971

Sinks State Park a reality . . .

Senate approves state park bill

State representative Harold Meier of Lander reported today to the JOURNAL that the House bill, proposing Sinks Canyon be designated a state park, has passed third reading in the Senate and is awaiting Governor Hathaway's signature.

"The bill should be on his (the governor's) desk this week, and we should be notified of his decision quite soon," Meier said.

Funding for the proposal, which was introduced as a separate bill, has not yet left the Ways and Means Committee.

In other legislative action, Rep. Meier indicated there has been much argument concerning the drug control act, most particularly the "no-knock" provision, during its second reading in the House.

A bill requiring property owners, when filing a deed, to file a separate statement attesting to amount of money paid for the property passed first reading today in the House.

Meier indicated he was not in favor of the proposal. "It is supposed to help the assessor, but in my judgement the purchase price paid doesn't necessarily reflect the actual value of the property. As far as I'm concerned, it's just a waste of filing space and time."

Sinks Canyon is state park

Fremont County's . . . legislative delegation was in Governor Hathaway office for the signing of House Bill 5, which established the Sinks Canyon area as a State Park. The park contains approximately 520 acres, and will be jointly administered by the Wyo. Recreation Commission and the Wyo. Game and Fish Dept. From left are Rep. Walter Rhodes, Rep. Don Lockhart, Rep. Roy Peck, Sen. Percy Davis, Sen. Robert Novotny, Rep. Harold Meier, Sen. Fremont Miller and Rep. William Budd.

Stories on Rock

Activity to be completed: before trip to Sinks Canyon State Park

Essential Question:
Can art be used to communicate an idea or represent an experience?

Goal:
Learn how art can be used to communicate an idea or represent an experience.

Standards:

K-4th Grade Social Studies:
SS4.2.2 Students explain how culture is reflected in literature and the arts.

SS4.4.3 Students describe the chronology of exploration, immigration and settlement of Wyoming.

SS4.5.4 Students describe relationships among people and places, and the environmental context in which they take place.

5th-8th Grade Social Studies:
SS8.2.1 Students explain how family systems, religion, language, literature, and the arts contribute to the development of cultures.

SS8.2.2 Students describe cultural diversity and the interdependence of cultures.

SS8.4.1 Students identify people, events, problems, conflicts, and ideas and explain their historical significance.

SS8.5.2 Students apply the themes of geography to topics being studied.

Materials:
Writing and drawing materials

Books:
Songs of Ancient Journeys: Animals in Rock Art Elsa Marston
Stories in Stone: Rock Art Pictures by Early Americans by Caroline Arnold and Richard R. Hewett
Stories on Stone: rock Art Images from the Ancient Ones by Jennifer Owings Dewey

Videos:
Discovery Education:
Native American Rock Art
A Legacy of the Human Spirit
Alphabet and Written Language
Hieroglyph in Form of an Ibis at
http://streaming.discoveryeducation.com/
(set-up a password and login if you have never accessed this site)

Vocabulary:
Communication, rock art, petroglyphs, image

Activity Procedure:
1. Ask students to write a short story (1-2 paragraphs) about a significant event in their lives.
2. Now, ask the students to represent that story in art. Encourage students to use only 1, concise image to convey the story. Ask the students to give thought to how they

want the story represented or what the most important aspect of the story is. Define for the students what qualifies as an image- one single figure or object that will not tell the whole story but, will represent the story. Contrast this idea with a "scene" that could encompass many images.

3. Discuss as a class: How did you choose the image that you chose to tell your story? What was the most important thing about the story that you wanted to represent? Was it challenging to represent your story as a single image? Yes or no- why?

Without a means of writing words and preserving those for other people to read, some ancient people chose to capture their significant or important experiences on rock, at the places where the experiences occurred. It is likely that those experiences were spiritual in nature, as a result of intense prayer or meditation. Scientists believe that is what petroglyphs, or images on rock created long ago, are.

Writing:

Students' paragraph(s) about their significant life event.

Assessment:

Class participation.
Completeness of the students' paragraph(s) about their significant life event and/or the image they drew.

Follow-up Activities:

Research petroglyph or pictograph sites locally or in other countries.
Travel to Sinks Canyon State Park to see the petroglyphs.

Clues Left Behind

Activity to be completed: during trip to Sinks Canyon State Park with State Park Staff

Essential Question:
What signs of ancient or historic peoples are found at Sinks Canyon State Park?

Goal:
Students will visit the petroglyph site and develop stories about the images.
Students will understand the importance of preservation and stewardship of both cultural and natural resources.

Standards:

K-4th Grade Social Studies:
SS4.5.4 Students describe relationships among people and places, and the environmental context in which they take place.

5th-8th Grade Social Studies:
SS8.2.2 Students describe cultural diversity and the interdependence of cultures.

SS8.4.1 Students identify people, events, problems, conflicts, and ideas and explain their historical significance.

SS8.5.2 Students apply the themes of geography to topics being studied.

Materials:
Student journals, pencils.

Books:
Native American Rock Art by Judith Dupre

Vocabulary:
Petroglyphs, pictographs, culture

Activity Procedure:
1. Meet a Sinks Canyon State Park staff member at the Visitors' Center. Please arrange for this prior to your field trip. The Sinks Canyon State Park staff will take the group to the petroglyphs and pictographs.
2. At the site, ask the students to observe the petroglyphs and answer the following questions in their journals:
    1. Can a rock talk?
    2. What kind of sound can rocks make?
    3. If these petroglyphs could talk, what stories do you think they would tell?
    4. Look at the view seen by the image on the rock. Describe the scene as the image might be seeing it. Do you think this view might have influenced the artist to place the image there?
3. Ask students to write the story that the petroglyph would tell. The teacher could take photos of the rock art and print a photo for each student to add to his/her journal with the story.

Clues Left Behind continued ...

Writing:
Students' stories of what the petroglyphs would tell.

Assessment:
Evaluate the students' ideas from their student journals.

Follow-up Activities:
Students share their stories with the class.
See the post-activity.

Clues Left Behind

What do you think?
1. Can a rock talk?

_____

_____

2. What kind of sound can a rock make?

_____

_____

3. If these petroglyphs could talk, what stories do you think they would tell?

_____

_____

_____

_____

_____

_____

4. Look at the view seen by the image on the rock. Describe the scene as the image might see it. Do you think this view might have influenced the artist to place the image there?

_____

_____

_____

_____

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_____

_____

_____

A Historical Time-line of Your Home Town

Activity to be completed: after trip to Sinks Canyon State Park

Essential Question:

Who has lived in your town throughout history?

Goal:

Students will identify groups of people who lived in their hometown and surrounding area and what types of jobs supported the economy of the area historically.
Students will create a time-line depicting the years and groups of people who settled in the area.

Standards:

K-4th Grade Social Studies:

SS4.3.2 Students describe different ways that people earn a living in the local community and in Wyoming.

SS4.4.3 Students describe the chronology of exploration, immigration and settlement of Wyoming.

SS4.5.4 Students describe relationships among people and places, and the environmental context in which they take place.

5th-8th Grade Social Studies:

SS8.2.2 Students describe cultural diversity and the interdependence of cultures.

SS8.3.1 Students communicate how economic considerations influence personal, local, state, national, and international decision-making.

SS8.4.1 Students identify people, events, problems, conflicts, and ideas and explain their historical significance.

SS8.4.3 Students analyze the impact of historical events and people on present conditions, situations, or circumstances.

SS8.5.2 Students apply the themes of geography to topics being studied.

Materials:

Primary Sources Analysis Worksheets; historic photos, newspapers, and documents illustrating history of your town; large sheets of paper for constructing timelines.

Optional: Visit the local museum to learn the history of your area or check with the local newspaper for information about the history of your area. Additionally, local Historical Societies or even local Senior Centers might be able to suggest resources, and public libraries may have a local history section.

A Historical Time-line of Your Home Town continued ...

Vocabulary:
Primary sources, economics, culture

Activity Procedure:
1. Give students photos, newspaper articles, and other primary sources to evaluate for information about their hometown.
2. Ask the students to use the Primary Source Analysis Worksheets to identify and record main historical facts about the area where they live.
3. Students share the information they learn from reading the primary sources.
4. Students create a timeline showing historical inhabitants of their hometown, historical activities and events in the area, and when events occurred.

Writing:
Students write "I wonders" about early settlers of the area and the ways those people thrived economically.

Students will write a summary to include the information gathered from the primary sources.

Assessment:
- Students present information gathered from the primary documents.
- Students create a timeline of the history of their town.
- Students compare the history of Sinks Canyon State Park to their hometown.

Written Document Analysis Worksheet

1. TYPE OF DOCUMENT (Check one):

☐ Newspaper	☐ Map	☐ Advertisement
☐ Letter	☐ Telegram	☐ Congressional Record
☐ Patent	☐ Press Release	☐ Census Report
☐ Memorandum	☐ Report	☐ Other

2. UNIQUE PHYSICAL CHARACTERISTICS OF THE DOCUMENT (Check one or more):

☐ Interesting Letterhead	☐ Notations
☐ Handwritten	☐ "RECEIVED" stamp
☐ Typed	☐ Other
☐ Seals	

3. DATE(S) OF DOCUMENT:

4. AUTHOR (OR CREATOR) OF THE DOCUMENT:

   POSITION (TITLE):

5. FOR WHAT AUDIENCE WAS THE DOCUMENT WRITTEN?

6. DOCUMENT INFORMATION (There are many possible ways to answer A-E.)

   A. List three things the author said that you think are important:

   B. Why do you think this document was written?

   C. What evidence in the document helps you know why it was written? Quote from the document.

   D. List two things the document tells you about life in the United States at the time it was written.

   E. Write a question to the author that is left unanswered by the document:

Photo Analysis Worksheet

Step 1. Observation

A. Study the photograph for 2 minutes. Form an overall impression of the photograph and then examine individual items. Next, divide the photo into quadrants and study each section to see what new details become visible.

B. Use the chart below to list people, objects, and activities in the photograph.

People	Objects	Activities

Step 2. Inference

Based on what you have observed above, list three things you might infer from this photograph.

Step 3. Questions

A. What questions does this photograph raise in your mind?

B. Where could you find answers to them?

Designed and developed by the Education Staff, National Archives and Records Administration, Washington, DC 20408

Petroglyphs Today

Activity to be completed: after trip to Sinks Canyon State Park

Essential Question:
How is art used to communicate an idea?

Goal:
Learn how art can be used to communicate an idea.

Standards:

K-4th Grade Social Studies:
SS4.2.2 Students explain how culture is reflected in literature and the arts.

SS4.4.3 Students describe the chronology of exploration, immigration and settlement of Wyoming.

SS4.5.4 Students describe relationships among people and places, and the environmental context in which they take place.

5th-8th Grade Social Studies:
SS8.2.1 Students explain how family systems, religion, language, literature, and the arts contribute to the development of cultures.

SS8.2.2 Students describe cultural diversity and the interdependence of cultures.

SS8.4.1 Students identify people, events, problems, conflicts, and ideas and explain their historical significance.

SS8.5.2 Students apply the themes of geography to topics being studied.

Materials:
Paper bags, markers, paint, pencils

Books:
Songs of Ancient Journeys: Animals in Rock Art by Elsa Marston
Stories in Stone: Rock Art Pictures by Early Americans by Caroline Arnold and Richard R. Hewett
Stories on Stone: rock Art Images from the Ancient Ones by Jennifer Owings Dewey

Videos:
Discovery Education:
Native American Rock Art
A Legacy of the Human Spirit
Alphabet and Written Language
Hieroglyph in Form of an Ibis

Vocabulary:
Communication, petroglyphs, rock art

Activity Procedure:
1. Review what students learned from their visit to Sinks Canyon State Park to see the petroglyphs.
2. Invite a graphic artist or marketing specialist (a consultant or perhaps a graphic artist who works for a federal or state government agency) to speak to the class about how he/she creates images or logos to represent businesses, programs or ideas.

Petroglyphs Today continued ...

3. Ask students to prepare questions for the guest speaker pertaining to how he/she develops logos and/or images which represent businesses, ideas or programs. Ask the students to share with the guest speaker their experience from the pre-site activity, Stories on Rock. The students' experience with the pre-site activity might help them develop questions to ask the guest.
4. After their visit with the guest, ask the students to think about the image they created for their story (pre-site activity "Stories on Rock"). Is there anything they would like to change or add now after having heard from a graphic designer and learning how he/she develops logos?

Writing:

Ask students to write a story describing one of their classmate's petroglyphs.

Assessment:

Analysis of questions for guest speaker graphic artist,
Journal writing

Trees and Plants
Table of Contents

Adapting to Your Environment

Activity to be completed: before trip to Sinks Canyon State Park

Location of Activity:
School, nearby park, local natural area

Essential Question:
How are plants suited to the environment where they live?

Goal:
Students will identify the ways people adapt to the environment.
Students will identify ways plants are suited to the environment.

Standards:

K-4th Grade:
SC4.1.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC.4.2.3 Students identify and use appropriate scientific equipment.

5th-8th Grade:
SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

Materials:
Chart paper, markers

Vocabulary:
Environment, adaptations, drought, predation, disperse

Activity Procedure:
1. Ask the class to list ways that they as humans adapt to environmental conditions such as temperature changes. Answers may include:
   - Put on more clothing or remove layers
   - Move to a heated or air-conditioned building
   - Move to a sunny area or a shady area
2. Now ask the class to list environmental conditions that plants have developed adaptations to:
   - Drought
   - Predation
   - Need to disperse/reproduce
   - Need to produce food
3. Walk around the playground or a local natural area and look for ways that plants are suited to their environment, allowing them better chances to survive.
   - Grow low to the ground
   - Grow tall

Adapting to Your Environment continued ...

- Thorns to prevent predation
- Poison or bad taste, also to prevent predation
- Growing in a protected area
- Color
- Turns towards the sun
- Seed dispersal mechanisms (sticky seeds or seeds that float in the air)
- Drought resistance mechanisms (leathery leaves, very small leaves, deep tap-roots)
- Sun-catching mechanisms (broad leaves)

Assessment:

- Students identify ways people and/or plants adapt or are suited to the environment where they live.

Follow-up Activities:

- Visit Sinks Canyon State Park and look for plant adaptations.
- Identify ways the seeds are dispersed in Sinks Canyon or where you live.

Introduction to the Bark Beetle – Meet Buford the Bark Beetle

Activity to be completed: before trip to Sinks Canyon State Park

Location of Activity:
School

Essential Question:
How do bark beetles live and reproduce in a forest?
How have bark beetles impacted the trees in forests around Wyoming?

Goal:
Students will describe the life cycle of a bark beetle.
Students will describe how bark beetles impact or affect trees.
Students will identify the cause for the increase in the bark beetle population.

Standards:

K-4th Grade Science:
SC4.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC4.1.2: Students sequence life cycles of living things, and recognize that plants and animals resemble their parents.

SC4.1.3 Students show connections between living things, their basic needs, and the environments.

5th-8th Grade Science:
SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

SC8.1.5 Students recognize behavior as a response of an organism to an internal or environmental stimulus and connect the characteristics and behaviors of an organism to biological adaptation.

SC8.1.6 Students illustrate populations of organisms and their interconnection within an ecosystem, identifying relationships among producers, consumers, and decomposers.

Materials:
"A Year in the Life of a Mountain Pine Beetle" at http://csfs.colostate.edu/pdfs/Buford_MPB_Book.pdf

Introduction to the Bark Beetle continued ...

student journals

Resources that may be useful:
Wyoming Tribune Eagle two-day feature story on bark beetles

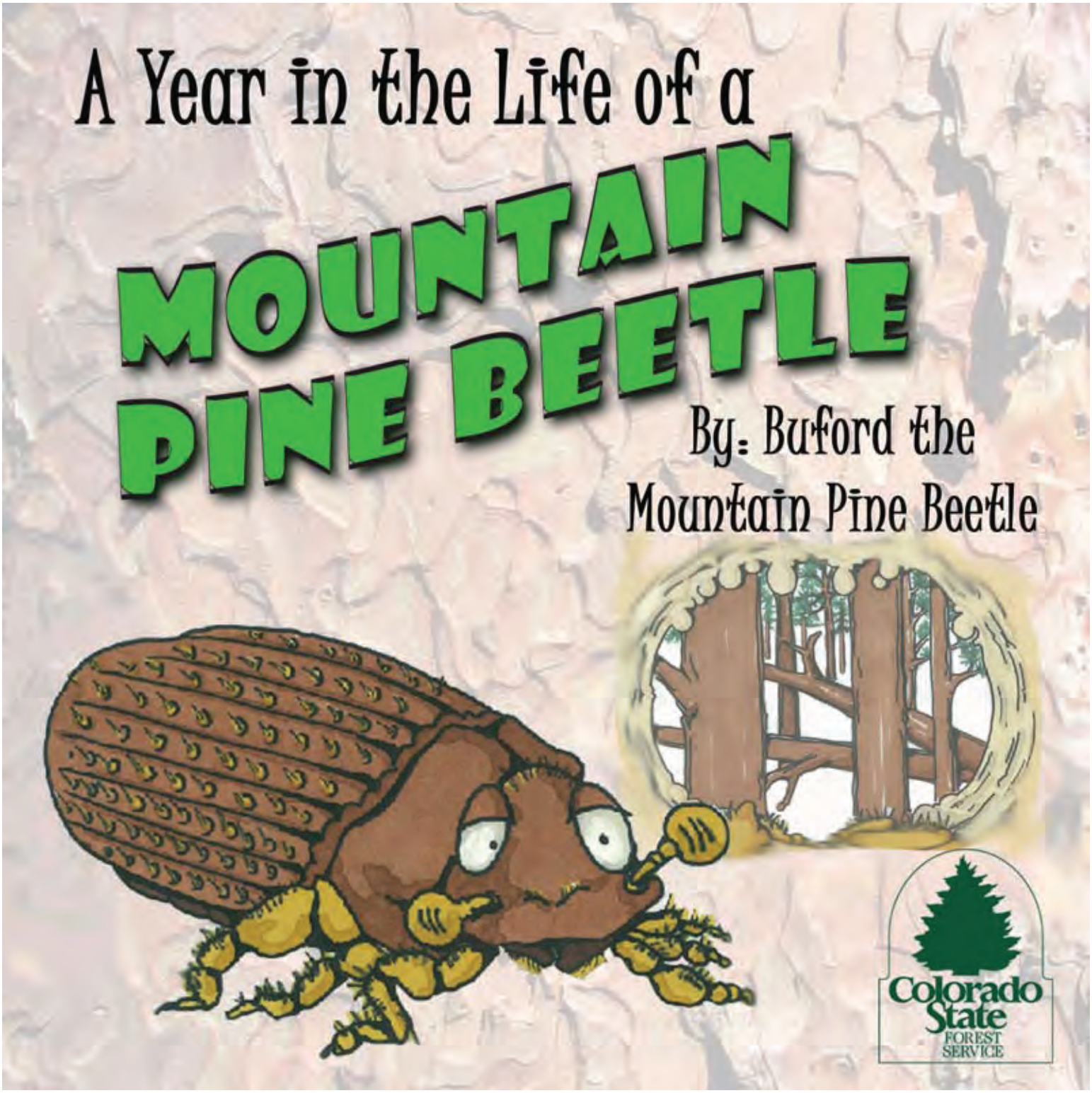
Vocabulary:
pheromones, insecticide, pitch tubes, life cycle, xylem, phloem, gallery, drought, symbiotic relationship

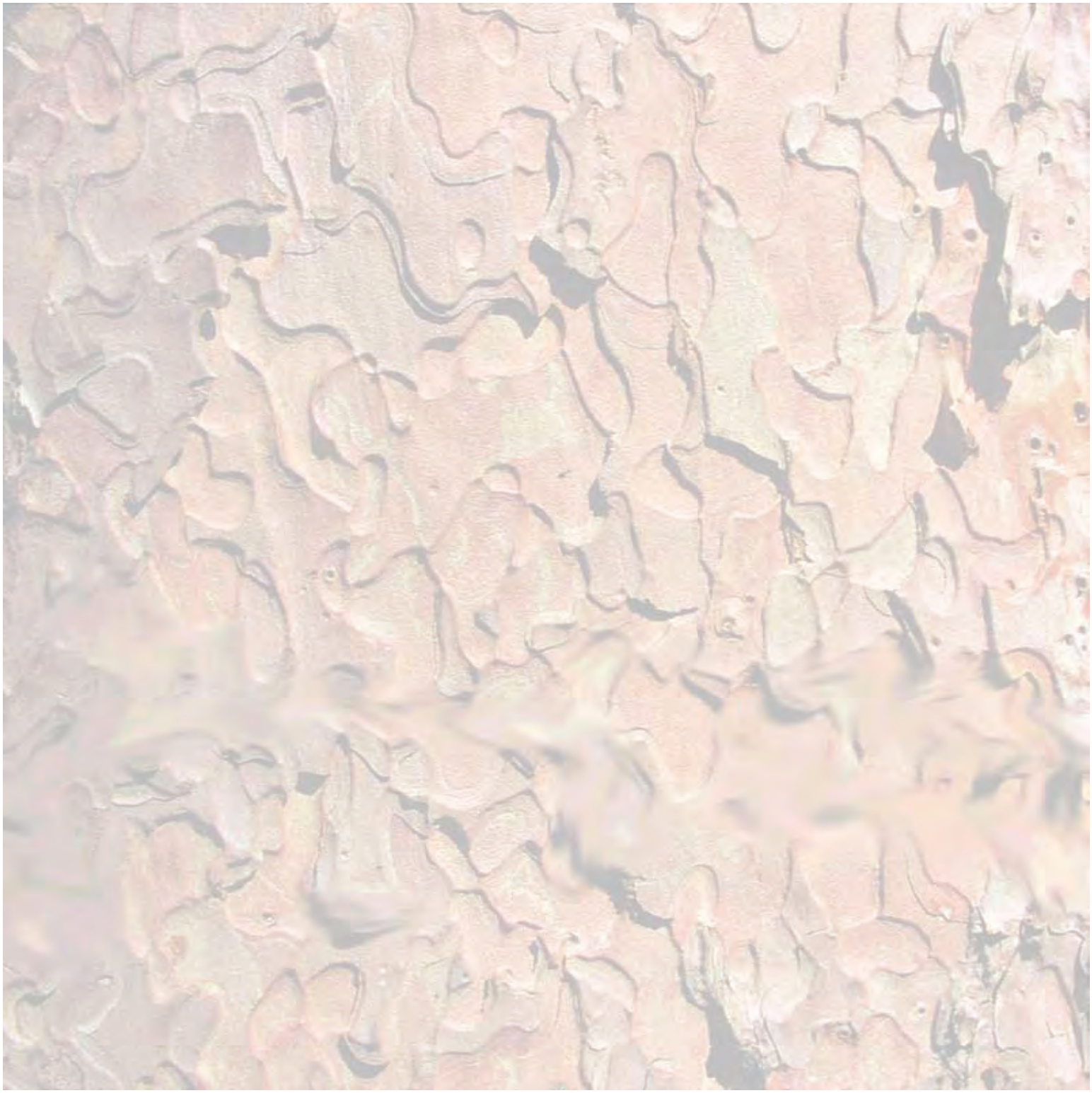
Activity Procedure:
1. As a class, or individually, students read, "A Year in the Life of a Mountain Pine Beetle."
2. Students answer the following questions in their student journals:
    1. What role do Mountain Pine Beetles play in a forest?
    2. Where does a Mountain Pine Beetle spend most of its life?
    3. What helps a Mountain Pine Beetle survive when temperatures are really cold?
    4. How does the blue stain fungus benefit the beetle? How does the beetle benefit the fungus?

Writing:
1. Students will write a paragraph explaining how the bark beetle affects trees.

Assessment:
1. Answers to journal questions.
2. Written paragraph on how beetles affect trees.

Follow-up Activities:
- Visit Sinks Canyon State Park to observe trees that are being affected by bark beetles and learn what Sinks Canyon State Park staff is doing to protect unaffected trees.


A Year in the Life of a
MOUNTAIN PINE BEETLE
By: Buford the Mountain Pine Beetle
Colorado State FOREST SERVICE



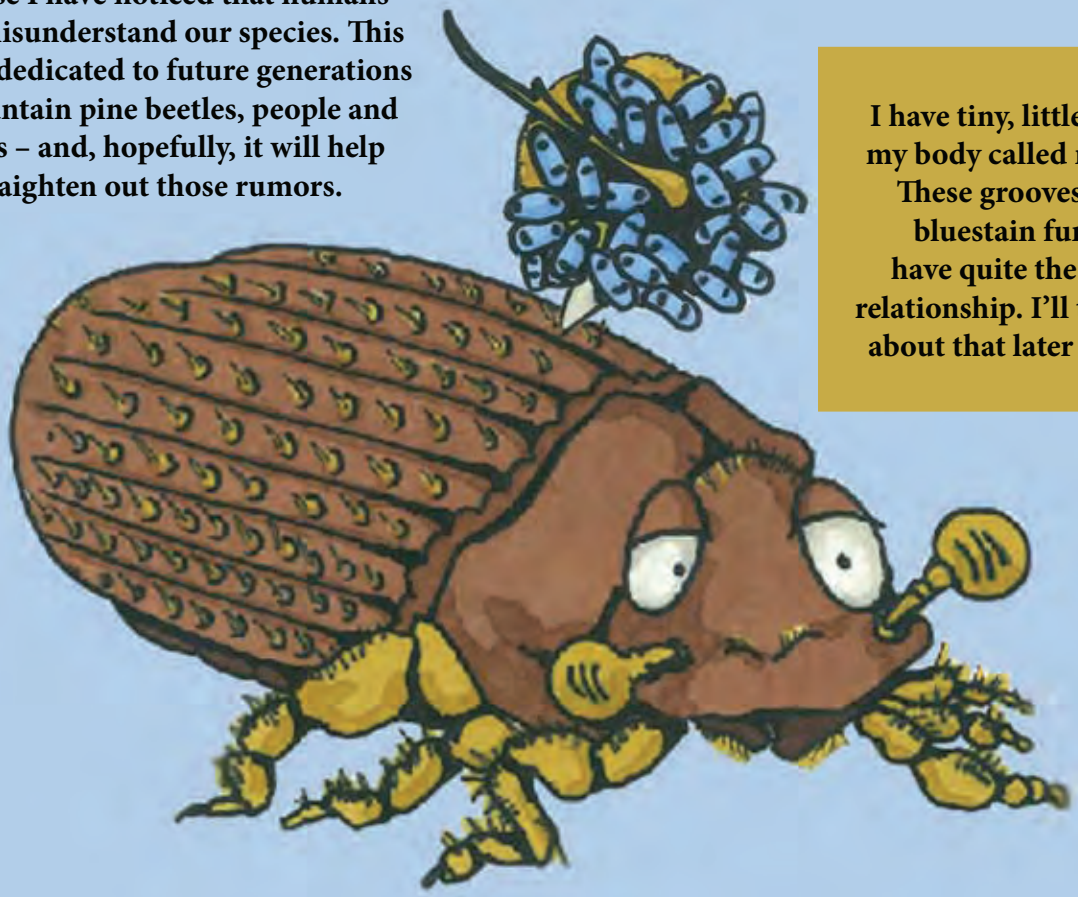
The mission of the Colorado State Forest Service is to provide for the stewardship of forest resources and to reduce related risks to life, property and the environment for the benefit of present and future generations.

Written and Prepared by Lisa Mason and Ingrid Aguayo
Illustrated by Mary Ann Bonnell

A very special thanks to Dave Leatherman, retired Colorado State Forest Service entomologist, for bringing Buford and Bernadette to life — and for sharing his knowledge of mountain pine beetles and his passion for forestry with the citizens of Colorado for over 30 years.

Well, hello there. My name is Buford. I am a mountain pine beetle!

Scientists like to call us *Dendroctonus ponderosae*. I wrote this autobiography because I have noticed that humans often misunderstand our species. This book is dedicated to future generations of mountain pine beetles, people and forests – and, hopefully, it will help straighten out those rumors.



I have tiny, little grooves on my body called mycangium. These grooves carry the bluestain fungus. We have quite the symbiotic relationship. I'll tell you more about that later in the story.

We, mountain pine beetles, play a very important role in our forests. We infest and kill older, larger, stressed trees. This allows more sunlight, nutrients and water to reach smaller trees and help them grow.

To help you understand me better, I want to give you a little background about where I come from. My relatives and I are part of the order Coleoptera. My distant relatives include ladybugs and all other species of beetles. Mountain pine beetles are native to Colorado. We have been here for thousands of years! I also have family throughout Western Canada and all the way down to New Mexico and further West.

1

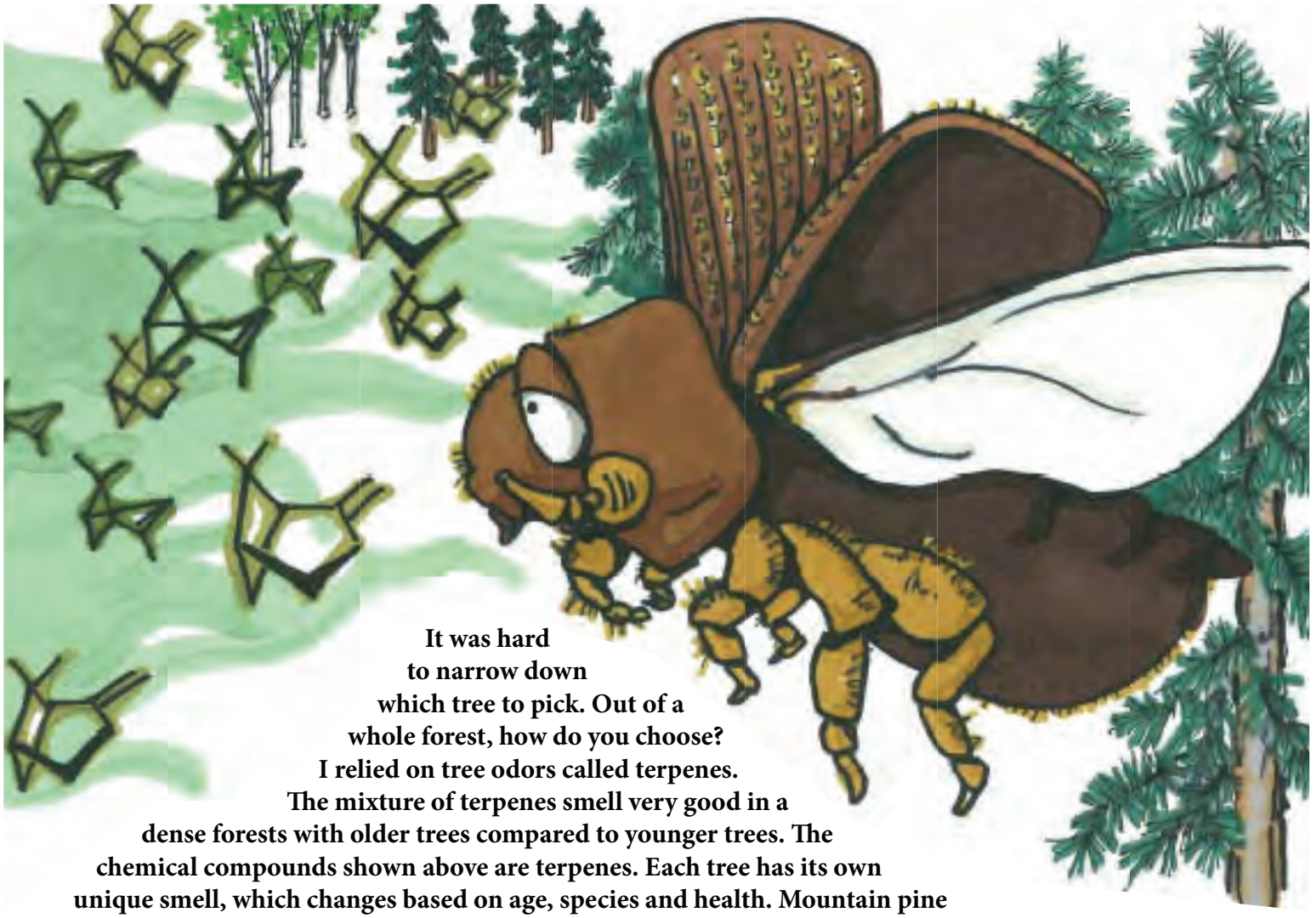
Here is a picture of me. I just became an adult beetle after almost a year of eating and growing. It's time for me to leave the tree I grew up in, so I can find a new host tree and a mate.

Like the rest of my family, I live under the bark of trees. We like to live in a variety of tree species, including: ponderosa pine (*Pinus ponderosae*), lodgepole pine (*Pinus contorta*), limber pine (*Pinus flexilis*), and bristlecone pine (*Pinus aristata*). I have some friends that have tried living in piñon pine (*Pinus edulis*), Scotch pine (*Pinus silvestris*) and Austrian pine (*Pinus nigra*). Some of my friends like those species, but others do not. My family prefers to live in lodgepole pines.

2

This was my first look at the real world. It's now time for me to take flight and find a new host tree. My instincts told me to find a large, old, or stressed-out tree. Any ideas on how I found the right tree? I looked for wide, vertical silhouettes, in hopes it was a tree. It took awhile. I accidentally ran into a human during my flight, but I didn't hurt him.

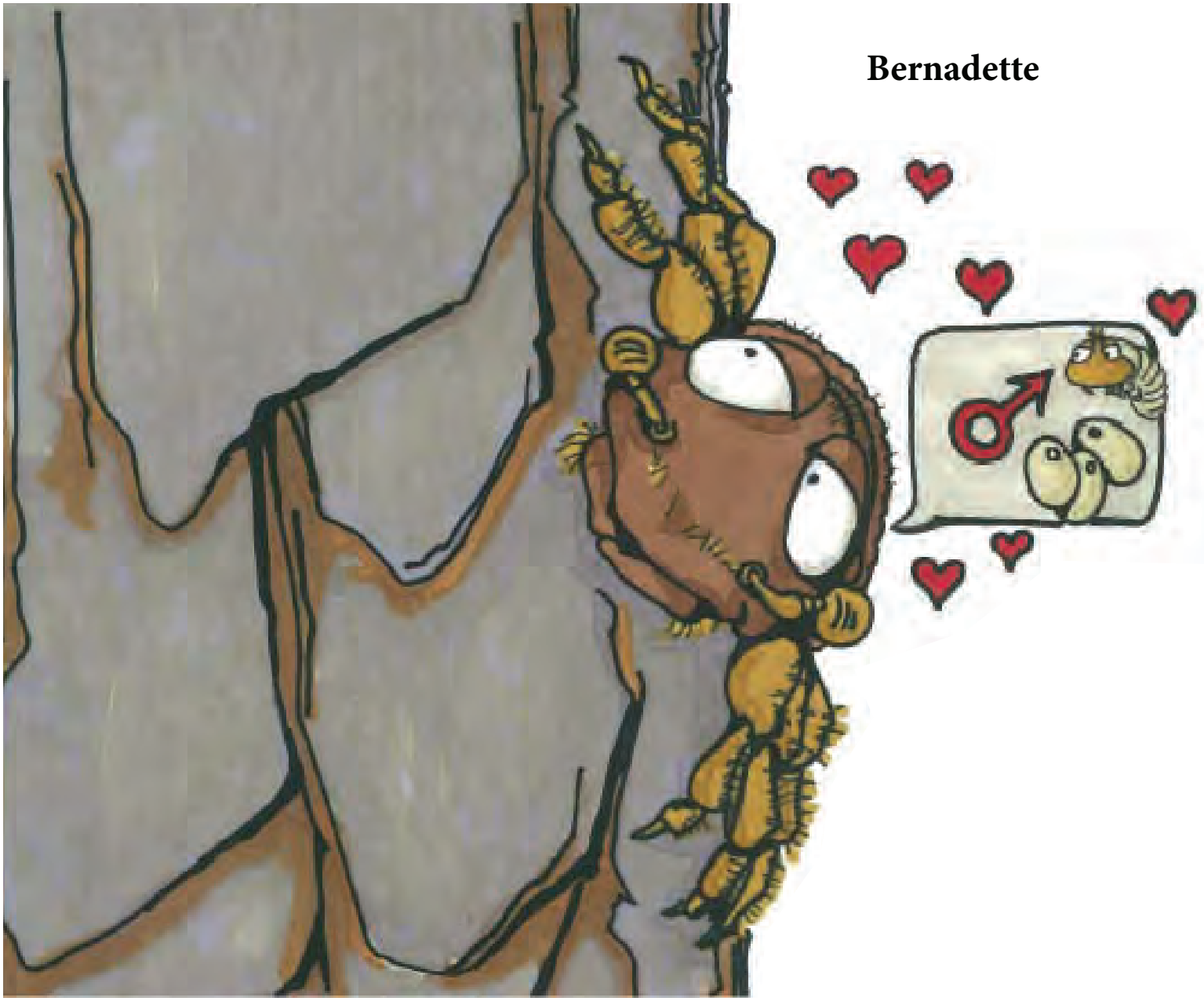
3



**It was hard
to narrow down
which tree to pick. Out of a
whole forest, how do you choose?
I relied on tree odors called terpenes.
The mixture of terpenes smell very good in a
dense forests with older trees compared to younger trees. The
chemical compounds shown above are terpenes. Each tree has its own
unique smell, which changes based on age, species and health. Mountain pine
beetles are attracted to trees over 80 years old.**

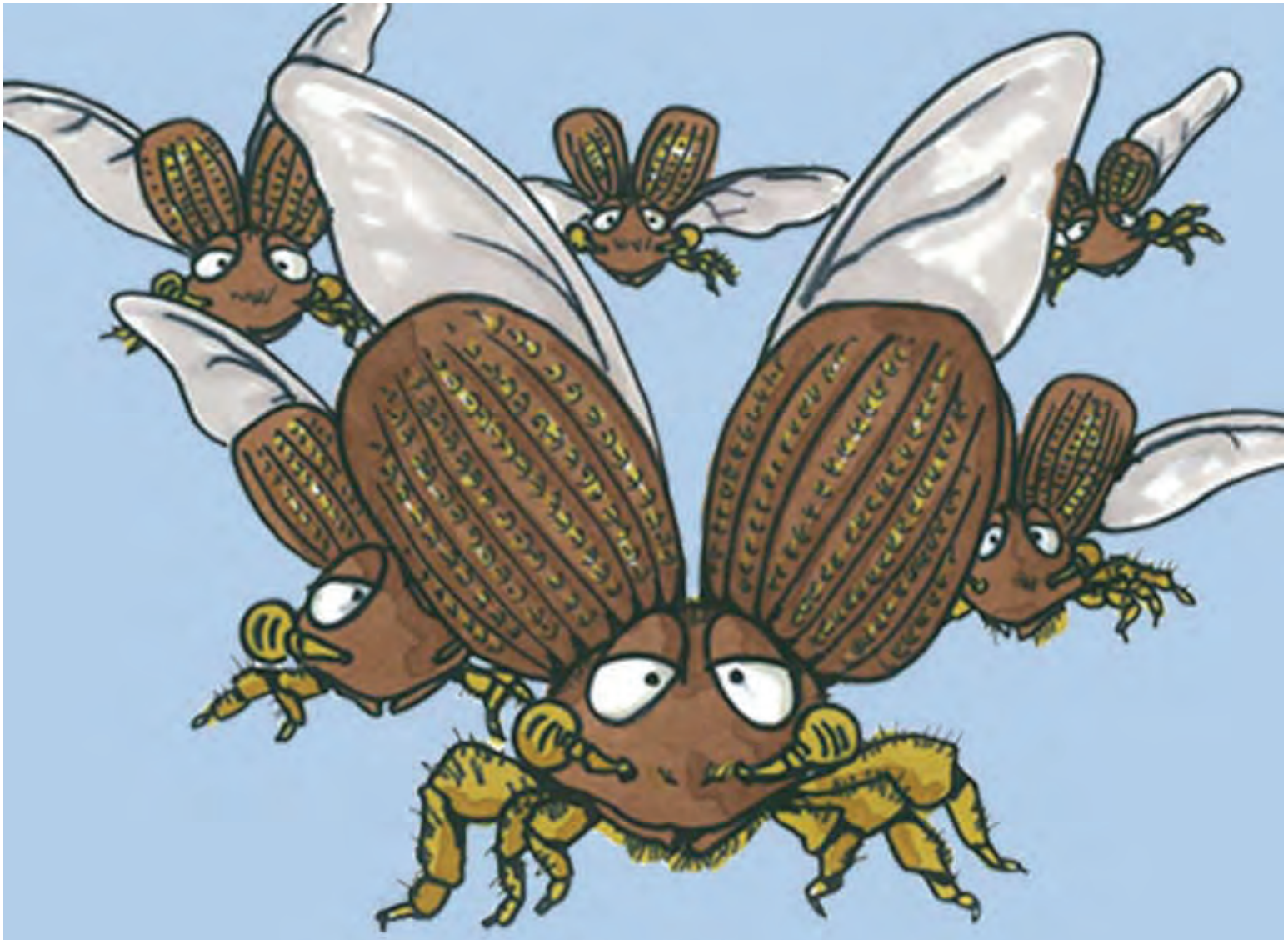
We usually live about one year. During the course of our lives, we go through a complete metamorphosis. Butterflies go through the same cycle, but they get all the fame and glory. Just because they have big, beautiful wings, they are popular among humans. Well, mountain pine beetles go through the same stages! We start off as an egg, and then hatch into a little larva. After hanging out as a pupa, we become adults. This cycle all happens in the protected area under the bark of a tree.

4



In the meantime, my future mate, Bernadette, has already found a host tree. This tree will provide food for our future children. When our children hatch into larvae, they will feed and grow in the phloem, just under the bark of the tree trunk. The phloem transports food and nutrients to the tree.

5



So many trees and pheromones...Bernadette, here I come!

6

Once my fellow beetles and I find a tree, we crawl into the bark. This can be a real challenge. The tree has a set of defenses to keep us out. A tree can produce a high amount of a substance called resin. We could get stuck in the resin. If we can get into the bark, the tree can release an even more toxic resin! I lost brothers and sisters after they got stuck in a sticky tomb of resin. Healthy trees have stronger defenses. This is why we like trees that are older and stressed out.

7

Bernadette was already successful at entering the tree.

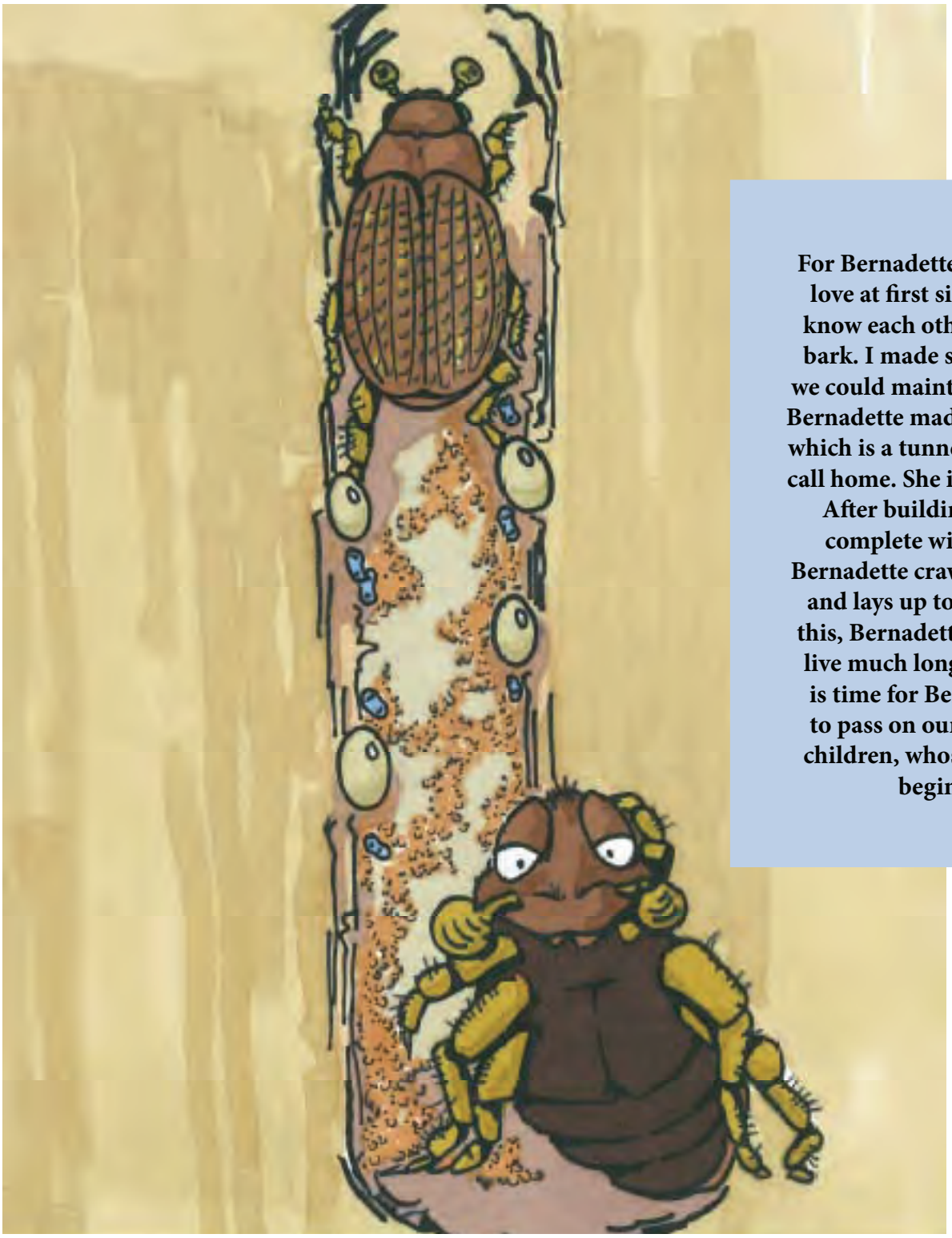
Look at her go!

8

Once Bernadette was inside the tree, she started producing an attractive smell so I could find her. This smell also attracts other male beetles, so I had a lot of competition. Many other beetles made their home in the same tree. Together, all the beetles helped overcome the tree's defenses.

A tree has limited food and can hold only so many of us. When a tree is full, we work with some microorganisms to produce a scent that repels other beetles. They will have to find another tree for their family.

9



For Bernadette and me, it was love at first sight! We got to know each other beneath the bark. I made sure to chirp so we could maintain our privacy. Bernadette made an egg gallery, which is a tunnel in the bark we call home. She is a hard worker! After building our home, complete with a nursery, Bernadette crawls up the trunk and lays up to 75 eggs. After this, Bernadette and I will not live much longer. After all, it is time for Bernadette and I to pass on our legacy to our children, whose lives are just beginning.

10

Here are some of my wonderful children in various stages of growth. They hatched into larvae and some have already turned into pupae. You can see them at the end of their galleries. In this picture, they're burrowing in the inner bark, expanding the gallery. Soon, they will prepare for winter. My kids will be able to produce compounds such as glycerol and sugars to help them survive when the temperatures are extremely cold. These compounds act like antifreeze. Did you know that mountain pine beetles can survive when temperatures reach almost -40 degrees Fahrenheit? After a cold, harsh winter, the kids will start feeding again, until late spring when they molt into pupae. That is similar to when a butterfly enters the cocoon stage.

11

Winter isn't all that easy. The bark and antifreeze keep us protected. But no matter how quiet we are, birds such as this red-breasted nuthatch always seem to find us. I lost some of my children to woodpeckers and other birds this year.

12

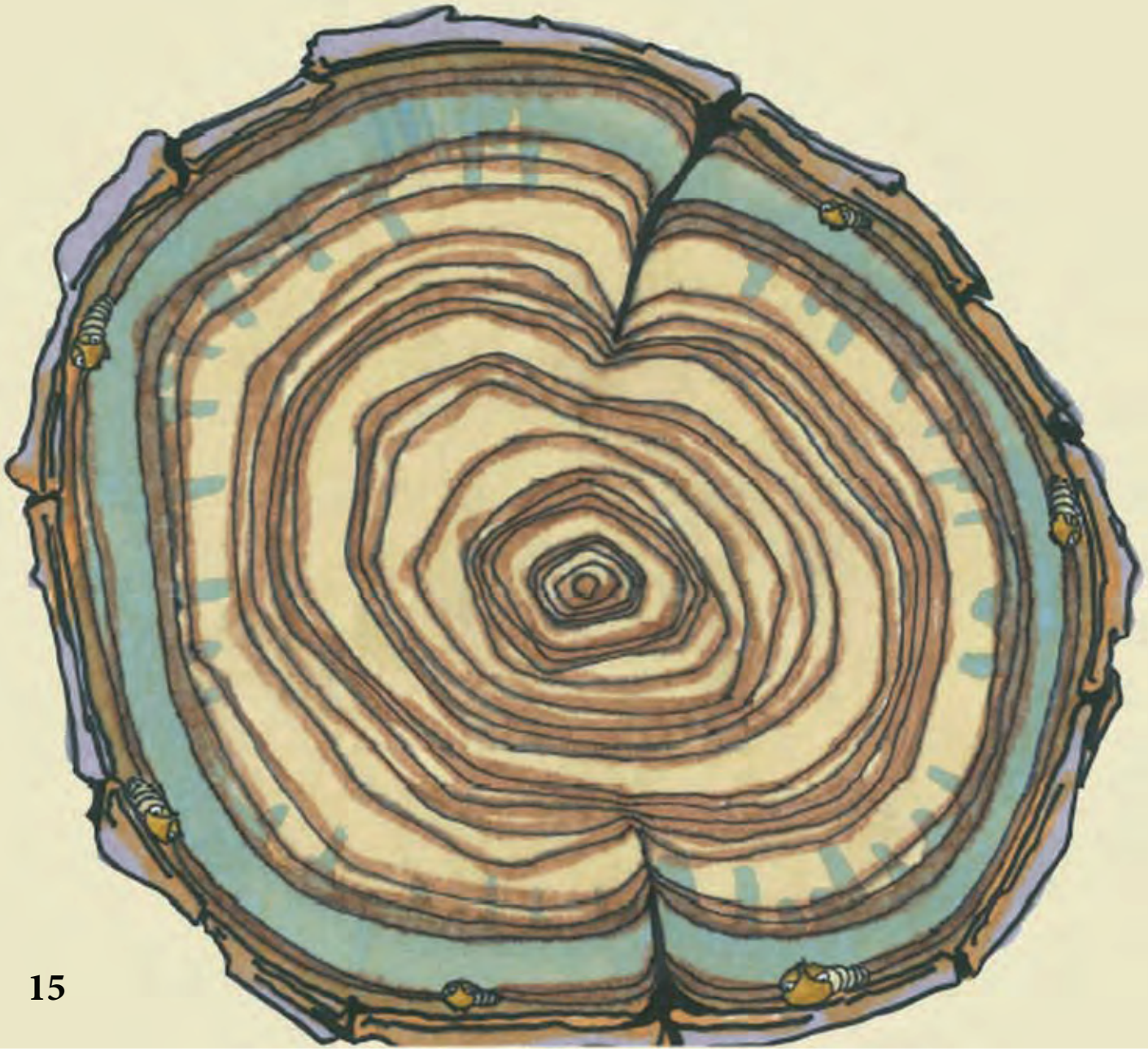
Unfortunately, woodpeckers are not our only enemy.

Tiny predatory wasps can detect larvae under the bark, and they lay their eggs in the body of our children. The tiny wasp larvae eat the beetle larvae from inside out.

Other predatory beetles also like to prey on us for dinner.

Remember the beginning of the story when I mentioned the great relationship we have with bluestain fungi? Their spores live in little grooves called mycangium on our exoskeleton. As beetles enter the tree, they leave fungi spores along the tunnels they bore. The fungi start growing the moment the beetle enters the tree colonizing the wood and producing a characteristic blue stain, some of which feeds our young. The fungi grow in the phloem area around the beetle and throughout the sapwood of the tree. This relationship works out nicely. The fungi hitch a ride with us, and provide our teenagers with food.

Here's a cross-section of a tree trunk after the winter following a mountain pine beetle infestation. The bluestain fungi grow toward the sapwood. The fungi do not weaken the wood, but they certainly do make it more interesting. Our children, the larvae, are still feeding on the inner bark.



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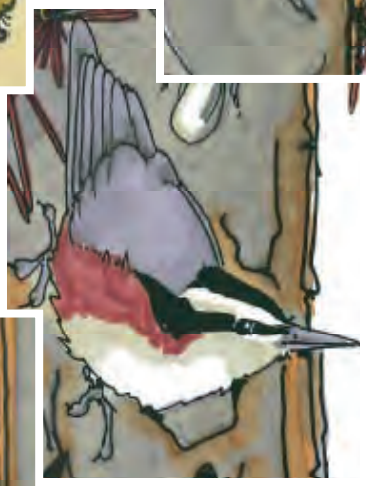
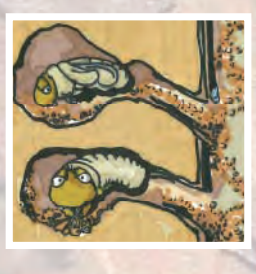
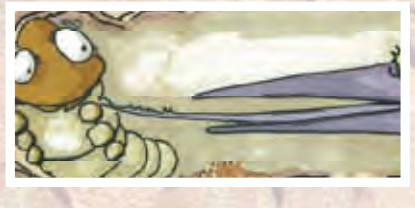


This concludes my life story. I hope it helps you understand my role in the forest. We, mountain pine beetles, play a very important part in a forest ecosystem. For example, lodgepole pines need a disturbance such as an insect infestation or wildfire every 150-300 years to start a fresh, new forest. The trees get old, and it is time to make room for new trees. Mountain pine beetles can sense when the trees are getting old, and it is time for the forest to change. We help make room for water, nutrients and sunlight for the new trees. The cavities of old, dead trees provide homes for wildlife and other organisms such as decay-eating fungi and other insects. With new trees, there is new life and more oxygen. It is one of the many cycles in nature. We depend on the trees, and the trees depend on us. Nature is a dynamic and beautiful process!

16

Humans can sometimes reduce the risk of our populations growing so large that we kill most trees. This can be done through careful forest management by creating a more diverse forest with different tree species and different ages. That way there will always be green forests for humans to use and enjoy and we will continue to have a home and survive as one of Colorado's native species.





For more information on the Colorado State Forest Service or the mountain pine beetle: www.csfs.colostate.edu

Meet Buford The Bark Beetle

1. What role do mountain pine beetles play in a forest?

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2. Where does a mountain pine beetle spend most of its life?

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3. What helps a mountain pine beetle survive when temperatures are really cold?

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4. How does the blue stain fungus benefit the beetle? How does the beetle benefit the fungus?

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Wyoming Tribune Eagle

SATURDAY, OCTOBER 17, 2009 CHEYENNE, WYOMING WYOMINGNEWS.COM 50¢

The sun shines through some beetle-killed trees in the Medicine Bow National Forest near Encampment earlier this month. Much of the forest south of the small Wyoming community is infested. Michael Smith/staff

Beetle impact

Life's going to change after this – and not just in the forest

A close-up look at a pine beetle as it crawls across a piece of bark. It is about the size of a grain of rice. Its strength is not in its size but in its numbers.

But it's not the end of the world. And it's not the end of the forest. Change is a fact of life, a fact we have ironically forgotten when it comes to Mother Nature.

By Shauna Stephenson
sstephenson@wyomingnews.com

A blue fog hangs over the trees at Hog Park Reservoir, ominously foreshadowing the coming storm. A breeze slides through the stiff trunks of trees, grazing over their bare limbs.

It is eerily quiet out here, as if you have come upon the remains of a battlefield. Clouds begin to roll in, and the deep hues offset the reds and grays of the forest, trees killed by an epidemic of bark beetles.

What was once young and lively seems stark and cold.

Shock and anger come to mind. Who did this to the forests, you want to say. What happened to the green limbs that shaded my campsite? What happened to the mighty boughs I used to climb?

Sunlight filters through the clouds, casting a mosaic of light on the landscape. Across the lake, it falls on a patch of vibrant green, young trees, popping up in the remains of a clear cut – a sign of life where

See Beetle impact, page A7

BEETLE IMPACT

An in-depth, two-day series

Today

Sunday

We may not feel it as strongly in Cheyenne as in more wooded parts of the state, but rest assured, it's not just the color of the forests that will change.

The bark beetle will have an impact on your life if you ...

- hunt
- fish
- hike
- mountain bike
- kayak or canoe
- swim
- drink water
- bathe
- cook
- go for long scenic drives
- irrigate
- breathe clean air
- fight fires
- pay heating bills
- pay air conditioning bills
- have conifers in your yard
- watch wildlife
- work for a government agency
- have a cabin in the mountains
- want a cabin in the mountains
- watch weather
- go four-wheeling
- rock climb
- bird watch

MOUNTAIN PINE BEETLE

Actual size
1/8 to 1/3 in.
(3-9 mm)

Actual size of a dime

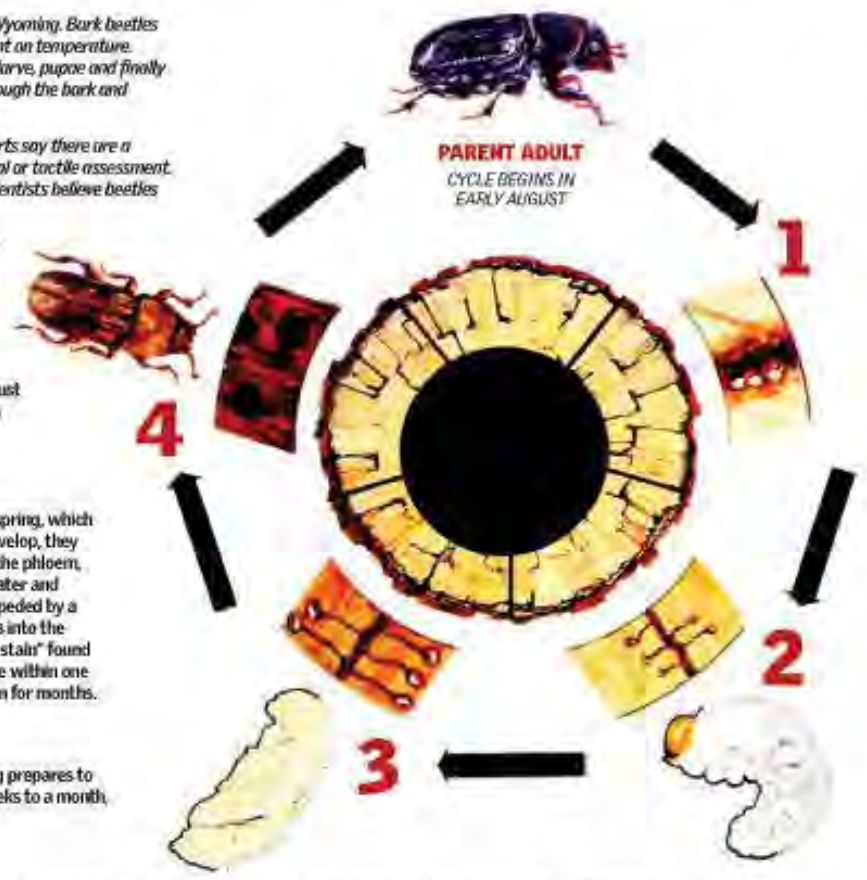
Introducing a tiny insect whose genius lies in its numbers

Life cycle of a bark beetle

The life cycle of a beetle takes one year to complete in Wyoming. Bark beetles are ectotherms, meaning their development is dependent on temperature. Beginning as eggs in a host tree, they then develop into larve, pupae and finally an adult. Once conditions are right, the adults chew through the bark and emerge together from the tree in search of a new host.

Finding a new host is accomplished in a few ways. Experts say there are a combination of identifying factors. There may be a visual or tactile assessment. It may be random, a process of trial and error. Many scientists believe beetles fly until they detect a pheromone plume.

Pheromones are emitted as other beetles chew through the bark and phloem of a tree. This odor can attract thousands of beetles, which then overwhelm the tree.



1. EGGS *AUGUST – SEPTEMBER*

Eggs are laid by the female in a host tree between August and September. Females can lay up to 200 eggs, which typically hatch within one to three weeks.

2. LARVAE *SEPTEMBER – JUNE*

Eggs then develop into larvae through the winter and spring, which are white and less than a quarter-inch long. As they develop, they tunnel around the tree, essentially creating a noose in the phloem, the vascular tissue, which allows the tree to take up water and nutrients. Flow of these vital resources also may be impeded by a fungus that is introduced by the adult beetle as it bores into the tree. The fungus leaves behind the characteristic "blue stain" found in the wood of beetle-killed trees. The tree often will die within one to two years, even though its needles may remain green for months.

3. PUPAE *JUNE – JULY*

In June to July, they develop into pupae, where the bug prepares to become an adult. This typically takes between two weeks to a month, depending on the temperature.

4. BROOD ADULT *JULY – AUGUST*

Between July and August, the pupae morph into adults and prepare to fly. In colder climates, there is only one flight per year, usually en masse. Females choose a host tree and emit pheromones, attracting other beetles by the thousands. They bore into the tree and begin to construct an egg gallery across the grain of the wood. The frass (essentially sawdust) is then cleared out before mating. Eggs are then laid in galleries, and the process begins all over again.

Cross section of an infected tree

Most of the time, the host tree is larger in size, about 8 inches or bigger. Les Koch, forest health specialist at the Wyoming State Forestry division, says that's because the size makes a difference in ability to reproduce: smaller space equals fewer eggs, and fewer eggs means decreasing population.

After choosing a host, shallow tunnels are made called "galleries." Galleries typically extend up along the tree. As they do this, they brush along the phloem, distributing a fungus they carry on their backs, legs and antennae. There are varying viewpoints on the role of this fungus, as little is actually known about it, but it is thought to help reduce the tree's ability to pitch out the beetles, essentially plugging it up. The fungus also seems to provide a source of nutrients for the beetles.

In the absence of natural group mortality (i.e. massive die-off due to a cold snap), populations multiply exponentially, and beetles look for more ideal sources. In a mature lodge pole pine forest, those sources are abundant for a few years.

But as those become scarce, they begin to choose hosts that are less ideal. Koch says that at this point, population numbers will begin to dwindle as their resources begin to dwindle.

"Easily said, they run out of food," he says.

ANATOMY OF A TREE

- **Heartwood:** The central supporting pillar of the tree. It is dead, but it doesn't decay so long as the other layers are still intact.
- **Sapwood:** Pipeline for moving water to the leaves. Sapwood is new wood. As newer rings of sapwood are laid down, inner cells lose their vitality and turn to heartwood.
- **Inner bark, a.k.a. phloem (brown ring):** The pipeline for the tree's food and primary beetle habitat. It lives for only a short time, then dies and turns to cork to become part of the protective outer bark.
- **Cambium cell layer (yellow ring):** It annually produces new bark and new wood in response to hormones that pass down through the phloem with food from the leaves. These hormones, called "auxins," stimulate growth in cells. Auxins are produced by leaf buds at the ends of branches as soon as they start growing in spring.
- **Outer bark:** The tree's protection from the outside world. Continually renewed from within, it helps keep out moisture in the rain, and prevents the tree from losing moisture when the air is dry. It insulates against cold and heat and wards off insect enemies.

PITCH OR EXIT HOLES
Resin mixed with **boring dust**; lack of rain **prevents tree from** making enough **resin to "pitch out"** beetles

"BLUE STAIN"
Beetles carry blue-staining fungi into tree; after one to several months, the sapwood begins to discolor

Main beetles found in Wyoming

Common name	Scientific name	Major host tree species
Mountain pine beetle	Dendroctonus ponderosae	Lodgepole pine, ponderosa pine, bristlecone pine, whitebark pine, western white pine, sugar pine, limber pine and others
Spruce beetle	Dendroctonus rufipennis	Engelmann spruce, white spruce, Lutz spruce, Sitka spruce
Douglas fir beetle	Dendroctonus pseudotsugae	Douglas fir
Pinon ips	Ips confuses	Pinon pine
Western balsam	Dryocoetes confuses	Subalpine fir

By Shauna Stephenson
sstephenson@wyomingnews.com

So, let us start small.

The appearance of the mountain pine beetle probably won't bring any "ooohs" or "ahhs" from the crowd.

Blackish in color, it has exterior armor, the exoskeleton, and a three-region body (head, thorax and abdomen) with two compound eyes, three pairs of jointed legs, two antennae and two sets of wings, one hardened to protect the other.

It's a small beetle, about the size of a grain of rice, cylindrical in shape and dull.

Its eyes are made up of many pieces called "ommatidia," which has been compared to looking through a kaleidoscope. This gives the bug the ability to respond to motion much better than humans, even though our sight is still better. So, while they can see relatively well, they still rely on their other senses to get around, such as their antennae.

The antennae allow them to touch, smell and taste, which helps locate food and identify pheromones of other beetles, which comes into play later. All-in-all, it seems pretty ho-hum. No fancy markings, no pretty colors. Just a drab little bug that, on the surface, looks pretty harmless.

But the genius of the beetle is in its numbers. Alone, a mountain pine beetle is just a little fleck of black, something you might step on and not even hear a crunch, it's so small.

But en masse, it is a force to be reckoned with, a plague of sorts that can take down trees, entire forests and, indeed, entire regions of forests.

To back up a little, there have always been endemic (not to be confused with epidemic) populations of these beetles in our forests, and there are many kinds of beetles that are native to the West: mountain pine beetle, spruce bark beetle, Douglas fir beetle, and the Ips beetle, just to name a few.

For our purposes, we will mainly focus on the mountain pine beetle, because it is the most common and lives in the largest number of tree species. However, there are established and growing populations of spruce beetle and Douglas fir beetle, which also play a role in the bigger picture.

These bugs have been helping the forests regenerate themselves for ages, attacking small stands, killing them, and then allowing smaller trees to regenerate and replace the old stands. They're part of the natural disturbance process that forests need to remain healthy.

In a perfect world, the process works relatively seamlessly. Trees depend on the bugs, and the bugs depend on the trees. The forest gains diversity in small outbreaks, thereby eliminating unhealthy trees, which benefits habitat, wildlife and overall forest health.

The beetles gain a little momentum about every 10 to 30 years, fulfill their biological destiny and then are cut back by a cold winter or by predators. They then quietly recede back into the fabric of the forest to wait for their next opportunity.

In a healthy forest, this isn't a problem. The strong trees survive by flushing out the invaders. Through their own natural defenses, they are able to produce enough resinous pitch to essentially drown out the bugs.

But if a tree is stressed due to drought, damage, competition or many other factors, its ability to produce pitch is reduced and it may succumb to the attack.

On the other hand, even healthy trees may not be able to ward off an attack when beetle numbers are high and they swarm a tree simultaneously, which is the situation we are seeing in the forests today.

Sources: "Bark Beetle Outbreaks in Western North America," by the Bark Beetle Symposium Participants, held in Snowbird, Utah; "What's Eating the Trees" publication, put out by the U.S. Forest Service, Society of American Foresters and the Wyoming State Forestry Division; "Bark Beetles: Are your Trees at Risk?" put out by the U.S. Forest Service; Presentation by the Wyoming State Forestry Division; Public information from Parks Canada, www.pc.gc.ca. Graphics and design by Kiah Stalsgstaff

Beetle impact:
Many of us feel emotions of loss, anger and blame

Continued from A1

there is so much death.

Somewhere in that patch of light, there is the realization that, no, this is not the end of the world. No, this is not the end of the forest. Change is a fact of life, a fact we have ironically forgotten when it comes to Mother Nature.

Even now, small saplings come up, lauded by the fluttering of green, yellow and blue ribbons tied to the trunks of these gray ghosts, trees that will, in short time, fall to the forest floor.

No, it is not the end of the world. But it is a loss to grieve.

This place doesn't even smell like pine anymore.

■

"With the beetle we're seeing ecological changes on a scale none of us have ever seen before," says Bob Lanka, public information officer for the Wyoming Game and Fish Department. "In our lifetime, we will never see the Medicine Bow forest look like it does again."

And so we find anger.

At some point, an outbreak became an epidemic.

At first it was just the lodgepole-dominated forests. Then the spruce-fir habitat. Now pockets of Ponderosa pine are seeing increased beetle activity.

"It's kind of doing what we were afraid it would do," says Bob Cain, entomologist for the U.S. Forest Service Rocky Mountain Regional Office.

People have called this epidemic the biggest ecological change in the history of man, but that can be hard to prove.

True, there have been large-scale pine beetle outbreaks in the past. There are records of them as far back as the late 1800s. It's also true that they are part of the forest and naturally live in low population levels. But it is the size and the spread of this outbreak that has some people worried.

In his comments to a congressional subcommittee, Rick Cables, regional forester for the Rocky Mountain Region, said this particular outbreak is concerning because it is showing up in numbers and places that have been previously unrecorded.

He cited forest history, host susceptibility and changing climatic conditions – especially elevated temperatures and drought – as primary causes.

"The primary difference between previous beetle outbreaks and the current epidemic is people now live, work and recreate throughout the lodgepole pine ecosystem," he told the subcommittee.

It's hard to say if this is the biggest outbreak in forest history because the data for that is difficult to construct.

"We don't really know because we don't have the history," Cal Wettstein, acting incident commander for the Bark Beetle Incident Management Team says.

Experts are able to interpret a number of large ecological events based on the rings of a tree. But the trees that are killed by pine beetle don't live to tell the story.

Since beetles will typically attack larger trees first, smaller trees may show a dramatically increased growth rate when adjacent competition dies, i.e., their rings will reflect when they start to get more sunlight and water. This subtle increase in width of the growth ring can indicate a bark beetle outbreak, but that can be hard to interpret.

The other issue is length of the epidemic.

In the past, these outbreaks have lasted for about 10 years before a cold snap would come in and knock population levels back. But things have grown much larger than they have in the past.

"I think that 10-year course – that's based on what we've seen in the past in smaller outbreaks," Wettstein says. "We're at 10 years right now, and it's still growing. The bark beetle grew to such a level that those factors that would control it in the past really are not going to control it this time."

■

And so we come to blame.

Jerry Paxton, a county commissioner in Carbon County, has a feeling this epidemic could have been stopped if local rangers had the authority to act. He thinks the top-down nature of the agencies in charge don't allow local management of forests, and additionally, don't take into account the best interests of the communities that rely on those forests.

"I firmly believe the best decisions are made closest to where they are implemented," he says.

It's all gotten too political he adds, citing environmental groups locking up forests from management. He says they saved the tree but killed the forest. Now he's trying to figure out what to do with those trees and how to provide jobs for his community in the meantime.


Koch

"They want to save every tree based on emotion, not on science," he says. "Emotion be dammed, let's look at what's best."

Some believe it's that "every tree is sacred" notion that is part of the problem.

"This idea that forests should look Walt Disney is false," says Les Koch, forest health specialist at the Wyoming State Forestry Division.

Koch says he thinks this mentality that every tree should live isn't realistic. He says politics have been part of the problem, preventing the natural cycle of regeneration and creating an unhealthy forest.

"I think the politics are unhealthy," he says. "The biology of the beetle is doing what it should do. We failed politically and socially. Everyone loses when you see a million of the trees die."

"You can point fingers at all kinds of reasons," says Bill Crapser, state forester for the Wyoming State Forestry Division. "Whatever happened, we're where we're at."

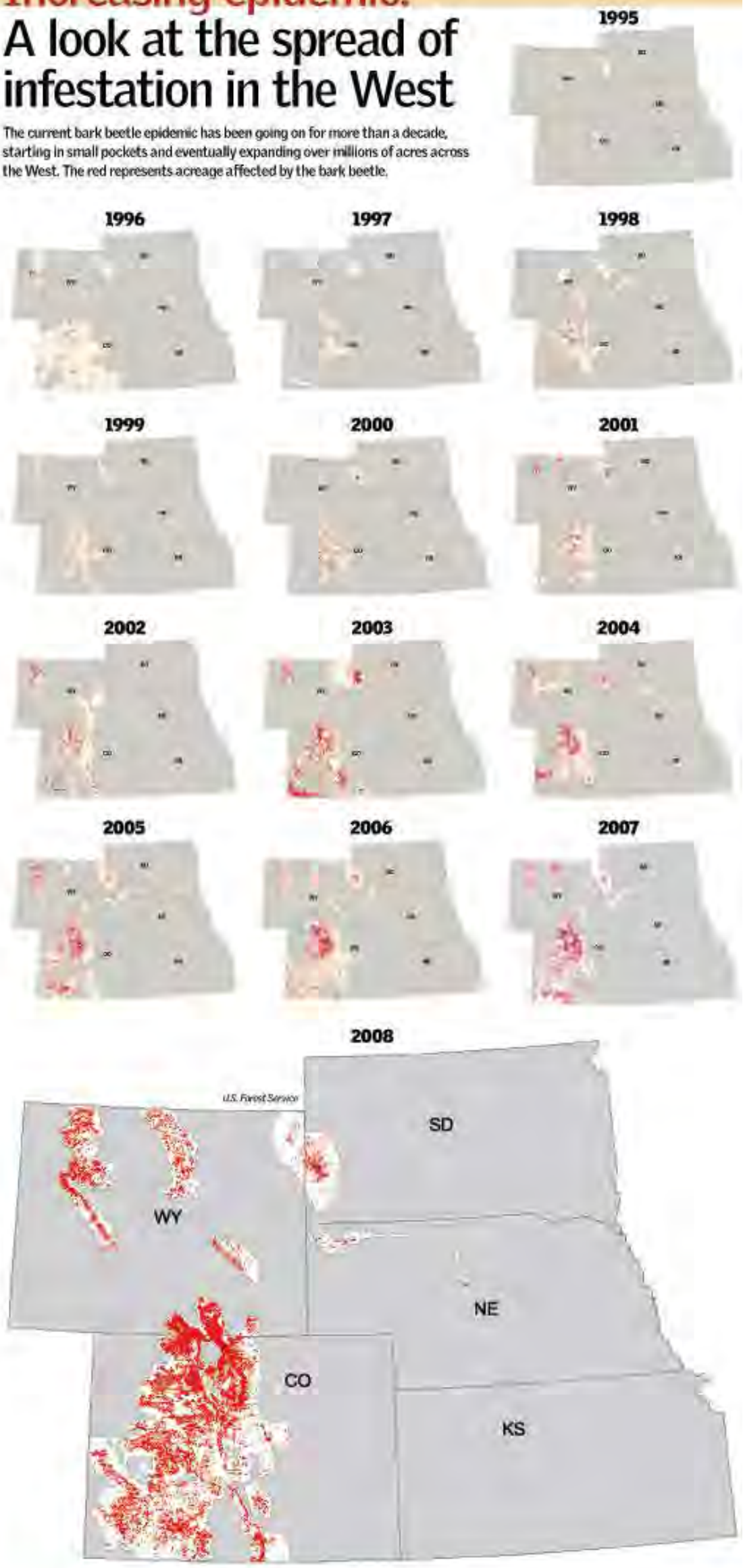
■

To understand the factors at play, we must first understand some of the history of the Medicine Bow National Forest.

See Being realistic, page A8

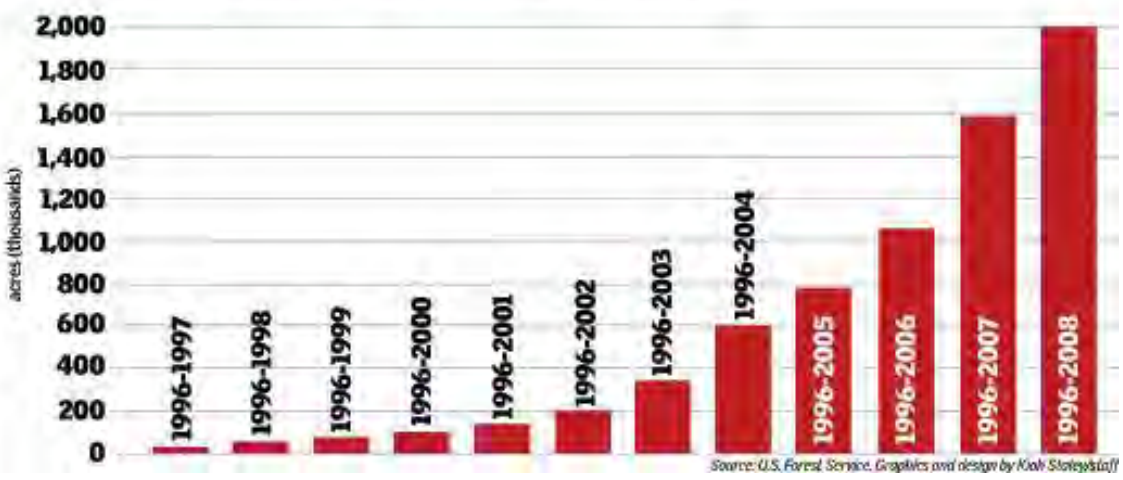
Increasing epidemic:
A look at the spread of infestation in the West

The current bark beetle epidemic has been going on for more than a decade, starting in small pockets and eventually expanding over millions of acres across the West. The red represents acreage affected by the bark beetle.



Cumulative acres impacted

Lodgepole pine trees impacted by the mountain pine beetle in Colorado since 1996.



Source: U.S. Forest Service. Graphics and design by Kaki Stalcup/staff

Being realistic: "The trouble with forestry is it takes so darn long"

Continued from A7

After a tumultuous history of warring tribes, trappers and pioneers, the opening and settlement of the area was sparked by the driving of the golden spike at Promontory Point on May 10, 1869. The Union Pacific Railway chose this region to lay track for the first transcontinental railroad.

Thus began the tie-hacking days. As the railroad was built, timber companies began logging the forest, building up vast piles of logs and then floating them down creeks and rivers, sometimes using dynamite to get them going.

During that era, the land was exploited for natural resources and logging, and ranching and mining were largely unregulated. But in 1899, local residents petitioned President McKinley to set the area aside. That effort was delayed by powerful timber interests, but was finally designated in 1902. After that, the industry was more regulated, setting the stage for modern-day forest management.

Which brings us to today.

Since the days of large stand-replacing fires (pre-Forest Service) and tie hacking, natural disturbance has really been reined in, resulting in one even-aged, even-sized forest – the perfect host for a bark beetle epidemic.

Many point to a mismanagement of the forest or a lack of management of the forest as one of the culprits in this epidemic. But Crapser argues that management is a product of what the public considers socially acceptable.

He says there are basically three schools of thought on how to manage the forests. First, there is the John Muir, founder of the Sierra Club, philosophy, which looks at forests as a sacred place to be left alone. Next, there is Gifford Pinchot, first chief of the U.S. Forest Service, who falls in middle ground, using management such as logging and grazing as tools, but sticking to that multiple-use notion. Last, there is the philosophy from many industrialists of the day, who viewed man as the master of his domain and that nature was something to be tamed.

"In my opinion, a constant shift in society's place on this philosophical continuum has been the number one driver of forest management on our public lands over the last 110 years," Crapser said in a March speech to the Intermountain Roundwood Association.

Carbon County Commissioner Jerry Paxton surveys a stand of dead trees that are located right next to an old clear cut on Oct. 7 just south of Encampment. The clear cut is now full of live trees. Shauna Stephenson/staff

But it seems that societal pendulum is swinging again.

■

So we come to bargaining.

While arguments have been made to let the forest take care of itself through the natural burning process, many managers across the agencies don't view that as an option.

"We're not in a position to just leave it to Mother Nature, because we've got people living there," Crapser says.

He says the pre-settlement argument is a good philosophical point, but it's just not realistic.

Forest management will no doubt change in the future.

"We kind of have a blank slate, really," says Larry Sandoval, Laramie district ranger for the U.S. Forest Service. "It's our opportunity to make the future forest what it needs to be."

Wettstein says the focus will shift to the bigger picture in the future.

"What we've learned over the past 20 some years is we've probably been too focused on that 'timber as a crop' kind of mentality and not entire ecosystems and habitat changes through multiple lifespans of the forest," Wettstein says.

In the meantime, plans will have to be made for how to deal with the economic impact this outbreak will have. Power lines will have to be cleared, water systems will have to be evaluated, and roads and recreation areas will have to be treated. Ranchers will have to adapt their grazing practices, and recreationists will have to find other places to play. Forest communities will have to pitch in to create defensible spaces should a fire come, and volunteer firefighters will be increasingly called upon to defend those places.

"I really think the key is to look at how to work toward a mosaic-type forest," Crapser says. "The trouble with forestry is it takes so darn long. To most people, 20 years is forever."

■

When Bill Munroe, wildlife biologist for the U.S. Forest Service, thinks of the future forests, he thinks of his child.

"We, as adults, look at it as 'what a shame,'" he says. "We look at it as a tragedy, and they look it as the status quo – this is what life is just like right now."

He says most of us have always seen the forest as mature and green. But children and their children's children will be able to witness a forest in action.

"One of the interesting things this epidemic has done is it has changed the perception about the forest," Wettstein says. "You move to this country for scenery and trees and expect it to stay that way. This has been a real eye-opener for a lot of folks, even including the old-school foresters like myself."

John Muir once said, "When we try to pick out anything by itself, we find it hitched to everything else in the universe."

Perhaps the greatest realization in all of this is that our forests still matter to us – and that in a weird way, we are still all intricately linked together. While they may seem distant to some, the change in an entire forest affects everyone.

As one tree falls, another grows. And somewhere in between, we will move into acceptance.

Wildfires

What to do if one is near your house

As the potential for fire increases, residents must make a plan for what do to if a wildfire occurs in their area. To better prepare yourself, make an emergency plan checklist and follow these guidelines.

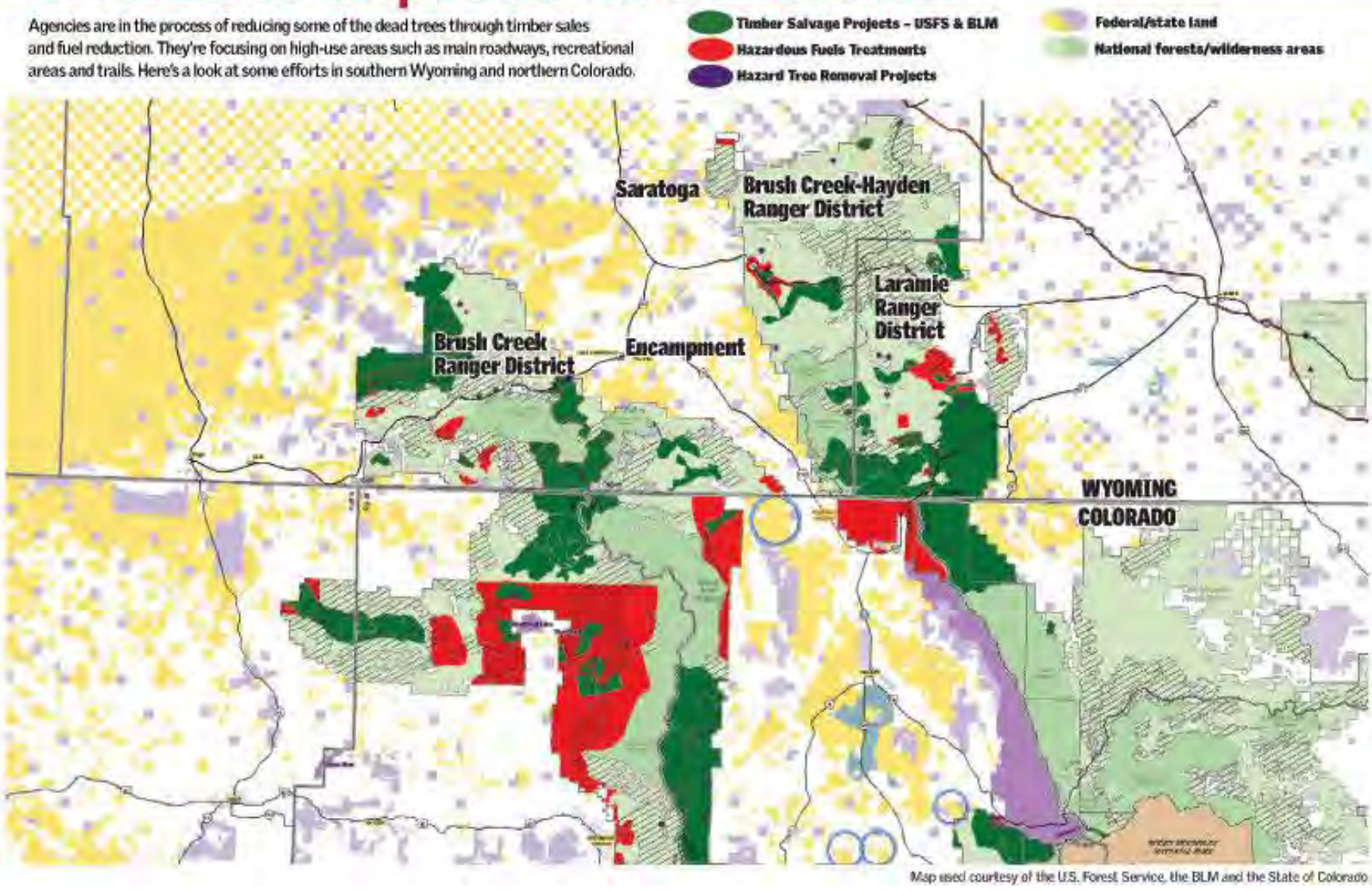
When a wildfire threatens:

- Report the fire to emergency dispatch 911, your local fire department or your local police.
- Back your car into the garage or park it in an open space facing the direction of escape. Shut doors and roll up windows. Leave keys in the ignition. Close garage doors and windows, but leave them unlocked. Disconnect automatic garage door openers so that in the event of a power failure, they can be opened manually.
- Confine pets to one room. Make plans to care for your pets in case you must evacuate.
- Close windows and doors to the house and close all inside doors. Take down drapes and curtains or move them away from windows.
- If time permits, move any remaining flammable materials 30 feet away from around the house.
- Turn off gas or propane/butane supply at the meter or tank. Turn off pilot lights inside the house.
- Open fireplace damper. Close fireplace screens.
- Turn on a light in each room of the house.
- Place a ladder against the front of the house so firefighters have easy access to your roof. Connect a garden hose to outside faucets.
- If you have a combustible roof, wet it down or turn on roof sprinklers.
- Tune in to a local radio station and listen for instructions.

Source: www.firewisewyoming.com

Efforts to improve forest health

Agencies are in the process of reducing some of the dead trees through timber sales and fuel reduction. They're focusing on high-use areas such as main roadways, recreational areas and trails. Here's a look at some efforts in southern Wyoming and northern Colorado.



Map used courtesy of the U.S. Forest Service, the BLM and the State of Colorado

Wyoming Tribune Eagle

SUNDAY, OCTOBER 18, 2009 CHEYENNE, WYOMING WYOMINGNEWS.COM $1.25

"We're at the peak"

Bark beetles are running out of places to go

An area cleared by logging near Encampment earlier this month. In the background is a mixture of live and beetle-killed trees. Michael Smith/staff

BEETLE IMPACT

An in-depth, two-day series

Saturday

- How did we get here, and what role do forests play in our lives?
- Introducing a tiny insect whose genius lies in its numbers. A visual look at the beetle's life cycle and how it affects a tree.
- A series of maps showing the infestation over time.
- What to do when a fire occurs near your home.
- What's being done to improve forest health.

Today

- Beetle habitat is running out. Now what happens? Also, how to protect the trees around your house. **A1**
- An illustration showing the ripple effect that could occur once the trees die. **A6-A7**
- Take precautions now: How to create a defensible space around your house. **A8**
- Profiles on five area residents and how they feel about the epidemic. **A8-A9**
- Some wildlife species will suffer. Others will prosper. **A10**

When beetles come knocking ...

Some tips for protecting your own trees

- Keep pines healthy by watering them year-round. Some healthy trees are able to overcome beetle attacks by pitching the bugs out.
- Spray any pine trunks greater than 4 inches in diameter with an insecticide labeled for killing or repelling mountain pine beetle. This will only be effective on healthy pines that have not been attacked.
- Watch conifers closely for signs of beetle infestation. Some common indicators are globs of sap or pitch called pitch tubes or frass or sawdust at the base of trees.
- Be vigilant with firewood. Gather only dry firewood. If it has bark, peel it back, destroying the beetle's food source. Burn all wood before spring.
- Cover any leftover firewood.
- Thin out dense tree stands, leaving the healthiest, most vigorous ones.
- Increase age and species diversity to increase stand resistance.
- Always clean up any recently blown down trees or slash piles more than 4 inches in diameter.

If you notice signs of the beetle:

- Remove the tree before the beetles have a chance to spread more. Beetles will typically emerge in late spring to early summer. Experts suggest removing the tree before June.
- Spraying once the beetles have attacked the tree is not effective.
- Take infested limbs and trunks to the compost facility on Windmill Road.
- For more information, contact Wyoming State Forestry at 777-7586 or Cheyenne Urban Forestry Divisions at 637-6428. Or go to: http://slf-web.state.wy.us/forestry.aspx and www.cheyennetrees.com.

Larry Sandoval, district ranger for the U.S. Forest Service, right, and Bill Munroe, wildlife biologist for the U.S. Forest Service, look at a map that shows the most recent infestation of pine beetle Oct. 7 at the Laramie office. Shauna Stephenson/staff

The damage is done. Now the trickle-down effect begins. It will change ecosystems, infrastructure and human lives – even those of us who never set foot in the forest.

By Shauna Stephenson
sstephenson@wyomingnews.com

More stories and visuals on pages A6-A10

Laid out on a long conference room table sits a funny-looking map of the southeast portion of Wyoming.

Large orange blotches, marks signifying the most recent infestations of pine beetle, are smeared over the green topographic lines as if a kindergartner had been turned loose to finger paint the Medicine Bow National Forest.

Larry Sandoval, Laramie district ranger for the U.S. Forest Service, and wildlife biologist Bill Munroe hover over the map, noting the new areas on the 2009 draft.

"If you look at it, it moves a lot like a fire front," Munroe says.

"Next year we expect the gaps to be filled in," Sandoval says.

"We're at the peak. They're running out of places to go," Munroe replies.

Looking at this mess of orange and green, it's hard to get a perspective on the widespread nature of this epidemic.

Consider a single tree. As a sapling, it emerges from the ground, taking up a modest amount water per week, converting carbon dioxide into oxygen. As it grows, it provides habitat for wildlife such as elk and blue grouse. It may provide a home and forage for a red squirrel, and in turn, provide a red squirrel meal for a marten.

See Peak, page A2

Peak: Cycle of water changes with the trees

Continued from A1

As it grows, it takes up more water, hundreds of gallons now. Cows belonging to the rancher down the road will bask in its shade. Mountain bikers will stop to lean up against it, sipping water during a break. A hunter will steady himself against it as he readies to harvest an animal.

As the winter comes, its boughs hold the snow, sending half of it back up into the atmosphere to create more weather and permitting half to reach the ground. The boughs shade that snow from the brisk winter winds until spring, where it then melts, trickling down drainages, hydrating riparian areas, which

More stories and visuals on pages A6-A10

hold birds and fish and larger game such as moose and deer.

From there, that water flows downstream, irrigating fields and filling reservoirs, and eventually coming out of your faucet into a glass that you put to your lips and drink.

What will happen when that tree dies?

Now multiply that by millions.

"All those things can trickle down and affect everyone, even if they never set foot on a national forest," Sandoval says.

The ripple effect

When vast swaths of trees disappear, what happens to ecosystems and our infrastructure? No one knows exactly what will happen. But here's a look at how experts say the domino effect *could* play out.

Fire

The wildcard in this entire scenario is fire.

As the trees first begin to die, fire hazard goes up, specifically canopy fire, because of the presence of dead needles. If a fire were to go through the crown, it could be a large fire, but the lasting effects wouldn't be completely devastating.

As the needles fall off, fire threat goes down and stays moderately low while the dead trees remain standing.

"It goes pretty low, because there's no aerial fuel to carry fire through the crowns quickly," says Cal Wettstein, acting incident commander of the bark beetle incident management team.

But as the trees fall, the fuel load on the forest floor increases. Simultaneously, the forest has started to re-generate in the previous years, sending up saplings, shrubs and grasses. This is when the threat of surface fire is at its greatest.

These will be the high-intensity, high-severity fires – the ones you can't put out. When those come through, they can burn off a lot of that re-growth that has popped up in intervening years and even sterilize the soil. Once that happens, watersheds can be affected, eventually causing problems in infrastructure for municipalities.

IMPACT: An increase in fire danger will mean more acres will burn, more homes will be destroyed, more firefighters will be put at risk, and more money will be spent on fighting fire. On the extreme end, it could mean damage to watershed and infrastructure if fires are severe enough.

Funding

While funding is beginning to roll in for pine beetle projects, the overarching issue remains.

"The reality is, Congress only funds us so much to treat so many acres," says Larry Sandoval, Laramie district ranger for the U.S. Forest Service.

Part of the problem is the vast acreage that needs to be addressed. Add to that the disagreement over how to address it, and the task of funding becomes even more difficult.

Currently work is being done to reduce fuel loads, especially in the areas where people live, also called the urban interface, but it can be difficult to find enough funding to deal with an issue that seems to multiply exponentially.

Cal Wettstein, acting incident commander of the bark beetle incident management team, says it is far more cost-effective to put money into prevention than trying to stop fire.

"It makes a lot more sense to do this work upfront than it does to wait for the fire to come," he says.

While there has been a lot of congressional support for this issue, the scope of the pine beetle outbreak makes it challenging to fund everything.

"It's difficult because there are high priorities all over the national forest system. The Forest Service budget has been declining for several decades. It gets more difficult to get the necessary funding to address these high-priority issues."

IMPACT: More dollars may have to come from the pockets of private stakeholders. While government agencies are scrapping for every dollar they can get, there's only so much money to go around.

Fisheries

The next 10 to 20 years will be a balancing act for fishery managers.

On one hand, additional woody debris from fallen trees can have a good effect on habitat for fish. On the other hand, too much debris can do more harm than good. Add to that the fire wild card and nothing, it seems, can be guaranteed.

Mike Snigg, Laramie region fisheries supervisor, says fire will play a major factor in this entire process.

"Controlled fire is beneficial," he says.

But when it gets too hot, the soil is sterilized, and ash enters surrounding streams and kills the fish. This happened in the early 2000s in the Laramie Range when a fire got too hot, sterilizing the soil and killing fish in Duck Creek and Ashley Creek. Both had to start from scratch.

Additionally, runoff may change, which could have an impact on water levels and water quality. The increase in water could be beneficial for fish in reservoirs, but it remains to be seen what will happen to habitat in streams and rivers.

"The forest will change, but Mother Nature adapts," he says.

IMPACT: Fishery managers will have their job cut out for them in the upcoming years. Much of the future depends on water quantity and quality and the presence and severity of fire. If fisheries die out, more dollars will have to be pumped into restoring them.

Utilities

Utility companies across the West are assessing the cost of removing trees along hundreds of miles of distribution and transmission lines.

Chuck Larsen, general manager of Carbon Power and Light Inc., says their company has about 34 miles of distribution line that needs to be cleared, which sounds easy, but it's not.

Larsen says he has been working for the past three years to get approval to remove hazard trees along his power lines. In the past, they were only responsible for maintaining their right of way, about 20-30 feet around the power line. But in a meeting requested by Larsen about three years ago, the Forest Service informed them they were now financially responsible for removing dead trees about 150 feet outside their permit area. And not only that, they were liable if any tree fell and started a forest fire by contacting their power line.

This was surprising news to Larsen, who then increased his general liability insurance from $4 million to $10 million.

After a lot of bureaucratic hoop jumping, an environmental assessment was just recently completed, giving them the go-ahead to start clearing that space.

"It's just a huge issue for us. I've been over this thing so many times," Larsen says.

The cost of 34 miles? More than $1.5 million.

IMPACT: While utilities are trying to keep the cost of energy low, the cost of tree removal is going to be in the millions of dollars. This may or may not be passed on to the consumer. And the process is just beginning. Carbon Power and Light Inc. is one of the first companies to complete an environmental assessment.

Recreation

Recreationists may feel the biggest impact.

Forests will become less safe for travel. Hikers and mountain bikers will have to choose their routes more carefully, always watchful for adverse weather. Hunters will have to adjust their hunting spots based on accessibility and changing movements of local game. Anglers will have to adjust based on timing of runoff and water quality.

More damage will be caused both to gear and to people. Inevitably, deaths will result from falling trees.

Agencies are working quickly to try to minimize that possibility by removing trees along roadways, trails and established recreation sites. In Wyoming alone, there are 611 miles of road, 51 miles of trail and 139 developed recreation sites affected by hazardous trees. In the Medicine Bow-Routts, White River, Arapaho and Roosevelt National forests in Colorado and southern Wyoming, there are 911 miles of trails, 3,467 miles of road and 21,455 acres of developed recreation sites that have to be cleared.

"We're going after those areas where people congregate and where they recreate first," says Mary Ann Chambers, public affairs officer for the Rocky Mountain Region Bark Beetle Incident Management Team.

IMPACT: Those who play in the great outdoors are going to have to adapt just like the environment. Traditional recreation sites will close and reopen based on safety. Game animals will adapt, and the quality of fisheries may change in the short-term.

Snowpack

Live trees have a number of functions when it comes to snowpack.

First, they are windbreaks of sorts, helping to knock the snow down. They also keep it stacked and protected from wind, holding it until spring, when it melts and makes its way into streams and rivers.

They also help put some of the snow back into the atmosphere. About 50 percent of the precipitation that falls is caught by pine boughs and then re-evaporated says Matt Hoobler, North Platte River coordinator for the Wyoming State Engineer's Office. This can vary based on location and temperature.

So what happens when there are no boughs to hold snow or trees to keep it cool?

Experts say snowpack will actually increase.

Hoobler says even fallen trees hold snow, and without boughs to hold it, more snow will make it to the ground, causing increased snowpack. This, combined with the water the trees are no longer taking up (because they are dead), will then cause a gradual increase of runoff.

In the past, runoff was characterized by a sharper spike in water flows. In the future, he says, we will see runoff increasing more gradually, lasting longer, and then decreasing gradually – a sort of elongated bell curve.

However, a hot fire through downed trees could change all of that.

"When fire comes, the area won't hold snow," Hoobler says. "It'll blow to Nebraska instead of flow to Nebraska."

Which brings us to water law.

Currently, Wyoming cannot capture any flow until May 1. Most of that water goes to Nebraska. A drastic change in water quantity could mean a re-examination of that agreement – but it would have to be pretty drastic.

"Timing of runoff – even though it is on a rigid schedule set with the decree – it's not as much of an issue. It's the yield issue that is a big factor."

IMPACT: Snowpack is going to change one way or another in the next 10 to 20 years. Experts predict snowpack amounts will go up, and runoff will be more gradual and longer. However, a large, hot fire could change that scenario pretty quickly.

Text by Shawna Stephenson-Hoff
Graphics and design by Matt Shelby-Hoff

Water yield

The big question in the water business is "how much?" Currently, much of the West and many larger cities are dependent on snowpack for their water resources.

In testimony during the Subcommittee on National Parks, Forests and Public Lands on June 19, Rick Cables, regional forester for the Rocky Mountain Region, noted the grave importance the water question carried.

Cables said about 33 million people rely on water from the Rocky Mountain region. The sales of the water numbers in the billions of dollars.

With that in mind, it makes sense to put an enormous amount of importance on this issue.

Matt Hoobler, North Platte River coordinator for the Wyoming State Engineer's Office, says ongoing research is trying to answer that all-important question.

"The pendulum is swinging toward more (water)," he says.

Look at it this way, he explains. When trees are alive, they are taking up hundreds of gallons of water through their root systems each day. A lodgepole that is one to two years old takes up five to 10 gallons of water per week. A mature lodgepole takes up 100 to 200 gallons of water per day.

Now multiply that water uptake by the number of trees in the forest, and you have a significant increase in water availability on the trees' die.

But that increase in water isn't necessarily a good thing, says Hoobler. As water volume goes up, the quality of that water may go down. Rivers may experience an increase in sediment, which could affect fisheries, riparian areas, even municipalities and cities, which depend on that for drinking water.

IMPACT: A change in the amount of water could have a large impact on how we use water. If water yield increases, the quality may go down. This also could mean an increase in flood threats in some areas.

Cheyenne water

So what does all of this mean for Cheyenne's water?

It depends. Currently Cheyenne's water comes from several different sources. Part of it comes from reservoirs, which are fed by snowmelt, and part of it comes from underground aquifers.

One part of that reservoir complex involves the Sierra Madre mountain range, an area hard hit by pine beetle.

Water is collected in the Little Snake River basin and transmitted into Hog Park Reservoir. Because of the cost of moving water over mountain ranges, an exchange was arranged with Rob Roy Reservoir. The closer and more accessible Rob Roy is actually filled by the Douglas Creek drainage in the Sierra Madre, which also has been hard hit by beetles.

Essentially for every unit of water taken out of Rob Roy, an equal unit of water is released into the North Platte River (not necessarily at the same time), keeping this complicated system in balance.

Water is then stored in a series of reservoirs and distributed to residents of Cheyenne.

IMPACT: If snowpack and resulting water yield changes, there could be changes to the amount of water in reservoirs, which has the possibility of affecting Cheyenne residents.

However, if the predictions hold true, there will be more water in reservoirs, not less.

Climate change

A quick science refresher: Plants are known as natural air cleaners. Carbon dioxide enters through the stomata, mixes with water, light and oxygen and sugar are produced. When the plant dies, carbon is again released.

So what happens when entire forests not only stop taking in carbon, but also start releasing it?

According to a study published in the April edition of Nature, these forests become large producers of carbon.

The study "Mountain pine beetle and forest carbon feedback to climate change" looked at the pine beetle outbreak in British Columbia. That outbreak has been going on a few more years than the one in the Rocky Mountain West.

Researchers found that the forests go from a carbon sink (taking up carbon) to a large net carbon source. They estimated that a region of about 144,000 square miles would produce 270 megatons of carbon over a 20-year span.

"In the worst year, the impacts resulting from the beetle outbreak in British Columbia were equivalent to 75 percent of the average annual direct forest fire emissions from all of Canada during 1959-1999. The resulting reduction in net primary production was of similar magnitude to increases observed during the 1980s and 1990s as a result of global change," the authors wrote.

In addition to that, there are other interactions in particles, says Alex Guenther, senior scientist at the National Center for Atmospheric Research.

As beetles attack, trees release oils and sap as a defense. These chemicals then go up into the atmosphere, where they can impact ozone and other particles, and it is these small changes that may impact cities that already have air-quality issues, pushing them out of compliance.

IMPACT: As trees die, they release carbon. However, as smaller trees begin to grow, they take up that carbon. Researchers predict an increase in carbon over the next 10 to 20 years. There also may be shifts in ozone, causing problems for cities that already have air-quality issues.

Weather

No one really knows for sure how bark beetle will affect the bigger picture of our weather and climate, but a study is currently under way to model the possibilities.

The study is called BEACHON, pronounced beacon, which stands for Bio-hydro-atmosphere interactions of Energy, Aerosols, Carbon, H2O, Organics and Nitrogen. It is funded by the National Science Foundation and involves the National Center for Atmospheric Research, university groups and other researchers.

Alex Guenther, senior scientist at NCAR, says forests play a factor in shaping weather patterns. As precipitation hits their boughs, a certain amount of it is re-evaporated into the atmosphere.

"When trees are dying or die, they don't transpire," he says. "They don't release water anymore. That has a big impact on the weather."

He says this could have an impact on other regional weather by changing the distribution of where it rains.

"If you can impact the atmosphere, then you can impact the whole region," he says.

However, these changes may not be noticeable in our everyday lives. He says statistically, yes, things will change. For instance, for every increase in degree, there are statistically certain increases in hospitalizations due to heat. But daily changes may be hard to recognize.

IMPACT: It's hard to say exactly, but there is potential for increases in temperature, changes in precipitation and changes in general weather patterns. Only time will tell the degree to which these will change.

Urban trees

When trees are removed, their thermal cover goes with them.

In town, beetles have made the jump into parks and residential areas, causing untold amounts of tree loss.

Lisa Olsen, director of the city's urban forestry division, says Cheyenne has been proactive about preventative spraying.

"I think we're doing pretty good within the city limits," she says.

She says the areas that were sprayed have survived, but the areas that were not are starting to see some infestation.

With Cheyenne being so far from a forested area, it is thought that the beetles were brought in with infested firewood. There also is a theory that they were blown in with the wind currents. Either way, Olsen advocates being diligent about firewood and spraying at-risk trees.

"It's more than just the tree that's going to be removed," says Bill Cropper, state forester for the Wyoming State Forestry Division.

People will see heating and cooling bills go up as trees come down.

"It's an interesting predicament we've gotten ourselves into," he says.

IMPACT: As trees are attacked within city limits, they will have to be cut down, taking thermal cover and aesthetic value with them.

Wildlife

Members of different species will experience different impacts from bark beetle, depending on their role in the ecosystem. Reliance on certain types of habitat will play a large role in their adjustment to a changing forest.

For instance, three-toed woodpeckers will benefit immensely from this. In the short term, their populations will spike due to the availability of habitat (dead trees) and the abundance of food (beetles).

Other wildlife such as pine martes, blue grouse, red squirrels and boreal owls will experience temporary losses.

Aspen stands are predicted to increase, eventually increasing the diversity of the forest, which also will benefit species such as elk.

"These increases in animals may be short-lived, and then things will kind of come back down to normal," says Bob Lanka, public information officer for the Wyoming Game and Fish Department. "In our lifetime, we will never see the Medicine Bow forest look like it does again."

IMPACT: As wildlife changes, management actions will have to change. Changes in game populations may mean changes in the number of hunting licenses. Close monitoring will be required over the next few decades.

See A10 for more about impacts on wildlife

"I love trees too. But I recognize the fact they're a plant. They have lifecycles too. What we've got to get past is the idea that it's bad to cut a tree." – **Jerry Paxton** Carbon County commissioner

Chuck Larsen – Carbon Power and Light Inc., general manager

On one wall of his office hang photos of adventures past. Horseback trips, hunting trips, fishing trips, you name it.

Chuck Larsen gets up from behind his desk, lugging an eight-inch thick file with him, a white binder with hundreds of pages in it.

It's the paperwork he's done to clear 34 miles of power line from falling trees. The process has taken more than two years.

Larsen is the general manager of Carbon Power and Light Inc. in Saratoga. The company is a Rural Electric Cooperative providing power to the south-central portion of Wyoming. It is a smaller company, with just 3.3 customers per mile of line.

Currently, Larsen and his colleagues have distribution lines running through the national forest providing power to small cabin communities. Every time they run a line, they apply for a "Special Use Permit" which grants them the right of way to run those lines. In having those "rights of way," they are required to keep about 20 to 30 feet on either side of the line clear, removing trees that might become hazardous.

In the past, trees outside of their right of way were not their problem, which was fine in a healthy forest situation, he says. They were allowed to remove them if they were an immediate danger, but for the most part, it was left up to the Forest Service.

Larsen says that all changed with this bark beetle epidemic.

He says during a meeting with the Forest Service, he was informed that trees outside of their right of way – about 150 feet out – were now their responsibility, and, not only that, they were liable should any tree fall, contact the power line and start a forest fire.

"For my part, I wrote numerous letters and met with Forest Service officials, Wyoming's congressional delegates, the Rural Utilities Service, the National Rural Electric Cooperative Association and neighboring electric cooperatives expressing my concerns and to attempt to seek some cohesive common ground in addressing the problem," he told a congressional subcommittee on June 16. "Unfortunately... it was clearly apparent that no one knew just what to do. At this point, I must admit it felt pretty lonely out here in Wyoming."

Chuck Larsen, general manager of Carbon Power and Light Inc. in Saratoga, speaks about the mountain of paperwork he has compiled since the pine beetle outbreak began. Michael Smith/staff

Since then, he says, they have increased their liability insurance from $6 million to $10 million. An environmental assessment was recently completed, and they are waiting for bids to come back on the contract. Originally, they were looking at $1.3 million to $1.5 million to remove those trees. But costs are rising.

"I'm afraid it's going to come in much higher than that," he says.

He says he hopes these costs won't trickle down to the consumer, but it's hard to say.

"The revenue derived will never pay for this project," he says.

In the meantime, he thinks the forest rules and regulations need to be re-addressed and changed.

"Carbon ventured into this issue and laid the groundwork for other utilities in Colorado," he says. "It's one of the prices you pay for being first."

Larsen says something needs to be done to manage forests. He takes issue with environmental groups that say the forest should remain untouched.

"I'm as much of an environmentalist as anyone. I want the forest taken care of," he says. "If it was supposed to go natural, we wouldn't be here. But since we are, it has to be managed."

Jerry Paxton – Carbon County commissioner

Jerry Paxton stands in the middle of a group of dead trees.

Dressed in his cowboy boots and black cowboy hat, he inspects the trunk of a tree that still has green needles. Tell-tale pitch tubes extend from the trunk, foreshadowing its future.

The trees in this stand have been selectively logged, thinned to increase spacing, a technique some have touted to help slow the spread of bark beetle by decreasing competition for water and sun and increasing the health of the ones that remain. But their needles are all brown.

"Well, how much good did that do?" Paxton asks, looking skyward.

To his left is an old clear cut, filled with young trees. Their needles are all still green.

Paxton is a fiery guy to start with – certainly not afraid to tell you exactly what's on his mind. But he has a very frank way of making points.

Since the beetle outbreak reached epidemic levels, Paxton and other Carbon County commissioners have been hard at work trying to put the forest back to work. He says times like this require action.

So he is trying to position his county to take advantage of the current epidemic.

"There's no way you can stop beetle kill right now. You can only pick the lemons and make lemonade," Paxton says.

After receiving a business-ready grant from the Wyoming Business Council, the community started to update the infrastructure at the old mill in Encampment.

The saw mill, which closed about five years ago, leaving a good chunk of the community without jobs, is now home to a budding log home business that builds homes from the beetle-killed trees and a greenhouse. It also may be the future home of a biomass plant aimed at creating green energy from pine beetle-killed timber, but negotiations are still in the process.

"I think we need to look beyond the conventional timber industry," Paxton says.

Carbon County Commissioner Jerry Paxton surveys a stand of dead trees that are located right next to an old clear cut Oct. 7 just south of Encampment. The clear cut is now full of live trees. Shauna Stephenson/staff

If they were to focus on timber byproducts, there wouldn't be the traditional timeline in harvesting the timber. Most timber used for lumber products is only good for 5 to 7 years after it dies.

But to have a successful industry, you need to have a ready supply of products, which at the moment isn't a problem. It's looking down the road that becomes dicey. Paxton says the Forest Service has made no indication they would want to continue issuing permits at the same rate in the future for raw material.

"That's the 900-pound gorilla,"" he says. "They're not going to invest several million dollars into a business that is not going to be sustainable because of a lack of raw product."

It's that bureaucratic process that Paxton says is flawed from the start.

"The best decisions are made closest to where they are implemented," Paxton says.

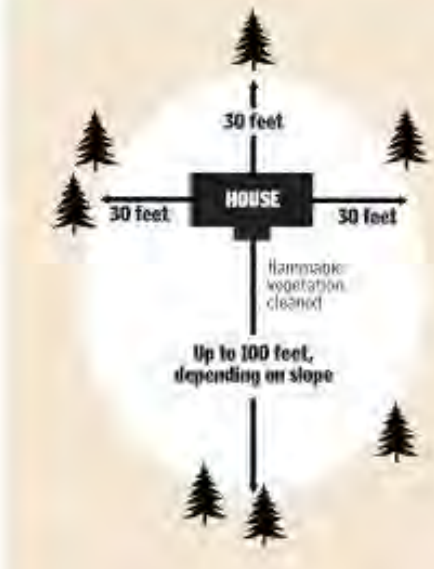
He wants to see the process become more bottom-up again, allowing locals to become more empowered when it comes to decisions affecting their own backyard.

"No one wants to deviate. They're going by the book," he says. "The hell with the book, I say."

Before running for county commission, Paxton was the ag teacher and later the principal at the Encampment school. He also ran outfitting trips in the mountains, taking people on horseback rides into the forest.

"I love trees too. But I recognize the fact they're a plant. They have lifecycles too," he says. "What we've got to get past is the idea that it's bad to cut a tree."

How to create a defensible space around your home



Defensible space is traditionally defined as the 30-foot area around a house. However, with the spread of bark beetle and the increasing number of homes in forested areas, that space can be much larger. A good rule to follow is to try to make your home the one firefighters would want to hole up in should a fire approach.

To create a defensible space:

- Clean the area of dead trees, fallen branches, twigs, leaves, dead shrubs and trash.
- Replace native plants with ornamental landscaping plants or shrubs that are fire resistant. Space shrubs 15 feet apart and no higher than 18 inches.
- Prune tree branches to provide a 10-foot clearance from the roof and 15 feet from any chimney.
- For trees taller than 18 feet, prune lower branches within 6 feet of the ground.
- Stack firewood and scrap woodpiles 30 feet from any structure.
- Space trees so their crowns are at least 10 feet apart.
- Keep grass cut to 2 inches and keep well watered.
- Keep driveways and access roads clear. Trim any overhanging branches up to at least 15 feet.
- Consider providing an emergency water supply of 1,500 to 10,000 gallons, with a gasoline-powered pump in case electrical power is lost.
- If your water supply is a well, consider a gasoline-powered electrical generator for the well pump.

Source: www.firewisewyoming.com

Graphics and page design by Kiah Staley/staff

Profiles by Shauna Stephenson | sstephenson@wyomingnews.com

Art Reese – private consultant and forest property owner

Up a hill, tucked away in the mountains, is a quaint, cozy little place, surrounded by a few other quaint, cozy little places.

Around that are acres of beetle-killed trees.

This particular cozy little place is painted brown and gold – dubbed the shrine to Cowboy Joe by its owners, Art Reese and his family. The cabin has a front porch where occupants can sit and look out onto the forest.

The aspens are starting to turn up here, and fall is in the air. On either side of his cabin are large forests of lodgepole pine, turning red and brown. Large slash piles line the road on either side.

The community up here has banded together to create a defensible space. They are hoping to spare their structures should a wildfire come through.

But the thought of wildfire doesn't really bother the Cheyenne resident.

Sitting at his kitchen table, he is flanked by two large windows. Western-themed draperies frame them, and groceries sit on the counter in anticipation of the following day's deer hunt.

The Reeses have owned the property since 1996, and the cabin was built in 2000. He crosses a leg and considers the changes this place has seen in the past 10 years.

"Usually, (change is) at glacial speed. Now you're seeing ecology in action," he says.

Reese worked for the Wyoming Game and Fish for a number of years before going to work for the government on federal land policy. He is now a private consultant. His background gives him an interesting perspective.

Cheyenne resident Art Reese sits in his cabin near Lake Owen in Albany County earlier this month. Reese and some of his neighbors applied and received grants to help with the cost of removing beetle-killed trees. Michael Smith/staff

"No one saw this coming," he says. "The Forest Service had an extremely difficult job."

He says whenever the agency would come up with a solution, it would get sued. Overlapping interest stymied any progress that might have been made.

He doesn't seem too upset by the situation at hand. Dozens of hours of work have gone into preparing these properties for the possibility of fire.

Reese and some of his neighbors applied and received grants to help with the cost of removing trees and have been doing so with great gusto. He says he's already seeing dramatic changes in their view. Sheep Mountain now appears in full, and other views are opening up as trees come down. It's just part of the price of being here.

But what if it burns?

This does not seem to phase him.

"If you have a fire, you'll still have the property," he says. "You've just got to be pragmatic. Otherwise, you shouldn't be here."

Scott Davis – Albany County fire warden

In his career as a firefighter, Scott Davis has changed his perspective on the natural course of things.

The Albany County fire warden grew up in a fire family. His father was a firefighter. Back then, fires were all bad and snuffed out immediately. Smokey the Bear was the poster child of forest fire, creating generations of "fire is bad" mentalities.

Watching the outbreak of pine beetle go from small patches to entire forests, Davis has started to rethink his stance.

He's a guy who has stood in front of wildfires before, feeling the hair on the back of his neck raise up as it approached. He's seen the destruction they cause and the resources they use. But he can't help but think they're an important part of the process.

"It took a long time to change my mind," he says. "The best thing is to burn when the needles are still on the trees."

Where all fire was once bad, he sees value in it now.

"Let nature have some of its reign back," he says. "It has its place in the scheme of things."

He drives through a tight stand of trees. Cabins sit in the middle of the forest surrounded by fuel. Dead and dying trees surround them. Firewood is piled up along their porches. They are seasonal properties, no doubt, and they have yet to hop on board with the defensible space concept.

"These fires have the potential of getting a lot worse a lot faster," he says.

Davis says it will be places like this that don't stand much of a chance at being saved should a large fire come through.

And they will come through, he says.

"We are expecting the big one, and all our planning is going toward that," he says.

Scott Davis, Albany County Fire Warden, explains the difficulty firefighters will have saving structures in heavily forested areas. Davis recommends that homeowners who live in fire-prone areas become educated in creating defensible spaces. Shauna Stephenson/staff

Part of the problem is if the property is on national forest, it takes one to two years to get through the approval process to remove the fuel in the surrounding vicinity.

Davis says about half the structures in the forest are in this type of condition.

"The forest is not the value at risk now," he says. Rather, it is the people and the structures within it.

And in these rural areas, it will be more difficult to save those structures. Much of the fire departments here are made up of volunteers. Terrain makes navigating these areas harder.

He says the upcoming years are going to be challenging for volunteer firefighters. To be placed in front of a raging wildfire is a scary thing, something they will increasingly be asked to do.

Davis says the hard part for him is just the waiting.

"I would rather burn and be done with it than wait," he says.

Across the main road and down another one-way, cabins spring up from nowhere. The road is tight and hemmed in by trees.

"Would you want to be in here if trees are burning?" he asks. "We burn as easily as you do. We don't want to be here either."

Mark Eisele – Wyoming Stock Growers Association, first vice president

Mark Eisele is a man of many opinions.

Part owner of a ranch just outside of Cheyenne, the first vice president of the Wyoming Stock Growers Association has watched the pine beetle outbreak grow to epidemic proportions, all the while wondering what will happen to his cow-calf operation.

The operation utilizes grazing leases on Pole Mountain and the Medicine Bow National Forest. Each year, the work associated with those leases grows.

For the areas they can graze, labor has been almost doubled. Where it used to take a couple of days to repair fence before turning cows out, it now takes a couple of weeks. Most of that time is spent cutting dead trees off of fences.

The action of fixing fence also is becoming more dangerous as trees begin to fall.

"We do the forest a big benefit by going in and harvesting the grasses and forage underneath," he says.

However, with the pine beetle epidemic, those permits go into question. He predicts there will be a time they won't be able to access the forest for awhile due to large areas of downed trees or wildfire.

"This is the kind of problem where we can see the wreck coming," he says.

The potential of losing livestock to a wildfire is certainly there, he says. He's seen their behavior with grassfires.

"They'll crowd into a corner and burn to death," he says.

Mark Eisele, part owner of a ranch outside of Cheyenne and member of the Wyoming Stock Growers Association, has watched the pine beetle outbreak grow to epidemic proportions. Michael Smith/staff

Eisele says when the cattle industry is affected, everyone is affected. It's not just the meat industry that they supply.

"There's such a huge disconnect with this society that we forget where those products come from," he says.

He cites the use of cattle products or cattle-based technology in pharmaceuticals, cosmetics, lubricants, firefighting foam, silicon chips, film, ball bearings, mayonnaise, crayons and insulin.

"When there is damage to the cattle industry, society ends up paying," he says.

He says that if his operation loses too much grazing area, he might have to cut back the size of the herd, an option he's not to crazy about.

He thinks something should be done to reduce fuel loads and remove dead trees.

"Man is already a part of the equation, whether he accepts that or not."

"It took a long time to change my mind. The best thing is to burn when the needles are still on the trees. ... We burn as easily as you do. We don't want to be here either." – Scott Davis Albany County fire warden

Sure, you're worried about the elk.
But what about the boreal toad?

This graphic is based on a set of predictions made by biologists at the U.S. Forest Service. Predictions are based on insights into how wildlife uses forests and an understanding of how the forest changes when there is no management by agencies. Fire or management decisions could change these possibilities.

	PRE-EPIDEMIC	1-5 YEARS	6-20 YEARS	21-80 YEARS	81-200 YEARS
Three-Toed Woodpecker	Seek out older forests because of the abundance of dead trees for nesting habitat and bark and wood-boring beetles for food. Not very abundant in numbers, but their population spikes following disturbance.	Dramatic increase in habitat quality and population. Numbers usually remain high for about 3-5 years and decline within 2 years of the beetle decline.	Abundance is closely tied to prey abundance, so while habitat will still be readily available, prey will decline. Birds will become scarcer than they were pre-beetle, except in places with more tree diversity.	A few trees will be susceptible to pine beetle by this point, giving birds some foraging opportunities. Numbers may increase slightly, close to pre-beetle populations.	Nesting habitat will be abundant, as will foraging habitat. If mature trees experience beetle kill again, populations levels will again increase.
Pine Squirrel	Pine squirrels (aka red squirrels or chickarees) rely on mature forests capable of producing seed. Can live in multiple habitats. Important prey for northern goshawk, American marten, Canada lynx and great gray owl. Also thought to influence forest regeneration.	Lodgepole-dominant forests will see a steep decline. Populations will drop within 3 years of tree stand death.	Populations will remain similar to those directly after the epidemic.	Habitat will gradually increase, resulting in recolonization of some sites. Food sources will become more available, and conditions for caches will improve. Nest sites will be limited.	Abundance and distribution will increase region-wide, possibly exceeding levels experienced prior to forest mortality.
Olive-Sided Flycatcher	Common throughout the Rocky Mountains and forested portions of Canada. Prefer mature forest stands with dead trees and snags for perches and open spots. The juxtaposition of mature trees and forest openings is important.	Response to beetle-killed forests will be gradual. As gaps in the canopy open up, birds may begin using the habitat. As the overstory begins to fall, that use will increase.	Habitat will be more suitable for the flycatchers, especially in areas where forests are diverse.	Populations will slowly decline to pre-outbreak levels as edge habitats decrease. Lodgepole pine habitat will become unusable as it matures.	Conditions will decline for the flycatcher during the first part of this time period. But as edge habitats increase, so will populations.
American Marten	Typically found in higher-elevation forests, but exist in relatively low population levels. Require habitat that can fulfill their need for food, security and year-round occupancy. Diet: small mammals. Prefer overhead and ground cover of mature forests.	As lodgepole pine canopy disappears, martens will begin to decline in small numbers and distribution, giving some individuals larger territories. Groups will become more isolated from other adjacent populations.	Much of the lodgepole pine forest will become unsuitable habitat for martens. Predictions say there will be about a 35 percent decline in population.	Martens will have spread back out from post-beetle habitats to a regenerating forest.	Habitat will be returned to moderate quality and will continue to improve, allowing animals to maintain smaller territories and therefore boosting the population.
Northern Goshawk	Nest in a variety of trees, but most commonly need mature forests with large trees, relatively closed canopies and open understories. Hunt a variety of prey, most commonly squirrels, rabbits, hares, woodpeckers or game birds.	Changes due to pine beetle are expected to be minor in this time frame.	Goshawks that traditionally held territories within beetle-killed area will begin to occupy other habitats within the vicinity. Populations may decline slightly.	Habitat for the birds will begin to improve, possibly increasing populations.	Pine forests will become good habitat again, stabilizing any losses the birds may have had in previous years. Populations may even increase slightly depending on habitat.
Boreal Toad	One of three subspecies of western toads. Found throughout the West, including some isolated populations in Wyoming. Wide spectrum of habitats. Usually depend on spring breeding pools of barely moving, shallow water and debris piles or underground holes for hibernation.	Boreal toads are already rare in Wyoming, but with habitat in declining condition, they may become even more rare. The outcome will ultimately depend on the local changes to their breeding sites.	Populations could slide. However, losses will again depend on the condition of their breeding habitat. Fire poses the greatest risk to the toads.	Habitat will slightly improve. Summer ranges will continue to increase in quality.	Abundance, distribution and quality of habitat should be similar to pre-epidemic levels. Population changes cannot be attributed to pine beetle alone. A lot depends on other individual factors.
Boreal Owl	Known to live in older forest stands where cavities used by other animals such as woodpeckers and squirrels can then be re-purposed into a nests. The availability of these suitable sites limits their distribution. Primarily prey on Southern red-backed voles.	Habitat will become marginal but will still be usable. Small, but measurable declines in populations.	Population levels are expected to dip by about 10-15 percent in areas that were predominantly lodgepole pine. They will continue to live in the more diverse areas less affected by beetles.	Numbers will remain below pre-epidemic levels, but they will begin to increase by the end of this period as regenerated aspen and lodgepole stands improve.	Through the first part of this period, habitat will still be improving, and owl populations will respond in kind.

Text by Steven Stephenson. Graphic by Josh Stacey.

Sources: "Response of Three-Toed Woodpecker to Environmental Conditions Under a No-Action Alternative" by Steve Lozar; "Response of Pine Squirrel Under a No-Action Alternative to Tree Mortality Resulting from a Mountain Pine Beetle Epidemic" by Gregory Hayward; "Response of Olive-Sided Flycatcher to Epidemic Mountain Pine Beetle-Caused Mortality Under a No-Action Alternative" by John Guzmbruno; "Response of American Marten to Epidemic Mountain Pine Beetle-Caused Mortality Under a No-Action Alternative" by Steve Kozlowski; "Response of Boreal Toad to Environmental Conditions Under a No-Action Alternative" by Steve McCormick and Deanna Sumella; "Response of Boreal Owl to Epidemic Mountain Pine Beetle-Caused Mortality Under a No-Action Alternative" by Gregory Hayward

No one can really say for certain what will happen to wildlife populations. But biologists examining the scenario are giving it their best guess.

Different species depend on different parts of the forest. As those parts change, they adapt, using other types of forest.

In some cases, population numbers will decline. But some populations will go up.

By analyzing the tendencies of wildlife and the data of how a forest reacts after disturbance, biologists have been able to put forth some predictions.

For instance, in the case of the American marten, there is potential for a marked population decline.

"We really are concerned at what will happen to overall habitat for them," says Bill Munroe, wildlife biologist for the U.S. Forest Service.

He says pine beetle will be a double hit to them, taking away their habitat, old-growth forest, and their prey, red squirrels.

Other species, such as elk, are predicted to benefit. With the regeneration of aspens, elk will have new habitat to utilize.

Canada lynx, on the other hand, may see positive impacts as well as negative ones. The reduction in the forest means there is less denning habitat. But with the growth of shrubs and new trees, there will be abundant habitat for their prey, the snowshoe hare.

For moose, the main problem will be maintaining connections between their habitats.

"In a lot of ways, it's going to be a hodgepodge," says Munroe.

The only constant in this epidemic is that there is no real way to tell with any certainty how things will look in the end.

The coming years will reveal intricacies in the web of the ecosystem that scientists never knew existed. Management decisions and the presence and severity of fire will also play a role.

Scientific Method

Activity to be completed: before trip to Sinks Canyon State Park

Location of Activity:
Classroom

Essential Question:
How can the scientific method be used to learn about Sinks Canyon State Park?

Goal:
Students will complete the steps of scientific method and develop a focus for their visit to Sinks Canyon State Park.

Standards:

K-4th Grade Science:
SC4.1.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC.4.2.3 Students identify and use appropriate scientific equipment.

5th-8th Grade Science:
SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

Materials:
Paper, pencil

Vocabulary:
Scientific method, hypothesis, question, procedure, materials, results, conclusion.

Activity Procedure:
1. Introduce or review the steps of the scientific method.
   - Ask a question
   - Do background research to gain knowledge about the topic of the question
   - Construct a hypothesis
   - Test the hypothesis by conducting an experiment or gathering information from expert sources to compile data
   - Analyze your data and draw a conclusion
   - Communicate your results
2. Have students write a question about Sinks Canyon State Park. This question should pertain to something that they would like to find an answer to during their field trip.

Scientific Method continued ...

3. Students will complete the following steps before the trip:
   - Question
   - Hypothesis
   - Procedure for testing the hypothesis: materials, step-by-step directions
4. The students will complete the results and conclusion during and after their visit.

Writing:

- Writing the steps to the scientific method with a research question in mind.

Assessment:

- Student's ability to follow the steps of the scientific method.

Trees and Plants of Sinks Canyon State Park?

Activity to be completed: before trip to Sinks Canyon State Park

Essential Question:

How does classifying objects help to identify them?
What tree and plants are found at Sinks Canyon State Park?
What makes Sinks Canyon State Park a place with a variety of plants and trees?

Goals:

Students will use a dichotomous key to identify trees and plants.
Students will understand how the location of a place determines what vegetation grows there.

Standards:

K-4th Grade Science:

SC4.1.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC.4.2.3 Students identify and use appropriate scientific equipment.

5th-8th Grade Science:

SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

Materials:

"A Pocket Naturalist Guide, Sinks Canyon, Wyoming" (class set available on loan by contacting Sinks Canyon State Park), Dichotomous key to deciduous and evergreen trees

Books:

Trees, Leaves, and Bark by Diane Burns
The Life Cylce of a Tree by Bobbie Kalman
Our Tree Named Steve by Alan Zweibel
Sky Tree by Thomas Locker and Candace Christiansen
Grandma's Button Box by Linda Willams Aber

Vocabulary:

Classification system, field guides, dichotomous key.

Activity Procedures:

1. Review the idea of classifying objects by a certain characteristic.
   Why is classification necessary/helpful?
   If you were shopping for a new car, you might say, "I'm looking at all cars that cost

Trees and Plants of Sinks Canyon State Park? continued ...

less than $40,000." Or, you might say, "I'm looking at all blue cars." Or, you might say, "I'm looking at all cars that both my dog and I will fit in comfortably."
What is the purpose of listing out those categories? To narrow down the many choices and to look specifically at only a few. To simplify the amount of information necessary to consider in making a decision about what car to buy.
We group things together based on common characteristics in order to simplify and organize a large amount of information.

2. Ask students to brainstorm things that are classified. Perhaps suggest that they look at the category Animals. That's a broad category, so how might we classify animals? 1. Wild animals or domestic animals, 2. Those animals that live on land (terrestrial) and those animals that live in water (aquatic or marine), 3. Those animals with fur/hair (mammals) or those animals with feathers (birds).

3. What are some categories we can use to classify plants? 1. Those that live in the rainforest or those that live in the desert, 2. Those with needles (conifers) or those with leaves (deciduous), 3. Those that need lots of water and those that are drought-tolerant. Classifying plants will help us as we start to learn more about the types of plants that we will find at Sinks Canyon State Park. We will also look at what influences certain plants to grow in certain locations and not in other locations.

4. Ask students to complete a web quest: go to the Sinks Canyon State Park website (www.sinkscanyonstatepark.org) and search the site to discover names of plants that are found at Sinks Canyon State Park. As students discover the names of different plants, encourage them to use context clues to begin developing categories to organize the plants. What are commonalities of plants by which to group them together?

From Sinkscanyonstatepark.org:
Sagebrush Habitat
- Sagebrush
- Bitterbrush
- Rocky Mountain Juniper
- Utah Juniper
- Plains Prickly Pear Cactus
- Sego Lily
- Blue Flax
- Gaillardia
- Evening Primrose
- Arrowleaf Balsam Root
- Sumac
- Wax Currant

Riparian Habitat
- Scouring Rush
- Choke Cherry
- Plains Cottonwood
- Quaking Aspen
- Sandbar Willow
- Red-osier Dogwood

Conifer Habitat
- Douglas Fir
- Limber Pine
- Oregon Grape
- Wild Rose
- Snowberry
- Serviceberry
- Heartleaf Arnica
- Shooting Star
- Phlox

Trees and Plants of Sinks Canyon State Park? continued ...

5. Once students have a list of plants from their search, discuss ideas about how to groups these plants. Students may suggest grouping plants by 1. Trees, shrubs, and flowers or, 2. By habitat areas where the plants are found, as the website groups the plants.

6. Categorizing plants based on habitat areas can lead to a discussion about habitat areas. The Sinks Canyon State Park website describes three habitat areas in the park: Sagebrush, Riparian, and Conifer. The website also describes moisture levels and sunlight availability of each habitat area. Emphasize with the students that those two factors, plus soil type (influenced by bedrock) and temperature, are very important in determining what plants can live in what areas.

7. Introduce the students to the dichotomous keys for deciduous trees and evergreen trees and explain briefly how they will use these keys when they visit Sinks Canyon State Park. A dichotomous key is a key used to identify a plant or animal in which identification results after a series of questions is answered. Each question presents descriptions of two distinguishing characteristics, and the answer will lead to another questions, until the species is identified.

Writing:

- Students list things that can be organized according to a classification system.
- Students complete web quest.
- Students list plants and trees found at Sinks Canyon State Park and explain how habitat characteristics influence what plants can grow in specific areas.

Assessment:

- Students' ability to use a dichotomous tree key to identify trees and plants.
- Students' ability to complete a web quest.

Follow-up Activities:

- Use a dichotomous tree key in the area where you live to compare and contrast local trees with those found at Sinks Canyon State Park.
- Use a field guide to identify plants in a natural area near your town.

ENVIRONMENTAL FACTORS THAT AFFECT PLANT GROWTH

MG Manual Reference
Ch. 1, pp. 30 - 33

Plant growth and distribution are limited by the environment. If any one environmental factor is less than ideal it will become a limiting factor in plant growth. Limiting factors are also responsible for the geography of plant distribution. For example, only plants adapted to limited amounts of water can live in deserts. Most plant problems are caused by environmental stress, either directly or indirectly. Therefore, it is important to understand the environmental aspects that affect plant growth. These factors are **light**, **temperature**, **water (humidity)**, and **nutrition**.

LIGHT

Light has three principal characteristics that affect plant growth: quantity, quality, and duration.

Light **quantity** refers to the intensity or concentration of sunlight and varies with the season of the year. The maximum is present in the summer and the minimum in winter. The more sunlight a plant receives (up to a point), the better capacity it has to produce plant food through photosynthesis. As the sunlight quantity decreases the photosynthetic process decreases. Light quantity can be decreased in a garden or greenhouse by using shade-cloth or shading paint above the plants. It can be increased by surrounding plants with white or reflective material or supplemental lights.

Light **quality** refers to the color or wavelength reaching the plant surface. Sunlight can be broken up by a prism into respective colors of red, orange, yellow, green, blue, indigo, and violet. On a rainy day, raindrops act as tiny prisms and break the sunlight into these colors producing a rainbow. Red and blue light have the greatest effect on plant growth. Green light is least effective to plants as most plants reflect green light and absorb very little. It is this reflected light that makes them appear green. Blue light is primarily responsible for vegetative growth or leaf growth. Red light when combined with blue light, encourages flowering in plants. Fluorescent or cool-white light is high in the blue range of light quality and is used to encourage leafy growth. These lights are excellent for starting seedlings. Incandescent light is high in the red or orange range but generally produces too much heat to be a valuable light source. Fluorescent "grow" lights have a mixture of red and blue colors that attempts to imitate sunlight as closely as possible. They are costly and generally not of any greater value than regular fluorescent lights.

Light **duration** or photoperiod refers to the amount of time that a plant is exposed to sunlight. When the concept of photoperiod was first recognized it was thought that the length of periods of light triggered flowering. The various categories of response were named according to the light length (i.e., short-day and long-day). It was then discovered that it is not the length of the light period but the length of uninterrupted dark periods that is critical to floral development. The ability of many plants to flower is controlled by photoperiod.

Plants can be classified into three categories, depending upon their flowering response to the duration of darkness. These are short-day, long-day, or day-neutral plants. Short-day,

(long nights) plants form their flowers only when the day length is less than about 12 hours in duration. Short-day plants include many spring and fall flowering plants such as chrysanthemum and poinsettia. Long-day, (short nights) plants form flowers only when day lengths exceed 12 hours. They include almost all of the summer-flowering plants, as well as many vegetables including beet, radish, lettuce, spinach, and potato. Day-neutral plants form flowers regardless of day length. Some plants do not really fit into any category but may be responsive to combinations of day lengths. The petunia will flower regardless of day length, but flowers earlier and more profusely under long daylight. Since chrysanthemums flower under the short-day conditions of spring or fall the method for manipulating the plant into experiencing short days is very simple. If long days are predominant, a black plastic sheet is drawn over the chrysanthemum for 12 hours daily to block out light until flower buds are initiated. To bring a long-day plant into flower when sunlight is not present longer than 12 hours artificial light is added until flower buds are initiated.

Temperature

Temperature affects the productivity and growth of a plant depending upon whether the plant variety is a warm-season or cool-season crop. If temperatures are high and day length is long, cool-season crops such as broccoli and spinach will bolt rather than produce the desired flower. Temperatures that are too low or high for a warm-season crop will prevent fruit set. Temperatures that are too high for warm-season crops such as pepper or tomato can cause pollen to become inviable and not pollinate flowers. Adverse temperatures also cause stunted growth and poor quality. For example, the bitterness in lettuce is caused by high temperatures.

Sometimes temperatures are used in connection with day length to manipulate the flowering of plants. Chrysanthemums will flower for a longer period of time if daylight temperatures are 59°F (15°C). The Christmas cactus forms flowers as a result of short days and low temperatures. Temperatures alone also influence flowering. Daffodils are forced to flower by putting the bulbs in cold storage in October at 35° to 40°F (2° to 4°C). The cold temperatures allow the bulb to mature. The bulbs are transferred to the greenhouse in midwinter where growth begins. The flowers are then ready for cutting in 3 to 4 weeks.

Thermoperiod refers to daily temperature change. Plants produce maximum growth when exposed to a day temperature that is about 10 to 15° F. (5.5 to 8°C) higher than the night temperature. This allows the plant to photosynthesize and respire during an optimum daytime temperature and to curtail the rate of respiration during a cooler night.

High temperatures cause increased respiration sometimes above the rate of photosynthesis. This means that the products of photosynthesis are being used more rapidly than they are being produced. For growth to occur photosynthesis must be greater than respiration.

Low temperatures can result in poor growth. Photosynthesis slows at low temperatures. Since photosynthesis is slowed, growth is slowed and this results in lower yields. Not all plants grow best in the same temperature range. For example, snapdragons grow best when nighttime temperatures are 55°F (12°C); the poinsettia prefers 62°F (17°C). Florist

cyclamen does well under very cool conditions while many bedding plants prefer a higher temperature. Recently it has been found that roses can tolerate much lower nighttime temperatures than was previously believed. This has meant a conservation in energy for greenhouse growers. However, in some cases a certain number of days of low temperatures are needed by plants to grow properly. This is true of crops growing in cold regions of the country. Peaches are a prime example; most varieties require 700 to 1,000 hours below 45°F (7°C) and above 32°F (0°C) before they break their rest period and begin flowering and growth. If this cold requirement is not met then small, misshapen leaves and fruit will result. Many times fruit will not set. In low desert areas where these temperatures are not experienced low chill peach trees should be planted. Lilies need 6 weeks at 33°F (1°C or below) before they will bloom.

Plants can be classified as either hardy or non-hardy depending upon their ability to withstand cold temperatures. Winter injury can occur to non-hardy plants if temperatures are too low or if unseasonably low temperatures occur late in the spring or early in the fall. Winter injury may also occur because of desiccation (drying out).

Plant roots need moist soil during the winter. When the soil is frozen the movement of water into the plant is severely restricted. On a windy winter day broad-leaved evergreens can become water-deficient in a few minutes, turning the leaves or needles brown. Wide variations in winter temperatures can cause premature bud break in some plants and consequent freezing damage. Late spring frost damage can ruin entire crops. If temperatures drop too low during the winter, entire trees of some species are killed by the freezing of plant cells and tissue.

Temperature Effects on Plant Growth

Photosynthesis:
Increases with temperature to a point.

Respiration:
Rapidly increases with temperature.

Transpiration:
Increases with temperature.

Flowering:
May be partially triggered by temperature.

Sugar storage:
Low temperatures reduce energy use and increase sugar storage.

Dormancy:
Warmth, after a period of low temperature, will break dormancy and plants will resume active growth.

WATER (HUMIDITY)

As mentioned earlier, water is a primary component of photosynthesis. It maintains the turgor pressure or firmness of tissue and transports nutrients throughout the plant. In maintaining turgor pressure, water is the major constituent of the protoplasm of a cell. By means of turgor pressure and other changes in the cell, water regulates the opening and closing of the stomata, thus regulating transpiration. Water also provides the pressure to move a root through the soil. Among water's most critical roles is that of a solvent for minerals moving into the plant and for carbohydrates moving to their site of use or storage. By its gradual evaporation of water from the surface of the leaf, near the stomate, helps stabilize plant temperature.

Relative Humidity is the ratio of water vapor in the air to the amount of water the air could hold at a given temperature and pressure expressed as a percent. For example, if a kilogram of air at 75°F could hold 4 grams of water vapor and there are only 3 grams of water in the air, then the relative humidity (RH) is:

$$\textbf{RH} = \frac{\text{water in the air}}{\text{water the air could hold (at constant temperature and pressure)}}$$

so, **RH** = 3/4 = .75 expressed as a % = 75%

Warm air can hold more water vapor than cold air. If the amount of water in the air stays the same and the temperature increases the relative humidity decreases. Water vapor will move from an area of high relative humidity to one of low relative humidity. The greater the difference in humidity the faster water will move. The relative humidity in the air space between the cells within the leaf approaches 100%. When the stomata are open water vapor rushes out. As the vapor moves out, a cloud of high humidity is formed around the stomate. This cloud of humidity helps slow down transpiration and cool the leaf. If air movement blows the humid cloud away transpiration will increase as the stomata keep opening to balance the humidity.

NUTRITION

Many people confuse plant nutrition with plant fertilization. Plant nutrition refers to the needs and uses of the basic chemical elements in the plant. Fertilization is the term used when these materials are supplied to the environment around the plant. A lot must happen before a chemical element supplied in a fertilizer can be taken up and used by the plant.

Plants need 18 elements for normal growth. Carbon, hydrogen, and oxygen are found in air and water. Nitrogen, phosphorus, potassium, magnesium, calcium, and sulfur are found in the soil. The latter six elements are used in relatively large amounts by the plant and are called macronutrients. There are nine other elements that are used in much smaller amounts; these are called micronutrients or trace elements. The micronutrients, which are found in the soil are iron, zinc, molybdenum, nickel, manganese, boron, copper, cobalt, and chlorine. All 18 elements, both macronutrients and micronutrients are essential for plant growth.

Most of the nutrients that a plant needs are dissolved in water and then absorbed by the roots. Ninety-eight percent of these plant nutrients are absorbed from the soil solution and only about 2% are actually extracted from the soil particles by the root. Most of the nutrient elements are absorbed as charged ions or pieces of molecules. Ions may be positively charged cations or negatively charged anions. Positive and negative are equally paired so that there is no overall charge. For example, nitrogen may be absorbed as nitrate (NO_3^-) which is an anion with one negative charge. A potassium ion (K^+) is a cation with one positive charge. Potassium nitrate (KNO_3^-) has one potassium ion and one nitrate ion. Calcium nitrate ($Ca(NO_3)_2$) has one calcium cation that has two positive charges and two negative, single charge, nitrate ions to match the two positive charges of the calcium.

The balance of ions in the soil is very important. Just as ions having opposite charges attract each other, ions having similar charges compete for chemical interactions and reactions in the environment. Some ions are more active than others or can compete better. For example, both calcium (Ca) and magnesium (Mg) are cations with two charges but magnesium is more active. If both are in competition to be absorbed the magnesium will be absorbed. This explains why the results of a soil test may indicate there is sufficient calcium in the soil, but the plant may still exhibit a calcium deficiency because of an excess of the more active magnesium. What may be expressed as a deficiency in one micronutrient may really be caused by an excess of another.

In order for the ions to be easily absorbed, they must first be dissolved in the soil solution. Some combinations of ions are easily dissolved such as potassium nitrate. When other ions combine they may precipitate or fall out of solution and thus become unavailable to the plant. Many of the micronutrients form complex combinations with phosphorous and calcium and precipitate out of the soil solution so the nutrients cannot be easily taken up by the plant. The pH, which means potential hydrogen, is a measurement of acidity or alkalinity. The pH greatly affects chemical reactions. If the soil pH is extremely high (alkaline), many of the micronutrients precipitate out of the solution and are unavailable to the plant. When the soil pH is extremely low (acid), some of the micronutrients become extremely soluble and ion levels may become high enough to injure the plant. The effect of pH varies with the ion, the types of ions in the soil, and the type of soil. Therefore, not only is the amount of the nutrient important but also the soil pH. For further information on what pH's effect on nutrients in the soil see Chapter 2 – Soils

Adequate water and oxygen must be available in the soil. Water is required for nutrient movement into and throughout the roots. Oxygen is required in the soil for respiration to occur to produce energy for growth and the movement of mineral ions into the root cells across their membranes. This is an active absorption process utilizing energy from respiration. Oxygen is not transported to roots from the shoot. Without adequate oxygen from the soil environment there is no energy produced for nutrient absorption. This also stops active absorption in which water flows into the cell due to the higher concentration of nutrients that were actively absorbed.

Anything that lowers or prevents the production of sugars in the leaves can lower nutrient absorption. If the plant is under stress due to low light or extremes in

temperature, nutrient deficiency problems may develop. The stage of growth or how actively the plant is growing may also affect the amount of nutrients absorbed. Many plants go into a rest period or dormancy during part of the year. During dormancy few nutrients are absorbed. Plants may also absorb different nutrients just as flower buds begin to develop.

Nutrients transported from the root to the cell by the vascular system move into the cell through a cell membrane. There are three different ways this happens. First, an entire molecule or ion pair may move through the membrane. If the cell is using energy, called active transport, to absorb ions then only one of the ions in the pair is pulled into the cell. The other will follow to keep the charges even. Most anions (negative ions) are actively absorbed.

The second way of keeping the charges inside the cell balanced and absorbing a new ion is to exchange one charged ion for another ion with the same charge. A hydrogen ion (H^+) is often released so that the cell can absorb another positive ion such as potassium (K^+). Since this is a simple passive exchange, absorption energy may not be required. Cations may be absorbed by this passive method.

Both of the methods mentioned above may be passive or active. The third method, the carrier system, is always active absorption, requiring energy. Scientists have discovered that within the cell membrane there are specialized chemicals that act as carriers. The carrier, through chemical changes, attracts an ion from outside the cell membrane and releases it inside the cell. Once the ion is inside the cell it is attached to other ions so that it does not move out of the cell. Complex chemical reactions are involved in the entire process.

Although nutrients can be absorbed passively, research has shown that active absorption must take place if the plant is to grow and be healthy. The factors discussed earlier about absorption by the roots are also true for absorption by the cell. Some of the factors that affect nutrient absorption are the type of ion, soil pH, solubility of ion pairs, water, soil oxygen, sugar supply, plant stress, and temperature.

Foliar Absorption, a Special Case

Under normal growing conditions plants absorb most nutrients, except carbon, hydrogen, and oxygen, from the soil. However, some nutrients can also be absorbed by the leaves if they are sprayed on with a dilute solution. The factors that affect absorption by the cell are still important because the nutrient must enter the cell to be used by the plant. Care must be taken that the concentration of the nutrient is not too high or the leaf will be injured. Also, high temperatures can cause nutrients to injure leaves. An example is sulfur that is applied to leaves when the temperature is or will be above 90° F. Remember the leaf is covered by a thin layer of wax called the cuticle that the nutrient must get around or through before it can enter the cell.

Keying and Classifying Trees According to Their Leaves

Activity to be completed: during trip to Sinks Canyon State Park

Location of Activity:
Nature Trail

Essential Question:
How do physical characteristics of leaves help in identifying tree species?

Goal:
Students will use a dichotomous key to deciduous trees (with leaf characteristic descriptions) to identify the trees found in Sinks Canyon State Park.

Standards:

K-4th Grade:
SC4.1.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC.4.2.3 Students identify and use appropriate scientific equipment.

5th-8th Grade:
SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

Materials:
Dichotomous key to deciduous trees (with leaf characteristic descriptions), student journals, pencils.

Books that may be useful:
Trees, Leaves, and Bark by Diane Burns
The Life Cycle of a Tree by Bobbie Kalman
Our Tree Named Steve by Alan Zweibel
Sky Tree by Thomas Locker and Candace Christiansen

Vocabulary:
Deciduous, evergreen, coniferous, classification system, dichotomous key, field guide, characteristics, lobe, margins, broadleaf.

Activity Procedure:
1. Drive to the Nature Trail trailhead, located in the Popo Agie Campground about a ¼ mile from the Sinks Canyon State Park Visitors' Center. There is plenty of room for a bus to park and bathrooms.
2. Walk across the swinging bridge; remind students to be careful and hold on to the sides when walking across the bridge. No running on the bridge, please.

Keying and Classifying Trees According to Their Leaves continued ...

3. On both ends of the swinging bridge are many Aspen trees.
4. Just past the boardwalk, notice a tree with maple-like leaves- this is Rocky Mountain Maple. Rocky Mountain Maple is more shrub-like, with many trunks, not one central trunk. Past the second boardwalk, the trail swings back to the west (and heads up-river). Notice the trees with very dark, reddish-brown smooth bark with white slash-marks (called lenticels.) These are Water Birch. The trees with very similar shaped, but larger, leaves and silvery-grey bark are Thinleaf Alder.
5. At each stop, ask students to use the tree key to identify the trees in the area.

Writing:

- Students write the names and sketch the leaves and trees they identified using the tools of a scientist.
- Students will identify and describe the leaves and trees they found in Sinks Canyon State Park.
- Students will explain the main characteristics among the deciduous trees in Sinks Canyon State Park.
- Students do a leaf rubbing and write adjectives, similes, metaphors to describe the leaf.

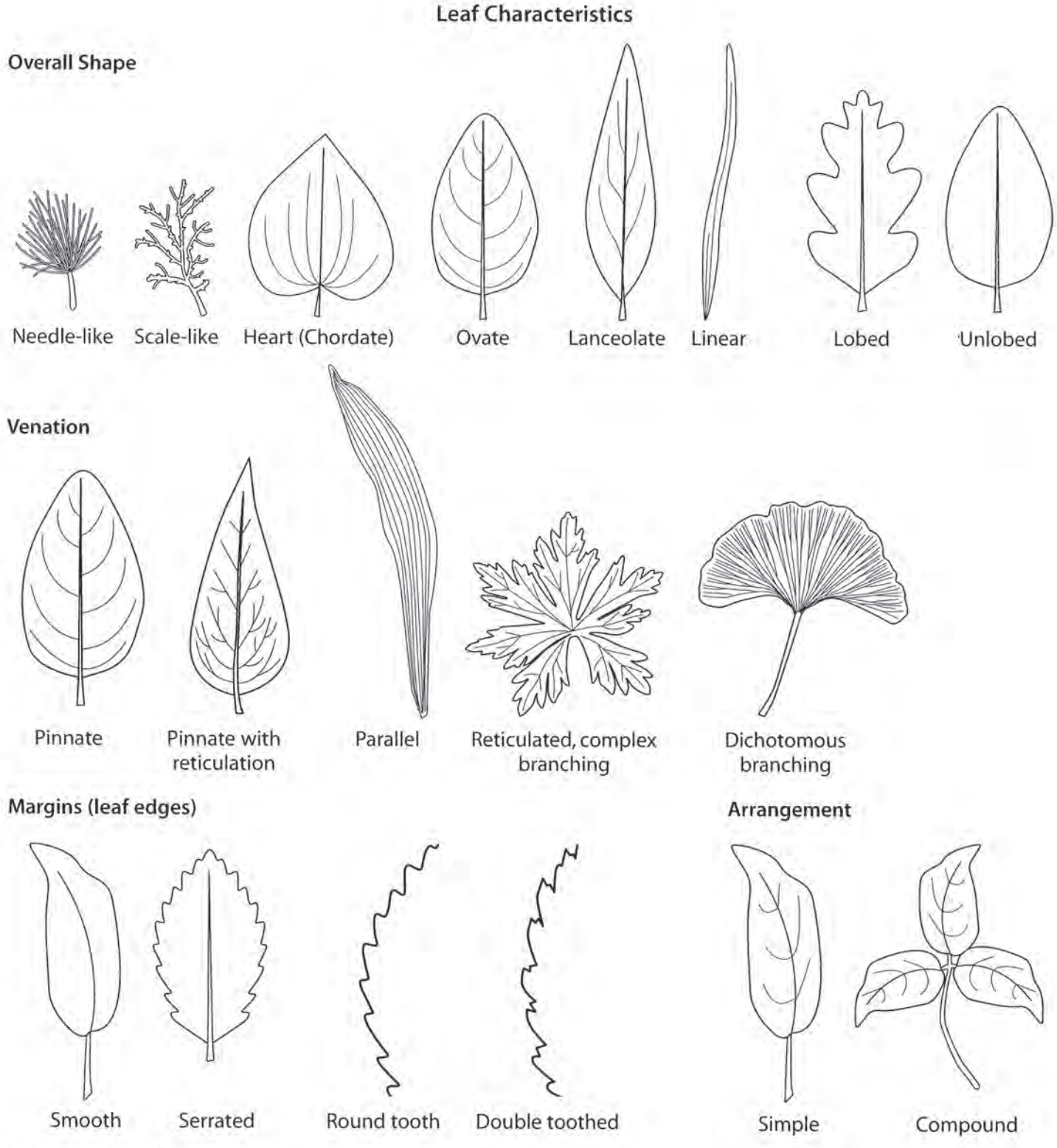
Assessment:

- Students' ability to use a tree key to identify deciduous trees and use descriptions of leaf characteristics.

Follow-up Activities:

- Use the dichotomous tree key to compare and contrast the trees where you live to those found in Sinks Canyon State Park.

Dichotomous Key to Deciduous Trees



Plant and Leaf Identification

Dichotomous Key to Deciduous Trees

Dichotomous Key

1a. Needle-like or scale-like leaves.....Go to 2
1b. Broad, flat leaves .....Go to 7

2a. Leaves reduced to overlapping scales.....Cedar (*Juniperus*) (GYMNOSPERM)
2b. Leaves reduced to needles.....Go to 3

3a. Needles borne in clusters .....Go to 4
3b. Needles borne singly.....Go to 5

4a. Short, soft needles, born in clusters of 10 to 20..... Larch (*Larix*) (GYMNOSPERM)
4b. Long needles, in bundles of 2, 3 or 5.....Pine (Pinus) (GYMNOSPERM)

5a. Round needles.....Spruce (*Picea*) (GYMNOSPERM)
5b. Flat needles.....Go to 6

6a. Flat needles without stalks (borne directly into twig) .....Fir (*Abies*) (GYMNOSPERM)
6b. Flat needles with stalks .....Hemlock (*Tsuga*) (GYMNOSPERM)

7a. Is the venation pinnate (feather-like) with the finer veins reticulate (net-like)?.....Go to 8
7b. Is the venation parallel? .....Go to 16

8a. Leaves are dichotomously veined (veins fork in pairs from base and they are not cross-connected) and fan-shaped with two distinct lobes. .....Ginkgo (*Ginkgo*) (GYMNOSPERM)
8b. Leaves not dichotomously veined .....Go to 9

9a. Leaves compound (blade divided into leaflets).....Go to 10
9b. Leaves simple (blade in one unit, not divided into leaflets).....Go to 11

10a. Leaflets and stalks are hairy and slightly sticky ..... Walnut (*Juglans*) (ANGIOSPERM, DICOT)
10b. Leaflets are smooth and hairless .....Ash (*Fraxinus*) (ANGIOSPERM, DICOT)

11a. Leaves are lobed.....Go to 14
11b. Leaves are unlobed .....Go to 12

12a. Leaves have smooth margins.....Dogwood (*Cornus*) (ANGIOSPERM, DICOT)
12b. Leaves have serrated margins .....Go to 13

13a. Leaves are doubly sharp-toothed and leaves are wedge or triangular-shaped.....Birch (*Betula*) (ANGIOSPERM, DICOT)
13b. Leaves have rounded teeth and leaves are round or heart-shaped.....Aspen (*Populus*) (ANGIOSPERM, DICOT)

14a. 5 or less lobes .....Go to 15
14b. 6 or more lobes.....Go to 17

15a. Leaves with 5 lobes, margins doubly serrated...Maple (*Acer*) (ANGIOSPERM, DICOT)
15b. Leaves with 5 lobes, smooth margin. Middle lobe is significantly longer than the rest.....Ivy (*Hedera*) (ANGIOSPERM, DICOT)

16a. Leaves are long, thin with a rounded, smooth edge. This plant produces a colorful, vibrant flower ....Lily (*Lilium*) (ANGIOSPERM, MONOCOT)
16b. Leaves are long, thin with a wavy edge and a long pointed tip. This plant is stalk-like .....Corn (*Zea*) (ANGIOSPERM, MONOCOT)

17a. Elongated leaves with 6-7 smooth lobes .....Oak (*Quercus*) (ANGIOSPERM, DICOT)
17b. Rounded leaves with 7-9 segments that are lobed and deeply toothed.....Geranium (*Geranium*) (ANGIOSPERM, DICOT)

Plant and Leaf Identification

Keying and Classifying Trees According to Their Leaves

Record the names of the deciduous trees that you identified on your hike.

_____

_____

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_____

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_____

Sketch a leaf or a tree that you identified and label it appropriately.

Tree Name: _____

Keying Evergreen Trees in Sinks Canyon State Park

Activity to be completed: during trip to Sinks Canyon State Park

Location of Activity:
Nature Trail

Essential Question:
How can a tree key be used to identify trees?

Goal:
Students will use a dichotomous tree key to identify the trees in Sinks Canyon State Park.

Standards:

K-4th Grade Science:
SC4.1.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC.4.2.3 Students identify and use appropriate scientific equipment.

5th-8th Grade Science:
SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

Materials:
Dichotomous key to evergreen trees, student journals, pencils.

Books that may be useful:
Trees, Leaves, and Bark by Diane Burns
The Life Cycle of a Tree by Bobbie Kalman
Our Tree Named Steve by Alan Zweibel
Sky Tree by Thomas Locker and Candace Christiansen

Vocabulary:
Limber Pine, Douglas Fir, Lodgepole Pine, Rocky Mountain Juniper, Utah Juniper dichotomous tree key, evergreen

Activity Procedure:
1. Drive to the Nature Trail trailhead, located in the Popo Agie Campground about a ¼ mile from the Sinks Canyon State Park Visitors' Center. There is plenty of room for a bus to park and bathrooms.
2. Walk across the swinging bridge. Remind students to be careful and hold on to the sides when walking across the bridge. No running on the bridge, please.
3. Walk up the trail with the stairs. Three-fourths of the way up the hill there will be a Douglas fir tree to the right and Rocky Mountain Juniper trees are easy to locate.

Keying Evergreen Trees in Sinks Canyon State Park continued ...

4. Continue walking up the hill past the benches. At the point where the trail splits is a Limber Pine to the left. There are Lodgepole Pine trees to the right as the trail turns and returns to the bridge.
5. At each stop, ask the students to use the tree key to identify the trees.

Writing:

- Students write the names and sketch the trees they identified using the tools of a scientist.
- Students identify and describe the habitat where each tree and plant was located, for example:

  Riparian habitat immediately near the river
  or
  Sagebrush habitat with direct sunlight and low-growing (no taller than 8") plants and shrubs
  or
  Conifer habitat with filtered sunlight due to the shade created by tall coniferous/evergreen trees
- Students explain the main characteristics among the evergreen trees in Sinks Canyon State Park.

Assessment:

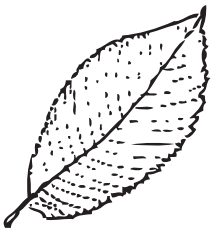
- Students' ability to use a tree key to identify evergreen trees.

Follow-up Activities:

- Use a tree key to compare and contrast the evergreen trees where you live to those found at Sinks Canyon State Park.

Dichotomous Key to Evergreen Trees

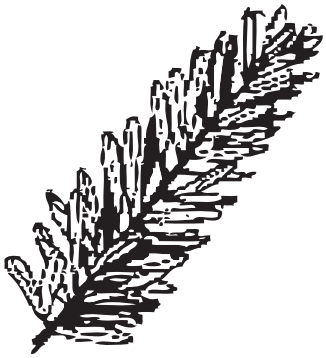
Coniferous (Evergreen)



Deciduous (Hardwood)

Leaves Needle Shaped

Leaves NOT Needle Shaped



Single Leaves

Grouped/Bundled Leaves

Clustered Leaves

Dichotomous Key to Evergreen Trees

1. **Are leaves overlapping scales and may have berries?**
   NO Go to #2.
   YES It is a Rocky Mountain Juniper (Juniperus scopulorum).

2. **Are the needles attached to the twig in bundles?**
   NO Go to #7. It is a spruce, fir or Douglas Fir.
   YES It is a pine. Go to #3.

3. **Are there two needles in each bundle?**
   NO Go to #4.
   YES Then it is a Lodgepole Pine (Pinus contorta). Look for its cones. Some of them are sealed with resin that only the heat of a fire can open. Eighty percent of Yellowstone's forests are lodgepole pine.

4. **Are there five needles in each bundle?**
   NO Go back to #2.
   YES Go to #5.

5. **Are the cones long (greater than three inches) and columnar with scales that thicken but are not pointed at the ends?**
   NO Go to #6.
   YES Then it is probably a Limber Pine (Pinus flexilis). Bend the outer twigs and you'll understand this tree's Latin name. This tree is very similar to the Whitebark Pine but is usually found below 7,000 feet.

6. **Are the cones round, purplish, and short (less than three inches) with scales that have pointed ends?**
   NO Go back to #2.
   YES Then it's probably a Whitebark Pine (Pinus albicaulis). This tree is very similar to Limber Pine but is found above 7,000 feet.

7. **Pull a needle off. Roll it between your thumb and first finger. Does it roll easily? Snap the needle in half. Is its cross section square? Are the needles spiky and sharp?**
   NO Go to #8.
   YES It's an englemann Spruce (Picea engelmannii).

8. **The needles' cross section should be flat. Look for cones either on the tree or on the ground. Do they have three-pronged, tongue-like things (bracts) hanging out of them?**
   NO Go to #9
   YES It's a Douglas Fir (Pseudotsuga menziesii).

9. **Is the bark silvery with groups of small black marks across most of the trunk?**
   NO Go to #8.
   YES It's a Subalpine fir (Abies lasiocarpa). Look for cones. They may be impossible to find! Fir cones grow upright from the branch and disintegrate at maturity.

Keying Evergreen Trees in Sinks Canyon State Park

Record the names of the evergreen trees that you identified on your hike.

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_____

Sketch a leaf or a tree that you identified and label it appropriately.

Tree Name: _____

Describe and identify habitats where the trees you identified were located.

_____

_____

_____

Pests of Sinks Canyon State Park: Bark Beetles

Activity to be completed: during trip to Sinks Canyon State Park with State Park Staff

Location of Activity:
Sinks Canyon State Park

Essential Question:
How do the bark beetles impact the trees in Sinks Canyon State Park?
What can be done to protect the trees in the canyon?

Goal:
Students will identify the types of trees affected by the bark beetles.
Students will identify how the trees are affected.
Students will identify the procedures in use to protect the trees in the canyon.

Standards:

K-4th Grade Science:
SC4.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC4.1.2: Students sequence life cycles of living things, and recognize that plants and animals resemble their parents.

SC4.1.3 Students show connections between living things, their basic needs, and the environments.

5th-8th Grade Science:
SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

SC8.1.5 Students recognize behavior as a response of an organism to an internal or environmental stimulus and connect the characteristics and behaviors of an organism to biological adaptation.

SC8.1.6 Students illustrate populations of organisms and their interconnection within an ecosystem, identifying relationships among producers, consumers, and decomposers.

Materials:
Student journals, pencil, cameras.

Vocabulary:
pheromones, insecticide, pitch tubes, life cycle, xylem, phloem, gallery, drought

Pests of Sinks Canyon State Park: Bark Beetles continued ...

Activity Procedure:

1. Drive to the Nature Trail trailhead, located in Popo Agie Campground.
   There are bathrooms located near the parking area. If you have made prior arrangements, Sinks Canyon State Park staff will meet your group at the parking area.
2. Prepare students for a short hike.
3. Students will observe an area impacted by bark beetles. Students will observe how the beetles enter the tree and spread in the trunk of the tree.
4. Sinks Canyon State Park staff will explain the procedures being used to protect unaffected trees to the students.

Writing:

1. Students write a reflection about what they learned about the bark beetle on the trip. Additionally, encourage the students to reflect on their own behavior on the trip by also writing about what they did well on the trip and what they could improve on for next time.

Assessment:

1. Students' behavior on the trip: listening to the Sinks Canyon State Park staff and interacting appropriately.
2. Notes and drawings in their student journals.
3. Students create a pamphlet that identifies the types of trees affected by the bark beetle (note: different species of beetle affects different species of coniferous trees), information about the life cycle of the beetle, ways to protect unaffected trees, and areas in Wyoming that have been affected by bark beetles.

Beetles of Concern in Wyoming and Tree Species Each Affects

Beetle Species	Tree Species Affected
Mountain Pine Beetle	Lodgepole Pine
	Ponderosa Pine
	Limber Pine
	Austrian Pine
	Scotch Pine
Douglas Fir Beetle	Douglas Fir
Spruce Beetle	Engelman Spruce
	Colorado Blue Spruce
Western Balsam Bark Beetle	Subalpine Fir
Ips Beetle	
Ips pini	Pine Species
Ips hunerti	Spruce Species

MPB - why an epidemic? (U.S. Forest Service Rocky Mountain Region website)

What factors are contributing to the current extensive mountain pine beetle outbreak in Colorado?

Three main factors, apparently happening concurrently, have fostered a "perfect storm" resulting in the intensive mountain pine beetle outbreak in Colorado. First, extensive areas of continuous lodgepole and ponderosa pine forests are growing with characteristics that make the stands susceptible to mountain pine beetle—such as the presence of large-diameter trees and dense stands with a high proportion of host trees. Second, drought conditions began in Colorado in the late 1990s, becoming severe by 2000. This lack of moisture stresses trees, which then become more susceptible to mountain pine beetle attack. Third, cold winter temperatures are a primary mortality agent of the mountain pine beetle, and during the last decade or so, Colorado has not experienced sufficiently cold temperatures to trigger significant insect mortality.

How cold do temperatures need to be to trigger insect mortality?

There is no simple answer to this question. Mountain pine beetles overwinter primarily in their "worm" or "grub" stage (the larvae). During this time, they accumulate alcohols that act as an anti-freeze and provide protection from freezing. The beetles are more susceptible to cold temperatures early in the fall and late spring, when alcohol levels are low, and less susceptible to cold in mid-winter when alcohol levels are highest. Studies show that temperatures from -13 F to -31 F in mid-winter can cause mortality. However, factors such as the stage of development, duration of exposure to cold temperatures, responses to seasonal changes in temperatures, and geographical location will influence potential mortality. So what temperatures, at what time of the year, or for how long will cause extensive insect mortality is not yet well-understood.

Pests of Sinks Canyon State Park: Bark Beetles

Record new information that you learned about bark beetles.

Using Field Guides to Identify Plants

Activity to be completed: during trip to Sinks Canyon State Park

Location of Activity:
Nature Trail

Essential Question:
How can field guides help people become better acquainted with an area?

Goal:
Students will use a field guide to identify or name plants found in Sinks Canyon State Park.

Standards:

K-4th Grade Science:
SC4.1.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC.4.2.3 Students identify and use appropriate scientific equipment.

5th-8th Grade Science:
SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

Materials:
Tree and/or plant field guides (class sets available at the Sinks Canyon State Park Visitors' Center), journals, pencils.

Books that may be useful:
Trees, Leaves, and Bark by Diane Burns
The Life Cycle of a Tree by Bobbie Kalman
Our Tree Named Steve by Alan Zweibel
Sky Tree by Thomas Locker and Candace Christiansen

Vocabulary:
Field guide, classification, habitat

Activity Procedure:
1. Stop at the Sinks Canyon State Park Visitors' Center to pick-up plant field guides.
2. Drive to the Nature Trail, located in Popo Agie campground about a ¼ mile from the Sinks Canyon State Park Visitors' Center. There is plenty of room for a bus to park and bathrooms.
3. Walk across the swinging bridge; remind students to be careful and hold on to the sides when walking across the bridge. No running on the bridge, please.

Using Field Guides to Identify Plants continued ...

4. Walk up the trail and stop occasionally to use the field guides to identify plants. Record the names in the students' journals.
5. Make a sketch of a plant or a leaf.

Writing:

- Students write the names and sketch the plants they identified using the tools of a scientist.
- Students will identify and describe the habitat where each plant was located, for example:

  Riparian habitat immediately near the river
  or
  Sagebrush habitat with direct sunlight and low-growing (no taller than 8") plants and shrubs
  or
  Conifer habitat with filtered sunlight due to the shade created by tall coniferous/evergreen trees

- Students will explain how plants are dispersed in different habitats in Sinks Canyon State Park.
- Students will explain what factors determine
  1. How plants are dispersed
  2. If plants are able to survive.

Assessment:

- Students' ability to use a field guide to identify plants at Sinks Canyon State Park.

Follow-up Activities:

- Use a plant field guide to identify plants in your neighborhood park. Compare/contrast the habitats and plants to those identified at Sinks Canyon State Park.

Using Field Guides to Identify Plants

Record the names of the plants that you identified on your hike. Sketch a leaf or a plant that you identified.

Plant Name: _____

Plant Name: _____

Plant Name: _____

Plant Name: _____

Identifying the Evergreen Trees in Your Area

Activity to be completed: after trip to Sinks Canyon State Park

Location of Activity:
Playground, city park, or any outdoor location with a variety of trees.

Essential Question:
How can a tree key help identify trees?
What are similarities and differences of the trees in your area and those at Sinks Canyon State Park?

Goal:
Students will use a tree key to identify the trees in a specified area.

Standards:

K-4th Grade Science:
SC4.1.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC.4.2.3 Students identify and use appropriate scientific equipment.

5th-8th Grade Science:
SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

Materials:
Dichotomous key to evergreen trees, student journals, pencils.

Books that may be useful:
Trees, Leaves, and Bark by Diane Burns
The Life Cycle of a Tree by Bobbie Kalman
Our Tree Named Steve by Alan Zweibel
Sky Tree by Thomas Locker and Candace Christiansen

Vocabulary:
Evergreens, Limber Pine, Douglas Fir, Lodgepole Pine, Rocky Mountain Juniper, Utah Juniper, Quaking Aspen, Plains Cottonwood, dichotomous tree key, ornamental or non-native tree

Activity Procedure:
1. Review the names of the trees and habitats in Sinks Canyon State Park.
2. Discuss with the students the types of trees found in their town and around their school.
3. Take a walk around the playground, neighborhood, or a favorite outdoor location and use the tree key to identify the evergreen trees in the area.

Identifying the Evergreen Trees in Your Area continued ...

4. Students may find trees which do not "key-out" or are not identifiable using the deciduous tree key. These trees may be "ornamental" or non-native trees which have been planted as part of a landscape design and are not occurring naturally.

Writing:

- Students create a Venn diagram comparing the trees in Sinks Canyon State Park to the trees found where they live.
- Students sit quietly in an area and draw and/or write about a tree they are observing.

Assessment:

- Students' ability to use a tree key to identify evergreen trees.
- Students' ability to compare and contrast two locations.

Follow-up Activities:

- Research the trees found at Sinks Canyon State Park and those found in the area where the students live. Determine which trees are native to the area and which ones were brought to the area. (ex. Utah Juniper is not native to Sinks Canyon)
- Students can present their research to the class.
- Visit a local greenhouse. Find out which species of evergreens are the best sellers and why.
- Ask the students to write questions to ask a local Arborist or Forester. Invite a local Arborist or Forester to speak to the class about native and non-native trees and different habitat requirements for trees to grow and thrive.
- Participate in Arbor Day activities.

Identifying the Evergreen Trees in Your Area

Record the names of the evergreen trees that you identified in town or around school.

_____

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_____

Draw or write about a tree.

Keying and Classifying Trees According to Their Leaves II

Activity to be completed: after trip to Sinks Canyon State Park

Location of Activity:
Playground, neighborhood, city park, or teacher's favorite outdoor location to take students.

Essential Question:
How do physical characteristics of leaves help to identify trees?

Goal:
Students will use a dichotomous key to deciduous trees (with leaf characteristic descriptions) to identify the trees found in their local community.

Standards:

K-4th Grade Science:
SC4.1.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC.4.2.3 Students identify and use appropriate scientific equipment.

5th-8th Grade Science:
SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

Materials:
Dichotomous key to deciduous trees (with leaf characteristic descriptions), student journals, pencils.

Books that may be useful:
Trees, Leaves, and Bark by Diane Burns
The Life Cycle of a Tree by Bobbie Kalman
Our Tree Named Steve by Alan Zweibel
Sky Tree by Thomas Locker and Candace Christiansen

Vocabulary:
Deciduous, evergreen, coniferous, classification system, dichotomous key, field guide, ornamental or non-native tree, characteristics, lobe, margins, broadleaf

Activity Procedure:
1. Review the types of deciduous trees found in Sinks Canyon State Park- Quaking Aspen, Rocky Mountain Maple, Thinleaf Alder, Water Birch, Mountain Ash, Plains Cottonwood.
2. Review the vocabulary associated with deciduous trees and leaves- lobes, leaf tooth, compound leaves, lobes.

Keying and Classifying Trees According to Their Leaves II continued ...

3. Take students on a walk to identify the types of trees around their school or at a local park or natural area.
4. Students may find trees which do not "key-out" or are not identifiable using the deciduous tree key. These trees may be "ornamental" or non-native trees which have been planted as part of a landscape design and are not occurring naturally.

Writing:

- Students write the names and sketch the leaves and trees they identified using the tools of a scientist.
- Students will identify and describe the leaves and trees they found on their walk.
- Students will compare and contrast the leaves found in Sinks Canyon State Park to the leaves found on their walk.
- Students do a leaf rubbing and write adjectives, similes, metaphors to describe the leaf.
- Encourage students to use descriptive words and phrases to write a poem about their experience or about their favorite tree.

Assessment:

- Students' ability to use a tree key and descriptions of leaf characteristics to identify deciduous trees.
- Students' ability to compare and contrast two locations.

Follow-up Activities:

- Take students to a local greenhouse and find out what types of deciduous trees they sell and whether or not those trees are native to the area or non-native/ornamental trees.
- Invite a guest speaker who is familiar with the local trees, for example, someone from the city or county Forestry Service, from the University of Wyoming Extension Service, or from the county Conservation District.
- Participate in Arbor Day activities.
- Plant a tree.
- Contact the local Conservation District to find out what species of trees they sell each spring.

Keying & Classifying Trees According to Their Leaves II

Record the names of the deciduous trees that you identified on your hike.

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Sketch a leaf or a tree that you identified and label it appropriately.

Tree Name: _____

Noxious Weeds and Invasive Species

Activity to be completed: after trip to Sinks Canyon State Park

Location of Activity:
School, city park, open field, an outdoor location that has a variety of plants.

Essential Question:
What effect do noxious weeds or invasive species have on other plant life?

Goal:
Students observe an area with invasive species and identify the effects on other plant life. Students will learn what they can do to prevent the spread of noxious weeds.

Standards:

K-4th Grade Science:
SC4.1.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC.4.2.3 Students identify and use appropriate scientific equipment.

5th-8th Grade Science:
SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

Materials:
Students' journal, pencil.

Websites that may be useful:
http://www.invasivespeciesinfo.gov/plants/main.shtml
http://www.uwyo.edu/ces/WYOWEED/wyoweed.htm
http://plants.usda.gov/java/noxious?rptType=State&statefips=56

Vocabulary:
Invasive, noxious

Activity Procedure:
1. Contact your local county Conservation District, University Extension Service, Forest Service, BLM, or other county agencies to obtain a list of plants and weeds that are not native to the area, especially those species causing the most problems. These agencies may also have teaching materials available.
2. Research plants and weeds that are considered to be invasive species.
3. Visit an area where these plants grow, so students can see the effect that the non-native plants have on other, native plants.

Noxious Weeds and Invasive Species continued ...

4. Invite a botanist or forester to talk to the class about what is being done to remove non-native plants from habitats.
5. Students can complete a web quest to learn about methods used to eliminate unwanted plants and weeds.

Writing:

- Students create a poster identifying invasive species, reasons to remove them, and how to remove them.

Assessment:

- Students' poster.
- Students' notes from listening to guest speakers, visiting an area with invasive species, or completing a web quest.
- Students write a speech for or against eliminating weeds and plants that aren't native to an area.

Follow-up Activities:

- Community Service Project: have your class become involved in the removal of invasive species in your area.
- Create a "Wanted" poster for noxious weeds that are causing problems locally.

Noxious Weeds and Invasive Species

Record new information that you learned from the Forester or Botanist

What Pest is in Your Neighborhood?

Activity to be completed: after trip to Sinks Canyon State Park

Location of Activity:
School, neighborhood, or town

Essential Question:
What pest is affecting your community?
What is the cause of the pests in your community?

Goal:
Students will identify what "pests" affect their community.

Standards:

K-4th Grade:
SC4.1.1 Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.

SC4.1.2: Students sequence life cycles of living things, and recognize that plants and animals resemble their parents.

SC4.1.3 Students show connections between living things, their basic needs, and the environments.

5th-8th Grade:
SC8.1.4 Diversity of Organisms: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.

SC8.1.5 Students recognize behavior as a response of an organism to an internal or environmental stimulus and connect the characteristics and behaviors of an organism to biological adaptation.

SC8.1.6 Students illustrate populations of organisms and their interconnection within an ecosystem, identifying relationships among producers, consumers, and decomposers.

Materials:
Newspaper articles, pamphlets from local agencies

Resources that may be useful:
- Contact a member of the local Weed and Pest Office, University of Wyoming Cooperative Extension Service, or County Conservation District to talk to the class about local invasive species and the effect they have on native plant species.

What Pest is in Your Neighborhood? continued ...

- Newspaper articles that discuss pests that have affected your community (an example is provided).
- Informational pamphlets that explain strategies to deal with local pests.

Vocabulary:

Insecticides, invasive and/or non-native species, native species

Activity Procedure:

1. Ask students to brainstorm "pests" in their community that affect plants (deer, grasshoppers, bark beetles).
2. Students identify the types of plants that are affected.
3. Students identify how the plants can be protected or how the pests can be eliminated.
4. Students create informational posters, radio ads, or brochures to educate people in the community about local pests and strategies to deal with them.

Writing:

1. Write radio ads or brochures to explain to the community what citizens can do to help the situation.
2. Compare and contrast Sinks Canyon State Park to the area where you live.

Assessment:

1. Student projects illustrating an understanding of the issue.

JH Weekly
JACKSON HOLE'S FREE INDEPENDENT NEWSPAPER

The Buzz: Planning for park invaders

Wednesday, April 06, 2011

by Benjamin R. Bombard

Jackson Hole, Wyo.-Spotted knapweed, houndstongue, and orange hawkweed sound like ingredients for a witch's insidious brew in a children's book, one that makes the young protagonists fall asleep in the middle of an adventurous day, causes them to sweat from their tongues and turns their noses into colorful beaks. But in Yellowstone National Park, plants, all non-native invasive species, could pose a threat to the park's gorgeous and fragile ecosystem if not properly controlled.

The world's first national park announced last week it is developing a plan to fight nonnative invasive plant species. The park has fought weeds for decades, but this is its first effort to devise a plan that integrates its individual weed management projects into a comprehensive policy combining education, prevention, early detection, control and monitoring of invasive plants.

Yellowstone is home to more than 200 species of nonnative plants, according to Dan Reinhart, the park's supervisory resources management specialist. That list includes less invasive and concerning exotics like dandelion and Kentucky bluegrass. Then there are the roughly 40 species that the park actively works to control. Noxious weeds like houndstongue, knapweed, orange hawkweed ox-eye daisy and Canada thistle are the primary targets for the park's invasive plant management program.

Millions spent, problem unsolved

The National Park Service is required by law to keep the parks as unaltered by human activities as possible. The potential for invasive plants to compromise that mission has worried the agency since as early as 1933, when policymakers recognized the harmful effects of nonnative plants and animals.

In 1996, the Park Service released a document laying out a strategic approach for fighting invasive nonnative plants. According to the "Strategic Plan for Managing Invasive Nonnative Plants on National Park System Lands," at that time researchers estimated nonnative plants infested an additional 4,600 acres of federal land, daily. Each year, non-natives spread into an area larger than the state of Delaware. The report noted that invasive plants were costing the agency millions of dollars every year, "and still the problem is not solved."

In the opinion of Sue Salmons, the liaison for the Exotic Plant Management Team's Northern Rockies division, Yellowstone's management of invasive plants hasn't been as "sophisticated" as it should be. And Reinhart said that while Yellowstone's invasive plant management plan is active, it's somewhat ad hoc. Luckily the scope of the park's invasive plant problem is rather limited.

According to a report compiled by the park's Resource Management staff, of Yellowstone's more than 2.2 million acres, only 105 – four-thousandth of a percentage of the park's acreage – were treated last year for invasive weeds. Three-quarters of those treated acres lay along the park's trails and around its developed areas. Just under 29 of those treated acres were along the park's trails or in the backcountry. "The presence of invasive plant species is sporadic and light throughout the park," Reinhart said.

Mostly, the plants are where people are. That's because vehicle's tires, peoples' shoe and pets' fur can carry plant seeds, which are then dispersed when you park at a campsite or stroll down a trail.

Suite of tools

Reinhart said that Yellowstone's new invasive plant management plan will include a "suite of tools to manage noxious weeds." That suite includes tilling, mowing and hand-weeding, but most invasive plant species are principally controlled chemically with herbicides. According to the Resource Management staff's report, 88 pounds of herbicide were used to control exotic plants in the park last year.

And while dousing weeds with herbicide may seem like the easy, no-nonsense way to kill them, Salmons said that it wasn't and isn't as straightforward as it sounds. When she entered the field of invasive plant management in 1996, most of the available herbicides were developed for "the opposite kinds of plants," she said. "There were not herbicides developed to treat nonnative plants in natural areas. Herbicides were developed to treat weeds in agricultural and horticultural areas. The plants you're trying to protect in natural areas are the plants herbicides were designed to kill."

A lot of study, research and a good deal of trial and error, went into developing herbicides that kill non-native invasive plants without killing all the surrounding native plants, Salmons said.

The parks developing an invasive plant management plan must go through the lengthy Environmental Assessment (EA) process required by the National Environmental Policy Act, or NEPA. The first stage of the EA process is public scoping, and that's where Yellowstone's invasive plant management plan currently sits. Salmons said the public scoping period for the Northern Rocky Mountain Invasive Plant Management Plan, which addresses exotic plants in 10 small national parks in the region, received few public comments, but they were mostly what she called non-substantial. "They were people saying, "Yes, you go," or " We don't want herbicides."

There are a few invasive plant management plans in place at national parks across the nation – Yosemite has one, as does Glacier – Salmons says they haven't been in place long enough to determine if they've actually improved things on the ground. Like most such initiatives, success depends on funding and having the tools required to do the job. She says the fight against invasive plants is going well in areas treated for them, but, she said with a self-conscious laugh, "We can't do everything."

courtesy YELLOWSTONE NATIONAL PARK
Park employees treat invasive plants with herbicide.

Stewardship
Table of Contents

Stewardship and Leave No Trace Principles I

Activity to be completed: before trip to Sinks Canyon State Park

Essential Question:

How can you be a steward of the land?
What are the seven Leave No Trace principles?

Goal:

Students will identify their role as stewards of the land in of their communities.
Students will identify the seven Leave No Trace (LNT) principles.

Standards:

K-8th Grade:

SC.4.3, SC.8.3 History and Nature of Science in personal and social decisions

Students recognize the nature of science, its history, and its connections to personal, social, economic, and political decisions. Historically, scientific events have had significant impacts on our cultural heritage.

Materials:

Chart paper, internet access and video projection capability, paper and colored pencils for posters, The Lorax and/or Just a Dream.

Vocabulary:

Stewardship, respect, impact, nature, preservation, conservation, legacy, ethic, passion, judgment, minimize, backcountry, sustainable

Activity Procedure:

1. Tell students that you will be reading a story to them and ask them to listen for the main idea of the story.
2. Read either The Lorax or Just a Dream to the class.
   - Ask students to write down the main idea of the story.
   - Discuss the students' ideas and write them on chart paper.
3. Introduce the concept of Leave No Trace by asking students what they know about the topic. Explain that Leave No Trace is an ethic (moral principle or rule of conduct) developed by three federal land-management agencies- The USDA Forest Service, The National Park Service, and The Bureau of Land Management- to preserve wilderness or backcountry areas and to assure that increased use of those area is sustainable (providing for continual reuse, maintainable) and not harmful to those areas. Explain that the Leave No Trace ethic is comprised of seven principles. Ask the students to listen for those seven principles as they watch the video.

Stewardship and Leave No Trace Principles I continued ...

4. Watch the following ten-minute video to teach the students the vocabulary and seven principles. *http://www.lnt.org/programs/principles.php
5. As you watch the video, list the seven principles on chart paper.
    - Write a description of each principle on the chart paper
6. Divide the class into seven groups and have them create a poster for each principle using illustrations, key words, and perhaps a scenario where the principle is in question.
7. Groups share the posters and display them in class.
8. As a whole class, discuss the meaning of each vocabulary word, how each Leave No Trace principle pertains to their lives, examples of the principles that they have seen being followed or not followed.
9. Students will utilize these principles on their field trip to Sinks Canyon State Park.

Writing Activities:

Students write the seven principles of Leave No Trace and a description of each in their student journal.

Assessment:

- Group posters of the seven principles of Leave No Trace.
- Teacher describe each principle and the students write the principle.

Extension of activity:

- Take the students to Sinks Canyon State Park to practice the Leave No Trace principles and stewardship.

Stewardship and Leave No Trace Principles I

Record the seven Leave No Trace principles and describe a situation where each principle could be used.

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Stewardship and Leave No Trace Principles II

Activity to be completed: during trip to Sinks Canyon State Park

Essential Question:

Why are the seven principles of Leave No Trace (LNT) important on a field trip?

Goal:

Students will identify their role as stewards of the land during the field trip.
Students will identify the Leave No Trace principles that they followed during their visit to Sinks Canyon State Park.

Standards:

K-8th Grade:

SC.4.3, SC.8.3 History and Nature of Science in personal and social decisions

Students recognize the nature of science, its history, and its connections to personal, social, economic, and political decisions. Historically, scientific events have had significant impacts on our cultural heritage.

Materials:

Student journal, pencils, camera, water bottles.

Vocabulary:

Stewardship, respect, impact, nature, preservation, conservation, legacy, ethic, passion, judgment, minimize, backcountry

Activity Procedure:

1. Two locations would work for this activity. Travel to the Popo Agie Campground parking lot and cross the swinging bridge. From there, the left fork of the trail will take you on the Nature Trail and the right fork of the trail will take you to the west along the river and eventually to the Sinks Canyon Campground.
2. Students can look for examples of people not following the seven principles and document the LNT principles as they hike. Interestingly, if park visitors are following the seven principles, there would be no visible evidence.
3. Hopefully (for illustrative purposes), students will notice quite a bit of dog feces along the trail. This, and having dogs off-leash, has become a problem at Sinks Canyon State Park. Discuss with the students which LNT principle(s) this behavior violates and why it is a problem.
4. After, or during the hike, discuss with students their observations.
5. Discuss why it is important to follow the LNT principles.

Stewardship and Leave No Trace Principles II continued ...

6. Discuss what should be done about the dog feces left in the park and what affect that is having on the environment.

Writing Activities:

1. Students write a letter to park visitors who are not following the LNT principles, explaining why their behavior is harmful to the park and upsetting to other park visitors.
2. Students write suggestions about how to maintain the park for future generations.
3. Students choose a problem that they noticed in the park (dog feces, litter, people not staying on designated trails, picking flowers/grasses) and develop a plan to solve the issue.

Assessment:

1. Students share what they observed on the hike.
2. Students write a reflection of what was done well and what could have been done better to achieve the seven LNT principles.
3. Students write a plan for solving a problem that they saw during the hike.

Extension of activity:

Take students on a hike/walk in your community. Have students identify any violations of Leave No Trace principles in their town.

Stewardship and Leave No Trace Principles II

Which Leave No Trace principles did the class achieve well and which did the class not achieve well while hiking at Sinks Canyon State Park?

Stewardship and Leave No Trace Principles III

Activity to be completed: after trip to Sinks Canyon State Park

Essential Question:
What is your responsibility for environmental stewardship?

Goal:
Students will identify their role as stewards of the land and of their community.
Students will identify a problem in the community that shows a lack of stewardship.

Standards:

K-8th Grade:
SC.4.3, SC.8.3 History and Nature of Science in personal and social decisions

Students recognize the nature of science, its history, and its connections to personal, social, economic, and political decisions. Historically, scientific events have had significant impacts on our cultural heritage.

Materials:
Chart paper to list ideas

Vocabulary:
Stewardship, respect, impact, nature, preservation, conservation, legacy, ethic, passion, judgment, minimize, backcountry, sustainable

Activity Procedure:
1. Take students to an area in your community that is frequently visited by many people.
    - Identify "lack of stewardship" issues and ask the students to develop a community service project to address that issue. Collect data to support the presence of a problem.
        1. Ideas: dog feces not being picked-up, garbage not being picked-up, lack of recycling, water over-usage.
    - Find organizations that might be able to assist in solving the problem.
2. Once the students' solution has been implemented, revisit the area to collect data to determine if improvements have occurred.

Writing Activities:
1. Students create posters to be displayed around the community to inform people of the problem and proposed solution(s).
2. Write radio ads and contact local radio stations. Ask if students could record their ads.

Stewardship and Leave No Trace Principles III continued ...

3. Write a letter to the editor of the local newspaper about the identified issue and proposed solution(s).
4. Contact community service organizations or not-for-profits organizations that would have an interest in the issue and share findings of the problem and solutions.

Assessment:

- Students verbalize examples of stewardship that they have witnessed.
- Students share examples of problems in the community.
- Students identify ways to solve the issues.

Dilemmas in Sinks Canyon State Park

Activity to be completed: after trip to Sinks Canyon

Essential Question:

How can you be a steward of the land?
What can you do to preserve Sinks Canyon State Park for future generations?

Goals:

Students will use creative problem solving skills to suggest solutions to some common problems facing both staff and visitors at Sinks Canyon State Park.

Standards:

K-8th Grade:

SC.4.3, SC.8.3 History and Nature of Science in personal and social decisions

Students recognize the nature of science, its history, and its connections to personal, social, economic, and political decisions. Historically, scientific events have had significant impacts on our cultural heritage.

Materials:

Paper, pencils, dilemma cards

Vocabulary:

Stewardship, respect, impact, nature, preservation, conservation, legacy, ethics, passion, judgment, minimize

Activity Procedure:

1. Divide the students into small groups, give each group a dilemma card.
2. Students read their dilemma card, brainstorm multiple ideas to solve the dilemma, and determine one solution to share with the class.

Writing Activities:

1. All students record all the ideas generated in their group.
2. All students write the idea for the class presentation.

Assessment:

1. Class presentation, including everyone being able to contribute to it.
2. Inclusion of the seven Leave No Trace principles when generating solutions.

Extension of activity:

1. Brainstorm real-life dilemmas found in your community.
2. Ask students to find solutions to the community dilemmas.

Is There a Party in the Park?

Sinks Canyon State Park has mandatory quiet hours from 11PM-7AM. Your family has decided to spend the night in the campground and have made sure that everyone in the family is being quiet by 11:00 PM. When your family gets ready to go to bed the music at a campsite near you is blaring and sounds like a party is starting.

What do you do?

- List all the possible options that your group brainstorms.
- Choose one solution that will be shared with the whole class.
- Be prepared to defend your solution and explain why it is the best way to handle the situation.

Hiking on the Nature Trail

The Nature Trail located in Sinks Canyon State Park is a good way to see the variety of ecosystems found in the area. It is an enjoyable hike for people of all ages. While hiking on the Nature Trail, you witness a class of students wandering off the trail. The group is running through the area, stepping on plants, and having no real concern for being off the designated trail.

What would you do?

- List all the possible options that your group brainstorms.
- Choose one solution that will be shared with the whole class.
- Be prepared to defend your solution and explain why it is the best way to handle the situation.

Vacation Homes

Some people enjoy camping in the forests or even sleeping under the starry sky. A group of citizens, who don't really care for camping, have proposed the building of a hotel with about 100 rooms. These buildings would be placed near the Sinks Canyon State Park Visitors' Center, so some people on the upper levels of the hotel would enjoy the view of The Sinks. The building would incorporate all of the latest green-building technology to minimize impact on the environment. This is a controversial issue, since another group of citizens opposes the building of the hotel

Should the hotel be built?

- List all the possible options that your group brainstorms.
- Choose one solution that will be shared with the whole class.
- Be prepared to defend your solution and explain why it is the best way to handle the situation.

Field Trips?

Each school year, the class travels to Sinks Canyon State Park to study ecosystems. Even though the students have been instructed in the Leave No Trace principles, someone always walks off the trail, runs across the swinging bridge, and even picks some of the grasses or plants.

Should the school continue to go on field trips to Sinks Canyon State Park?

- List all the possible options that your group brainstorms.
- Choose one solution that will be shared with the whole class.
- Be prepared to defend your solution and explain why it is the best way to handle the situation.

Picnic Time!

While visiting Sinks Canyon State Park, your class is having lunch in the picnic area, busy with other people also enjoying their meal. You observe one family preparing to leave the area in their car and they have not cleaned up any of their garbage. Paper plates have been caught in the wind and food scraps are on the ground.

What would you do?

- List all the possible options that your group brainstorms.
- Choose one solution that will be shared with the whole class.
- Be prepared to defend your solution and explain why it is the best way to handle the situation.

Walk the Dog

Do you like to take your dog for a walk? There are many people who like to walk their dogs on the trails at Sinks Canyon State Park. It is a beautiful place to be outside with a favorite pet. One of the problems that the staff of the state park has encountered is dog feces being left on the trail or thrown in the bushes.

What should be done about this problem?

- List all the possible options that your group brainstorms.
- Choose one solution that will be shared with the whole class.
- Be prepared to defend your solution and explain why it is the best way to handle the situation.