The Rivers and More: A Teacher's Guide to Ozark National Scenic Riverways

Contributions

This teacher's guide was developed in cooperation with the National Park Service and the following individuals:

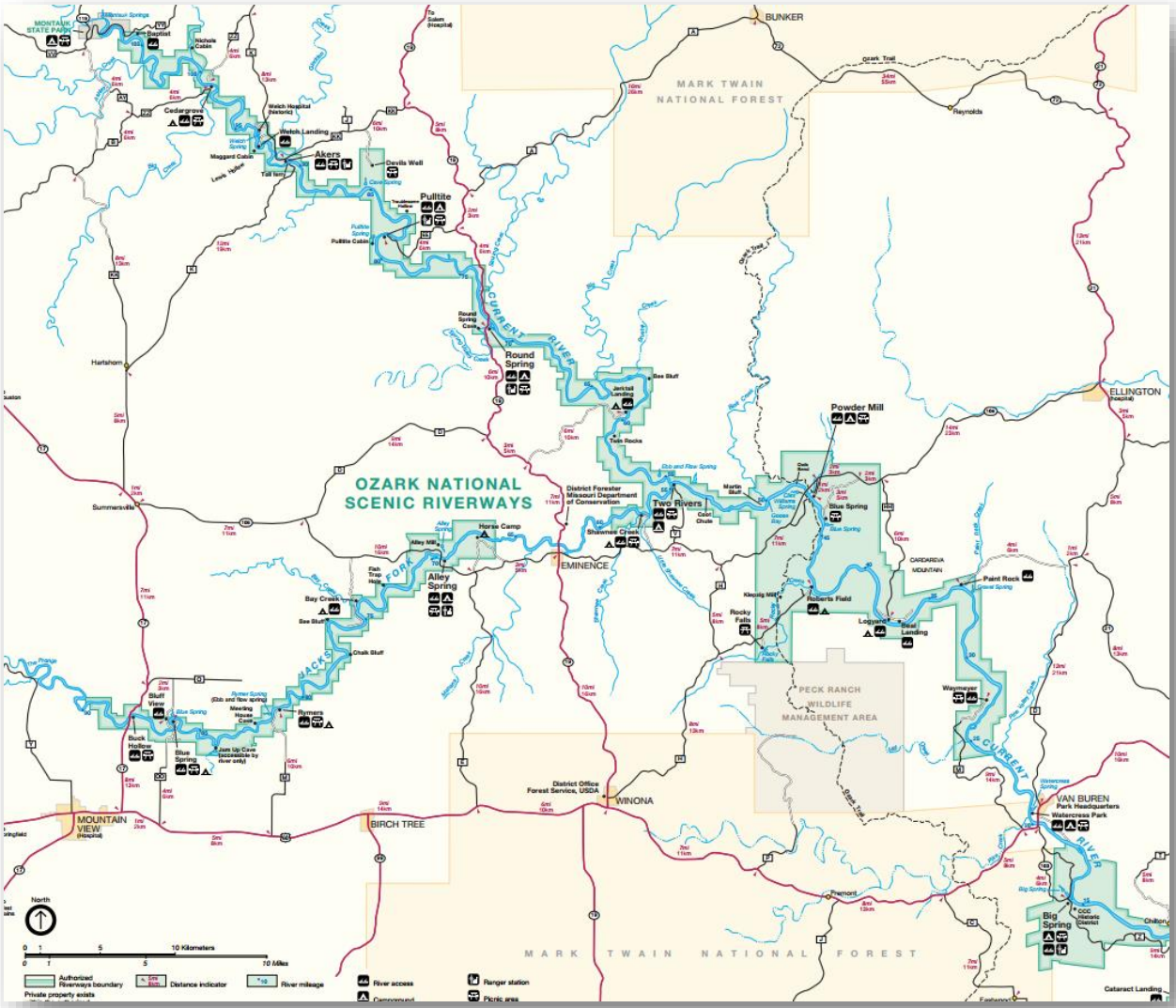
Emily Baker, Liberty/Mountain View Schools
Nona Capps, Research Associate, Department of Recreation, Park, and Tourism Studies, Indiana University
Samantha Majors, Van Buren R-1 Schools
Julie Northrip, Jefferson Expansion National Memorial
Bill O'Donnell, Ozark National Scenic Riverways
Kevin Poole, University of Colorado – Denver

If you have suggestions on how to improve this guide, please share them with Ozark National Scenic Riverways.

Ozark National Scenic Riverways
Attn: Interpretation
P.O. Box 490
Van Buren, MO 63965
www.nps.gov/ozar

Table of Contents

Introduction



Established in 1964, Ozark National Scenic Riverways is the first national park area to protect a river system. The Current and Jacks Fork Rivers, the rivers in the riverways, are spring-fed and home to fish, unique plants, and a variety of wildlife. The park is home to hundreds of freshwater springs, caves, trails, and historic sites, such as Alley Mill.

This teacher's guide is designed to be a resource for teachers in the classroom. Lessons, activities, and resources are included to incorporate the history and resources of Ozark National Scenic Riverways, a unit of the National Park Service, into your classroom. These sources can be used to prepare students for a field trip, either ranger led or on your own, or simply to bring the park inside.

The materials in this guide are designed for use in third grade to middle school classrooms. Some lessons include extensions or could be modified to fit high school as well. Lessons have been aligned to Common Core Standards and Next Generation Science Standards (NGSS) when applicable.

A separate teacher's guide has been developed about the park's many caves. *More Than Skin Deep* can be accessed online at http://www.nps.gov/ozar/forteachers/skin-deep.htm and hard copies are also available. Please contact the park if you are interested in receiving a copy of *More Than Skin Deep.*

Classroom Visits to Ozark National Scenic Riverways

School groups are always welcome in the park. Classes can tour the park on their own or with a ranger. Visits to the Round Spring Cave can only be made during limited times of the year, but the rest of the park is open year round. Rangers are also available to come to your classroom (in the local area) to present programs on a number of topics. See the "Teacher's Page" on the park's website for more information: http://www.nps.gov/ozar/forteachers/index.htm.

Section A: Springs

Ozark National Scenic Riverways is home to some of the largest freshwater springs in the country. Many of these are "first magnitude" springs, meaning that they have over 65 million gallons of water daily flowing from them.

Springs are unique ecosystems. Their stable year-round temperatures and distinctive water chemistry provide a unique environment for plants and animals not commonly found in rivers. Watercress and other aquatic plants play a key role in the spring ecosystem by providing organic matter used by other plants and animals and habitat for aquatic insects.

At least 38 animal species are found only in Ozark springs and subterranean waters. Several aquatic invertebrate species are found in as few as two Ozark springs including springs within Ozark Riverways.

Springs are small, delicate ecosystems, more sensitive to disturbances than rivers. Trampling the spring’s delicate vegetation to fish, wade and swim would damage the beauty of the springs. Dislodging aquatic plants in the springs could also alter this sensitive ecosystem. This is why the park prohibits wading, swimming and fishing in the springs and spring branches.

People often wonder why spring water is so blue. Spring water is actively dissolving away limestone as it moves through the earth. Springs are actually excavating new caves through this process. This dissolved limestone, along with the influence of the spring's depth and the blue of the sky, impart the blue color. Unique local conditions may give each spring its own tint. Rainy conditions wash silt into the water and may make springs appear milky or cloudy, or even brown.

Despite the saying, "pure as spring water," water from Ozark springs is generally not much cleaner than water from surface streams. It passes through huge tunnels underground, not the tiny porous spaces in the rock that cleanses spring waters in some other areas.

Activity 1: Introduction to Big Spring

Subject: Introduction to Big Spring; to be used in preparation for a field trip to Big Spring or Blue Spring

Grade Level: K-12

Duration: about 20 minutes

Brief Description: In this lesson students will be introduced to Big Spring. This lesson should be used in coordination with a field trip to the springs at the park.

Educational Standards:

Common Core: will vary according to grade level.

Next Generation: **3-5-ETS1.A** Engineering Design, **MS-ESS3**.C Earth and Human Activity, **HS-ESS3.C** Earth and Human Activity

Objectives:

At the end of this lesson and field trip, students will be able to:

- Recognize that their actions and behaviors can impact the environment around them in positive and negative ways.
- List human actions that harm spring ecosystems.
- Explain what may happen if springs are not protected.
- Describe the rules and expectations for visiting Big Spring.

Background Information about Big Spring:

http://www.nps.gov/ozar/planyourvisit/big-spring.htm

Big Spring is located near Van Buren, Missouri, in the Big Spring Campground at Ozark National Scenic Riverways. It is the largest spring in the state and one of the largest in the world. On an average day, some 278 million gallons of water gush forth from subterranean passages, swelling the nearby Current River. Experiments in which harmless dye is placed into the ground have shown that water travels from as far as 45 miles away through underground passages before coming to the surface at Big Spring. The trip took from 7 to 14 days.

Like all Ozark springs, Big Spring dissolves away the walls of its underground passages. One researcher estimated that about 175 tons of calcium carbonate rock are carried away in solution by Big Spring's water every day. Over the course of a year, this is enough rock to produce a cavern 30 feet high by 50 feet wide and one mile in length.

Essential Lesson Questions:

1. What could humans do that could harm springs?
    a. *Humans can pollute and leave trash. Human also participate in recreational activities such as swimming, boating, and fishing that may endanger the springs. Humans also remove plants on occasion.*
2. What may happen if the springs are not protected?
    a. *The spring could dry up, water could be contaminated, and animals and plants could die.*
3. What are some ways that we can protect springs?
    a. *We can make laws, follow laws, and clean up our trash.*

Evaluation:

Performance Task Student shows understanding of rules and regulations while visiting the spring.	**Other Assessment Opportunities** Observing students' reactions to the environment and interactions with one another exploring spring hydrology.
Self-Assessments KWL chart	**Other Evidence of Understanding** Class discussion and participation

Key Vocabulary:

1. Ecosystem: system formed by the interaction of a community of organisms with their environment.
2. Groundwater: the water beneath the surface of the ground, consisting largely of surface water that has seeped down: the source of water in springs and wells.
3. Hydrology: the science dealing with the occurrence, circulation, distribution, and properties of the waters of the earth and its atmosphere.
4. Karst Topography: landscape that is characterized by numerous caves, sinkholes, fissures, and underground streams.
5. Observation: an act or instance of viewing or noting a fact or occurrence for some scientific or other special purpose.
6. Spring: underground water that is held in the soil and in pervious rocks.

Material Needed:

- Paper
- Pencils
- Internet access for Big Spring Video - http://www.nps.gov/ozar/photosmultimedia/park-videos.htm, click Big Spring Video
- Field trip requirements

Lesson/Learning:

First have students independently make a KWL chart about Big Spring. Conduct a class discussion about the Know section of their charts. Then review general information about Big Spring. Keep students active in discussion by asking questions.

Example questions for class discussion:

1. How many gallons of water do you think enter the Current River every day from Big Spring?
    a. 278 million gallons
2. How far away do you think the water in Big Spring comes from?
    a. Up to 45 miles
3. How long do you think it took the water to make that trip?
    a. Up to 14 days
4. We know that water is dissolving the underground rock. How much rock do you think is being carried away each day?
    a. 175 tons

Show video of Big Spring to lead into conversation about protection of the spring as a natural resource.

After video lead discussion about why it is important to protect the spring as a natural resource.

Example questions:

1. Can you swim in the springs in Ozark National Scenic Riverways? Why or why not?
    a. No, because the water chemistry could be contaminated.
2. Why is protecting springs important?
    a. Because they are a source of fresh water, unique ecosystems, habitat for animals/plants.

Remind students that during their visit to Big Spring they should think about why the spring is important and what impact humans have on the spring ecosystem.

Lead discussion on the Want to Know section of their table to see what knowledge students want to gain. Ask for suggestions about how they could gather this information during their visit to the spring.

Take students on field trip to Big Spring.

After returning to class, have students complete the Learn section of their table to assess the knowledge they gained.

Activity 2: Introduction to Blue Spring

Subject: Introduction to Blue Spring; to be used in preparation for a field trip to Blue Spring.

Grade Level: K-12

Duration: about 20 minutes

Brief Description: In this lesson students will be introduced to Blue Spring. This lesson should be used in coordination with a field trip to the springs at the park.

Educational Standards:

Common Core: will vary according to grade level.

Next Generation: **3-5-ETS1.A** Engineering Design, **MS-ESS3**.C Earth and Human Activity, **HS-ESS3.C** Earth and Human Activity

Objectives:

At the end of this lesson and field trip, students will be able to:

- List what makes Blue Springs unique.
- Explain why Blue Spring is considered an ecosystem.
- Make observations about an ecosystem.
- Explain how to obtain information about an ecosystem.

Background Information about Blue Spring:

http://www.nps.gov/ozar/blue-spring.htm

Blue Spring is located approximately 12 miles east of Eminence on Highway 106. (Not to be confused with another "Blue Spring" on the Jacks Fork River near Mountain View.) The spring flows relatively slowly from a very deep cave shaft that is situated at the base of a dolomite bluff. The average flow of the spring (1923 to 1965) is 107 cfs, or 69 mgd (Vineyard and Fender 1974). The recharge area for the spring can be calculated to be approximately 107 square miles using the mean annual flow in cfs as a guide, and this approximation is supported by the current knowledge of the local groundwater flow that has been obtained using dye studies (Aley and Aley, 1987). The recharge area for the spring includes the headwaters of Logan Creek

which is nearly 10 miles from the spring itself (Aley and Aley, 1987). This part of the recharge area lies in the topographic watershed of the Black River. The underground conduit of Blue Spring has been explored and mapped to a depth of over 300 vertical feet.

The land around the spring was used as a lodge and retreat until 1960 when it was sold to the Missouri Department of Conservation (MDC). The land around the spring is still a MDC inholding and state designated natural area.

Blue Spring is 310 feet deep. If the Statue of Liberty was standing on the bottom, the top of her torch would be underwater. It is widely considered to be the most beautiful spring in Missouri due to its vivid blue color.

Essential Lesson Questions:

1. What makes Blue Springs unique?
    a. Plants, animals, depth, blue color
2. Why is Blue Spring considered an ecosystem?
    a. Because there are specific organisms that live there and interact with each other.
3. How should you make observations?
    a. Write specific information about what you see, hear, feel.

Evaluation:

Performance Task Student researches Blue Spring.	**Other Assessment Opportunities** Students compile pamphlet about Blue Spring.
Self-Assessments Students make observations about spring ecosystem.	**Other Evidence of understanding** Student "teaches teacher" about Blue Spring.

Key Vocabulary:

1. Ecosystem: system formed by the interaction of a community of organisms with their environment.
2. Groundwater: the water beneath the surface of the ground, consisting largely of surface water that has seeped down: the source of water in springs and wells.
3. Hydrology: the science dealing with the occurrence, circulation, distribution, and properties of the waters of the earth and its atmosphere.
4. Karst Topography: landscape that is characterized by numerous caves, sinkholes, fissures, and underground streams.

5. Observation: an act or instance of viewing or noting a fact or occurrence for some scientific or other special purpose.
6. Spring: underground water that is held in the soil and in pervious rocks.

Materials Needed:

- Paper
- Pencil
- Internet access
- Other resources about Blue Spring
- Field trip requirements

Lesson/Learning:

Have students independently research Blue Spring using the internet, pamphlets, or books obtained from Ozark National Scenic Riverways, or other sources available.

Go around the room and ask each student for one fact they learned about Blue Spring during their research. Lead discussion about research.

Example Questions:

1. How deep do you think Blue Springs is?
    a. 300 feet deep. It is the deepest known spring in the Ozark region.
2. How much water is discharged from Blue Spring each day?
    a. 90 million gallons per day
3. Where does the water in Blue Spring originate from?
    a. Logan Creek

Remind students that during their visit to Blue Spring they should think about why the spring is important and what impact humans have on the spring ecosystem.

Take students on field trip to Blue Spring. While students are at Blue Spring have them record observations about the spring ecosystem.

After returning to class, have class discussion about student observations that were made on the field trip.

Extensions:

Have students compile information from their knowledge and observations into an information guide.

Activity 3: How a Spring Works

Subject: Earth Systems

Grade Level: 4th grade

Duration: two class periods

Brief Description: In this lesson the students will act out a play to help them develop an understanding of how a spring works. They will explore where the water comes from as well as how it gets into the rock and back out to form a spring. They will uncover the process behind water erosion within the rocks as well.

Educational Standards:

Common Core: CCSS.ELA-Literacy.RI.4.7, CCSS.ELA-Literacy.RI.4.1

Next Generation: **4-ESS2 - 1** Earth's Systems , **4-ESS2.A** Earth's Systems

Objectives:

At the end of this lesson, students will be able to:

- Explain how a spring is formed
- Describe the role carbon dioxide has in creating a spring

Background Information:

A spring is underground water that comes to the surface. Water is a powerful force. It can carve out rivers, and it can tear down mountains. It can turn a mere piece of rock into an elaborate spring system. Water is strong enough to cut out huge caves, yet that very same water is gentle enough to form delicate structures within that cave. Water is the life-blood of the Ozarks.

When you cut yourself, what happens? You bleed. Blood brings nutrients to your body, and carries out wastes. Without it, you can't live. In the same way, water "forms" and "feeds" springs and caves. Without water, they die.

Very basically, rainwater, as it falls through the air picks up carbon dioxide. It also combines with carbon dioxide as it passes through the humus layer, which is the decaying vegetation on

the ground. This rainwater is slightly acidic. Next the acidic water seeps into cracks in the rocks, and actually dissolves the rock, like sugar dissolves in your coffee. The water moves from one crack to another, dissolving as it goes, until it finds an opening. Then, it's a "spring".

Think about when you have a lot of acid in your stomach and don't feel well. You may take an antacid. The acid dissolves the medicine, which neutralizes the acid, and you feel better. The acidic water dissolves the rock just like your stomach acid dissolves the medicine. Same thing! Another similarity is the ingredients on an antacid: calcium carbonate and magnesium. The dolomite rock in this area is also made of calcium carbonate and magnesium.

Essential Lesson Questions:

1. What role does the CO2 have in creating a spring?
    a. It dissolves rocks in the Ozarks.
2. Where during the journey of a raindrop does it collect CO2?
    a. In the atmosphere layer and the Humus layer.
3. What happens when the water reaches a large rock?
    a. The drops search for a way around the rock or a crack in the rock.

Evaluation:

Performance Task	**Other Assessment Opportunities**
The students will participate in the play and take on the roles given to make the path to a spring take life. This will happen by understanding their role and what part they have.	After the play the students will be asked to answer questions about what happened and why. This time will help the teacher to see if the students really understand the concepts or if they just played along.
Self-Assessments	**Other Evidence of understanding**
Students will need to know their role in order to fully take on their part.	As the play takes place the teacher is checking for understanding by watching how the students interact and respond to what is being said and the student's movements.

Key Vocabulary:

1. Atmosphere: the whole mass of air surrounding the earth.
2. Dolomite: a mineral found in broad layers as a compact limestone.
3. Humus: a brown or black product of partial decay of plant or animal matter that forms the organic portion of soil.

4. Limestone: a rock that is formed chiefly from animal remains (as shells or coral), consists mainly of calcium carbonate, is used in building, and gives lime when burned.

5. Spring: an opening at or near the surface of the Earth through which water from underground sources emerges.

Material Needed:

- None

Lesson/Learning:

Explain how a spring is born. Review the background information as needed.

Next split the kids into groups. Each group will present a short skit on how a spring is formed. Each group will need someone to play the atmosphere, someone to play humus, someone to play dolomite rock, and someone to play a raindrop. Give the students time to research springs, write a short 5-minute skit, and rehearse. If they have time they can develop props. Have students present their plays in the next class period. Have students review the scripts and assign roles in the groups. Then come together to act out the following play.

After the skits have been presented in the next class, lead a group discussion about how water forms into a spring. Ask the kids these questions to help confirm their knowledge of springs.

1. Rain falls through what layers before reaching rock?
2. What does water pick up along the way?
3. After rain reaches the rock what happens?
4. What is carbon dioxide's job in helping get the rock?

Activity 4: Groundwater

Subject: Groundwater

Grade Level: 5th grade

Duration: one-two class periods

Brief Description: In this activity students will learn about groundwater, including where it comes from, how it is stored, and why it is important. The students will learn these concepts by reading and participating in an experiment.

Educational Standards:

Common Core: CCSS.Math.Content.5.NF.A.1,

Next Generation: **5-ESS2.C** Earth's Systems , **5-ESS2.1** Earth's Systems , **3-5-ETS1** Engineering Design

Objectives:

At the end of this lesson, students will be able to:

- Recognize that groundwater is made up of rain water and is pulled down into the earth by gravity until it hits the water table
- Describe the path that water takes to get into the ground
- Explain the impacts water has on the water table
- List sediments that hinder the path of water into the ground
- List ways that rain can negatively affect the water table

Background:

When water hits the ground, gravity pulls it through the pores in the soil until it reaches a depth where all the spaces between the particles are filled with water. The water level at this point is called the water table. The water table can be affected by various factors. It can rise during high periods of rainfall and fall during a drought.

Below the water table, all the spaces between particles are filled with water, also known as groundwater. When there is an underground, saturated, permeable, geologic formation capable of producing significant amounts of water in a well or spring, it is called an aquifer.

Nearly 90% of all aquifers developed for water supplies are composed of sands and gravels. Porous sandstone, limestone, and highly-fractured crystalline and volcanic rock are other common aquifer materials.

Essential Lesson Questions:

1. What are some of the ways that rain can negatively affect the water table?
    a. It can cause the water table to be too high, creating a flood, or too low, creating a drought.
2. What are some of the sediments that hinder the path of water into the ground?
    a. Large rock formations, clay, gravel, sand
3. What causes rainwater to work its way into the ground?
    a. Gravity

Evaluation:

Performance Task	**Other Assessment Opportunities**
The students will be expected to participate in the experiment and conversations that show understanding. The teacher should walk around the room during the experiment asking questions to each group making sure that they are getting the concepts and are doing the experiment correctly. They should also watch for students who are intentionally not responding or offering their opinions.	During the game section of this activity the students should be able to describe why it is more difficult for the water droplets to make it through the rock and clay, and then the sand and gravel.
Self-Assessments	**Other Evidence of understanding**
The students will be working in groups and therefore will have time to talk with their team members to check for understanding.	As the students complete this activity you will be able to determine the student's depth of knowledge using multiple strategies. The students should all be working in groups to allow for collaboration. As the students work together you can get some overt responses by listening to their conversations, by looking at their work as the produce it, and by watching how the students interact with each other during this activity.

Key Vocabulary:

1. Aquifer: any geological formation containing or conducting ground water, especially one that supplies the water for wells, springs, etc.
2. Particle: a minute portion, piece, fragment, or amount; a tiny or very small bit: *a particle of dust; not a particle of supporting evidence.*
3. Hypothesis: a proposition, or set of propositions, set forth as an explanation for the occurrence of some specified group of phenomena, either asserted merely as a provisional conjecture to guide investigation (working hypothesis) or accepted as highly probable in the light of established facts.
4. Sediment: the matter that settles to the bottom of a liquid; lees; dregs.

Material Needed (per group):

- Two cups filled halfway with water
- One cup filled ¾ with gravel
- One cup filled ¾ with sand
- One crayon or tape

Lesson/Learning:

Start by asking the students some questions.

Example Questions:

1. What do you know about groundwater?
2. What makes groundwater?

Then provide them with information about groundwater. Divide students into groups and hand out two cups. One that is ¾ full of gravel and one that is ½ full of water.

Divide students into groups and hand out two cups. One cup should be ¾ full of gravel and the other should be ½ full of water.

This is a good time to review fractions explaining that the gravel cup is ¾ full of gravel and that there is only room left for ¼ cup of gravel. Then talk about how there is a ½ cup of water next to the cup of gravel. Ask the class if the ½ cup of water will fit in the cup of gravel that is filled ¾ of the way.

Students should really consider this question and not just jump to a no or yes answer. After they have responded ask the students to pour the water into the gravel cup slowly while watching where the water goes. After the students are finished see how much of the water fit in the cup.

Ask students to examine the material in their cup and describe where the water fits in it (between gravel particles – provide a definition for this word). Explain that water found in the ground is groundwater. This is like the water found under the earth's surface.

Have each group find the top of the water in the cup, and using a crayon or piece of tape, mark it on their cup. Explain that this is the water table.

Distribute one cup of sand and one cup of water to each group. Have students examine the sand for things like particle size, color, and texture. Students should discuss their observations with their group.

Ask the students how much water they think will fit in the cup. Tell them they are making a hypothesis. (Provide a definition for this word as well.)

Students should slowly pour the water into the cup of sand. Those not pouring should be carefully observing where the water goes. (It fills up the spaces between the sand particles.)

Ask the students if they were correct in their hypothesis. Allow conversations about this experiment.

Students should also watch for the telltale bubbles of air that may form as air is being forced out of the spaces between particles by the incoming water.

Ask students to mark the water table in the cup of sand and water with a crayon or tape.

Ask the students what they noticed about the water table in this cup compared to the other cup.

One student in each group should make a hole in the sand with their finger or a pencil. A small pool of water will form in the hole. The top surface of water in this pool is the water table.

Have students feel the sand on the top. How does it feel? Why? (The sand at the top of the cup is dry or damp. It is not saturated, unlike the sand under the water table.)

Ask the students what they think will happen if more water was added to the sand.

Make a connection to the real world. Ask the students to consider what happens when it rains a lot. What would happen to the water table? What if two days later it rained some more? What

would happen to the water table then? What do you think a flood has to do with the water table?

Ask the student to think about what might happen to the water table if it did not rain for two weeks. What about a month? Introduce the vocabulary work drought. What happens to the water table in a drought? What else is impacted during a drought?

Extensions:

Game Background:

Sand, gravel, rocks, and clay are four different types of earth materials. Whereas water can travel with relative ease around individual particles of sand and gravel, it is much more difficult for water to find its way around rocks or clay particles. In the case of rocks water must find a crack or hole and dissolve the rock, or simply go around the entire rock. In the case of clay, the particles are tiny and close together, and pore spaces are not interconnected well, so water cannot easily find its way through it to soak down into the earth.

Game:

1. Divide the class into groups representing water droplets, gravel (loosely packed), clay (tight, hard for water droplets to get through), a large solid rock (impossible to go through unless the water finds a way around the rock formation, or a crack in it). More students should be in the clay group then in the gravel; even more should be in the rock group. Fewer sediment types many be used if there are not enough people.
2. Gravel students should squat side by side without toughing.
3. Behind the gravel group, clay students should squat side by side, holding hands.
4. Behind the clay group, solid rock students should squat with their arms around each other's waists. They may choose whether or not to put a "crack" in their formation by having two students in the group not touching.
5. Water droplets (not toughing each other) must try to squeeze through these different sediment layers. Water droplets must crawl. No sediment types may grab water droplets with their hands, or trip them with their feet or legs.
6. On the word "GO!" water droplets start at one end of the room and try to make it through the various layers. (Optional: time how long it takes for the water droplets to get though.)
    a. May want to do many different rounds so all children can get the chance to try.

Additional Resources:

Karst in the Ozarks, with video: http://watersheds.org/earth/karst.html

Groundwater.org: http://www.groundwater.org/kids/

Activity 5: Where is Round Spring?

Subject: Reading topographic maps

Grade Level: 4th grade

Duration: one class period

Brief Description: In this lesson the students will be using a topographic map to help find different locations at Round Spring. This lesson could be followed by a visit to Round Spring.

Educational Standards:

Common Core: CCSS.Math.Content.4.MD.A.1
CCSS.ELA-Literacy.RI.4.7

Next Generation: **4-ESS2** Earth's Systems

Objectives:

At the end of this lesson, students will be able to:

- Explain the purpose of a topographic map
- Explain what the contour lines on a topographic map tell us about the land
- Use a map to find distances between locations
- Make conversions between measurement units

Background Information:

http://www.nps.gov/ozar/planyourvisit/round-spring-and-round-spring-cave.htm

A map is a representation of the Earth, or part of it. The distinctive characteristic of a topographic map is that the shape of the Earth's surface is shown by contour lines. Contours are imaginary lines that join points of equal elevation on the surface of the land above or below a reference surface, such as mean sea level. Contours make it possible to measure the height of mountains, depths of the ocean bottom, and steepness of slopes. A topographic map shows more than contours. The map includes symbols that represent such features as streets, buildings, streams, and vegetation. These symbols are constantly refined to better relate to the features they represent, improve the appearance or readability of the map, or reduce production cost.

Round Spring is located approximately 13 miles north of Eminence on Highway 19. The spring flows into an almost perfectly circular cavern that has collapsed, and from there it travels through a natural tunnel before it emerges into the spring branch. The average flow of the spring during a 16-year record is 40 cfs and 26 mgd (Vineyard and Feder 1974). The recharge area of the spring encompasses roughly 45 square miles (Aley and Aley 1987). A portion of the spring's recharge area is situated to the southwest under Spring Valley. It is also possible that part of the recharge area is situated to the northeast, which means that the groundwater would have to flow under the Current River to reach the spring.)

Round Spring was also one of the first parks in the Missouri state park system (1932). The Round Spring State Park was incorporated into the Ozark National Scenic Riverways in 1972.

Essential Lesson Questions:

1. What is the purpose of a topographic map?
    a. To show the relief features of the earth's surface, usually by means of contour lines to show changes in elevation.
2. What are contour lines? What do they tell you about the land?
    a. Lines on a topographic map connect points that have the same elevation on the land surface. Contour lines tell you the elevation. You can determine whether areas are flat (lines are far apart) or steep (lines are closer together).

Evaluation:

Performance Task: Measuring distances on a topographic map and converting the distance into alternative measurement units.	**Other Assessment Opportunities:** Class discussion about the topographic maps with open ended questions regarding reading and using these maps.
Self-Assessments: Students determining the measurements and volunteering their answers to contribute to class discussion.	**Other Evidence of understanding:** During the time students are working with their partners assess their understanding by listening to their conversations and reviewing their work.

Key Vocabulary:

1. Topographic map: a map showing the relief features of the earth's surface, usu. by means of contour lines to show changes in elevation
2. Topography: the art or practice of showing on maps or charts the heights and depths of the features of a place

3. Legend: an explanatory list of the symbols on a map or chart
4. Relief: the differences in elevation and slope between the higher and lower parts of the land surface of a given area.
5. Contour line: a line (as on a map) connecting the points that have the same elevation on a land surface (the squiggly lines on the topo map)
6. Scale: the line at the bottom of the map that allows you to measure accurate distances.

Material Needed:

- Topographic maps of Round Spring (available in Appendix E)
- Rulers
- USGS Topographic Maps video

Lesson/Learning:

Watch the video introduction to USGS topographic maps (almost 6 minutes) - http://gallery.usgs.gov/videos/568.

Have students pair up with a partner and then pass out the topographic maps. Lead class discussion about the maps.

Example questions:

1. What is a topographic map?
2. Who uses these maps?
3. Will you ever need to know how to use/find a topographic map?
4. Who makes these maps? Why?

Give student partners time to review the maps. Ask the students what they see on their maps, including the map scale.

Next let the students practice using the maps. Have students find the quickest way from one point to another point. Have students use ruler/paper and map scale to measure distances. Discuss what challenges there may be in navigating from one point to another. (Is there a road? Are the contour lines close together or far apart? Is there a river in between the two points?)

Now have students try to determine the path of least resistance between two points. (This may be a longer distance, but it is the easiest route.)

Instruct students to locate the distance from the road to the campground (should be about 0.25 miles).

Ask students what distances they got. Ask students whether this would be easy to measure.

Next have students draw a table to show conversions of measurement units.

Example:

Miles	Feet
Feet	Inches
Inches	Centimeters

Discuss what an appropriate unit of measurement would be.

Extensions:

Take students on field trip to Round Spring. Use topographic maps to compare real locations with locations on the map. Use meter sticks to measure distances between points and compare these to the distances on the map using the map scale.

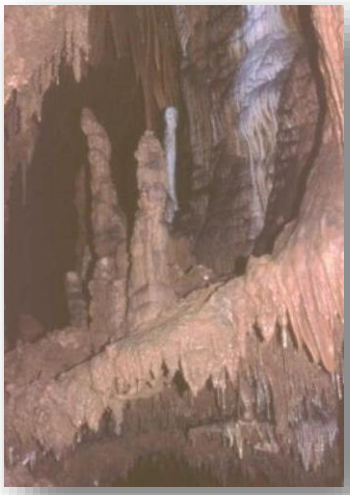
Additional Resources:

Topographic Map Symbols -
http://pubs.usgs.gov/gip/TopographicMapSymbols/topomapsymbols.pdf

Section B: Animals and Endangered Species

Ozark National Scenic Riverways preserves riparian, upland forest, aquatic and subterranean habitats for wildlife. Whitetailed deer and wild turkey delight hunters while at least 198 species of birds are waiting for the avid birder. Relict glade habitats are home to some of the more unusual animals in the Ozarks, including collared lizards more typical of the US Southwest and even tarantulas and scorpions. A prescribed fire regime keeps these habitats healthy.

Activity 6: Cave Critters



Subject: Natural Selection and Adaptations

Grade Level: 6-8th grades

Duration: one-two class periods

Brief Description: In this lesson students will learn about animal adaptations, specifically in animals that live in caves. It could be followed with a field trip to Round Spring Cave.

Educational Standards:

Common Core: CCSS.ELA-Literacy.SL.6.1c , CCSS.ELA-Literacy.SL.6.2

Next Generation: MS-LS4-4 Biological Evolution: Unity and Diversity, **HS-LS4** Biological Evolution: Unity and Diversity

Objectives:

At the end of this lesson, students will be able to:

- Explain that animals living in different ecosystems have adapted to their different environments
- Recognize that adaptation can promote survival of a species
- List adaptations that would benefit organisms in their environments

Essential Lesson Questions:

1. Why do organisms need adaptations?
    a. For survival so they can reproduce.
2. Are all adaptations beneficial?
    a. No. The adaptation has to help the species survive, reproduce, or get food to be beneficial.
3. How quickly do adaptations take place?
    a. Usually quite a while, but it some cases it can be faster.

Evaluation:

Performance Task	**Other Assessment Opportunities**

Students draw and describe an organism that has adapted to cave life.	Students present their cave critter orally to the class. Students use interactive bulletin board to review concepts.
Self-Assessments Students write down what they think "survival of the fittest" means.	**Other Evidence of Understanding** Students participate in class discussion providing answers and relevant information.

Key Vocabulary:

1. Variation: a change in a trait from the rest of the species.
2. Genetic Variation: differences in genes among individuals or species.
3. Inheritance: genetic traits are inherited from the parents and passed down to the offspring.
4. Selection: organisms with traits that are favorable to their survival get to live and pass on their genes to the next generation.
5. Species: a group of organisms that can breed and produce offspring that can breed.
6. Survival: ability to live.
7. Adaptation: a change in the genetic code or in the way a species lives that allows them to survive in their environment.

Material Needed:

- Material for drawing/creating animal – colored paper or posterboard, pencils, scissors, glue, etc.
- Internet access
- Videos

Lesson/Learning:

Have students write down what they think "survival of the fittest" means. Give them five minutes to do this and then have a class discussion regarding what they each wrote down. Note: Have students do this again at the end of the lesson as an assessment.

During the discussion, listen for student misconceptions and make sure they understand the following:

In terms of natural selection, there are two distinct processes in evolution that are important to understand. First, the occurrence of new traits in a population occurs because of environmental conditions, survival needs, over-use or under-use of certain bodily organs or abilities, genetic mutations, and/or the formation of new combinations of existing genes. Point out that a

genetic mutation OR the formation of new combinations of existing genes can affect the individual's life and that this change in genetics can be passed to one's offspring, thus affecting successive generations. Second, that these new traits have an effect on long-term survival.

In terms of the big picture of natural selection, it is important that students understand that a change in a population results from the survival of a few individuals that preferentially reproduce and NOT from the gradual change of all individuals in a population.

In terms of adaptation in the theory of natural selection, it is important to point out that populations change or adapt over generations inadvertently and not deliberately. Thus, this type of adaptation is not a conscious process. It may be helpful to point out that there are different types of adaptation. For example, there are non-inherited adaptations acquired during an individual's lifetime AND there are adaptive features that are inherited in a population (e.g., natural selection).

Suggested questions to clarify concepts:

1. Are evolution and "survival of the fittest" the same thing?
    a. Evolution and "survival of the fittest" are not the same thing. Evolution refers to the cumulative changes in a population or species through time. "Survival of the fittest" is a popular term that refers to the process of natural selection, a mechanism that drives evolutionary change. Natural selection works by giving individuals who are better adapted to a given set of environmental conditions an advantage over those that are not as well adapted. Survival of the fittest usually makes one think of the biggest, strongest, or smartest individuals being the winners, but in a biological sense, evolutionary fitness refers to the ability to survive and reproduce in a particular environment. Popular interpretations of "survival of the fittest" typically ignore the importance of both reproduction and cooperation. To survive but not pass on one's genes to the next generation is to be biologically unfit. And many organisms are the "fittest" because they cooperate with other organisms, rather than competing with them.
2. How does natural selection work?
    a. In the process of natural selection, individuals in a population who are well-adapted to a particular set of environmental conditions have an advantage over those who are not so well adapted. The advantage comes in the form of survival and reproductive success. For example, those individuals who are better able to find and use a food resource will, on average, live longer and produce more offspring than those who are less successful at finding food. Inherited traits that

increase individuals' fitness are then passed to their offspring, thus giving the offspring the same advantages.

Next share the “Biology of Caves” information found at http://www.nps.gov/ozar/forteachers/cave-biology.htm with your class. Use this information to present information about cave habitats and how the organisms that live there are adapted to this environment.

Ask students to come up with ideas about factors in the environment or interactions they have with one another that might affect the survival of those organisms. For example, temperature, light/dark, availability of food/water, competition for food/water/mate, etc.

Ask what adaptations organisms have in caves. For example, reduced eyes, no pigment, long antenna, anything that helps save energy because there is a lack of food, anything that increases senses other than vision because it is dark, etc.

Use the links below to supplement these ideas and provide a visual aid for cave critters. Give students time to explore the links while working in partners and then discuss as a class.

http://www.cavebiota.com/ - This link has videos about levels of adaptations, as well as videos about specific cave organisms like the blind cave crayfish.

http://www.goodearthgraphics.com/virtcave/cave_life/cave_life.html - This link has information and photographs of cave organisms.

Activity:

For this activity students will be “designing” a cave organism that has adapted to its environment and matches the adaptations to the level assigned. The students will need to support the adaptations they create. Below is a suggested procedure.

- In groups of 2-3 students assign each group a specific organism (frog, fish, salamander, bird, etc.) and also assign each group a level of adaptation. For example, a Troglobite Frog would be assigned to one group of students.
- Each group will need to list five adaptations that their organism has (needs to fit the level of adaptation) and a justification for each (what factor in the environment or interaction makes this a beneficial adaptation).
    - Example: The Troglobite has reduced eyes (because it lives in the dark), no pigment (because it takes energy to make and it is not necessary in a dark environment), etc.
- Have students draw their organism with the adaptations represented.

- Students should present their adapted cave critters to the class.

Extensions:

Teacher can display the cave critters on bulletin board and provide labels for the levels of adaptation that the students can pin next to the organisms.

For high school assign each student their own project, and have them write a summary report to explain their cave critter.

Additional Resources:

http://www.nps.gov/ozar/forteachers/cave-biology.htm

Activity 7: Native Species Restoration

Subject: Native Species Restoration

Grade Level: 6-8th grades; Extension for 9th-12th grades

Duration: one-three class periods

Brief Description: For this activity the students are going to do a small research project about native species restoration. They will follow this up by writing a summary using the research that they collected.

Educational Standards:

Common Core: CCSS.ELA-Literacy.RI.6.2 CCSS.ELA-Literacy.RI.6.7

Next Generation: MS-LS2 Ecosystems: Interactions, Energy, and Dynamics, **HS-LS2** Ecosystems: Interactions, Energy, and Dynamics

Objectives:

At the end of this lesson, students will be able to:

- List advantages and disadvantages of native species reintroduction
- Define a native species
- Explain how the extinction and reintroduction of species affects the ecosystem in which they live (their natural habitat)

Background Information:

In many parts of the country, native species have been driven out of their habitats by human activities leading some species to become endangered or even extinct. Today, several large animal species are being reintroduced to their native ecosystems. These include large predators such as gray wolves. Many people see the reintroduction of predator species as a threat to their livelihood. People are also afraid that large predators are a danger to other humans. Other groups of people see native species, including large predators, as part of the natural ecosystem and are working to reintroduce them to their native habitats.

Elk is one species that is being reintroduced in Missouri. While there are no elk within Ozark National Scenic Riverways, the Missouri Department of Conservation has reintroduced elk at the Peck Ranch Conservation Area, which is near the park boundary. Additional information about the elk restoration project can be found at http://mdc.mo.gov/discover-nature/wildlife-restoration/elk-restoration/elk-restoration-background/elk-restoration-plan.

Essential Lesson Questions:

1. What is a native species?
    a. Plants or animals that live in an area without being brought there by humans or human activity.
2. What is a natural habitat?
    a. The area or environment where an organism normally lives or occurs.
3. Why are some native species missing from their natural habitats?
    a. Hunters, habitat destruction, disease, etc.
4. Should humans restore native species?
    a. This depends.

Evaluation:

Performance Task Students will complete research on restoration of native species into their natural habitats.	**Other Assessment Opportunities** Students will be evaluated based on written journal responses, participation in class discussions, thorough and accurate group research on the reintroduction of an animal species, and well-supported persuasive essays.
Self-Assessments Group discussions during research completion.	**Other Evidence of understanding** Oral presentations of research.

Key Vocabulary:

1. Extinction: the death of an entire species.
2. Native species: plants or animals that live in an area without being brought there by humans or human activity.
3. Natural Habitat: the area or environment where an organism normally lives or occurs.
4. Reintroduction: to bring (an animal, plant, etc.) back to its native or original habitat.

Material Needed:

- Pencils
- Paper
- Journal/notebook
- Sources for research
- Internet access to view videos

Lesson/Learning:

Students investigate the impacts (on the animals themselves and on humans) of the reintroduction of animal species to the animals' natural habitats.

To prep for the activity have students write responses to the following questions in their journals:

- What is meant by the term "natural habitat"?
- How can the extinction of a species impact a habitat?
- How can the reintroduction (or replacement) of a species into a habitat affect that habitat?

Facilitate a class discussion where students share their responses. Clarify any misconceptions.

View the Missouri Department of Conservation video "2010 Missouri Elk Restoration Plan" at http://www.mdc.missouri.gov/media/video/2010-missouri-elk-restoration-plan (3 minutes)

View the news video "Conservation Connection: Elk Reintroduction" at http://kplr11.com/2013/06/05/conservation-connection-elk-re-introduction/ (4 min 30 sec)

Additional information can be found at

http://mdc.mo.gov/conmag/2010/09/elk-history-and-restoration and

http://www.mdsportsmensfoundation.org/uploads/Elk_History_and_Restoration_Background_in_Missouri_2010.pdf

Use the following questions for class discussion after viewing the videos:

1. Is the elk native to Missouri?
    a. Yes, prior to European settlement.
2. What do you think happened to the elk that were in Missouri before 1865?
    a. Elk were hunted, habitat destruction, disease, etc.
3. Why would Missouri want to restore elk?

    a. They were a native species in their natural habitat. There are also economic benefits to the state, including tourism and controlled hunting.
4. Do you think that everyone agrees that elk restoration is a good idea? Why or why not?
    a. Probably not. Possible objections may be that elk could interfere with livestock farms, introduce disease, cause car accidents, etc.

Further Questions for Discussion/Research:

- What classifies a species as "endangered"?
- How do the needs or desires of humans sometimes conflict with the survival of animal species?
- Why would an animal species need to be reintroduced to its natural habitat?
- What do humans do to endanger natural habitats of other living creatures?
- How do activities such as urban and suburban expansion, mining, pollution, agriculture, and recreation impact the natural habitats of various species?
- How do human population patterns affect where an animal species can be reintroduced?
- Why might land restrictions occur if an endangered species were reintroduced to an area, and how might these restrictions affect industries?
- What is the importance of "legally listing" an animal as an endangered species?
- How do an animal's physical features enhance its ability to survive in its natural habitat?
- What actions have been taken towards the conservation of various species?

Next divide students into small groups of 3-4, and explain that they will be investigating the impact of reintroducing different animal species. Assign each group an animal to research. Suggested Missouri species include: American burying beetle, hellbender, prairie chicken, wild turkey, etc. You can use species from other locations too, such as grey wolves.

Provide resources, including internet and library access to investigate to find answers to the following questions (write the questions on the board or provide handout). This assignment could be given as homework as well.

1. What is considered to be this animal's habitat?
2. Why did this animal become endangered?
3. How have humans impacted the habitat of this animal?
4. How did the animal's habitat change as its population decreased?
5. When and why was this animal reintroduced into this habitat?
6. What have been the effects, both positive and negative, of the reintroduction of this species on its habitat? Include effects on human population.

During the next class have students present their research.

Additionally, after completing their research, students should compose essays responding to the following question:

- Why should or should not the preservation of a species matter to people when that species does not directly help or otherwise impact humans?

Students should incorporate their group's research and information they gained from the class review of this topic.

Extensions:

Provide high school students with the W-elk-ome Home handout:

W-elk-ome Home

Imagine you are a wildlife manager working to restore the population of an extirpated species of wildlife. In this case we will look at elk. Currently, the herd is small and your task is to find the best habitat and situation for the population to grow and develop into a healthy herd. Which of the following scenarios do you think would provide the best situation for your herd of elk?

Scenario 1: The herd is currently living in a 365 square mile range in the Ozark Highlands of Missouri which was inhabited by this species prior to 1865. Human settlers drastically reduced all predator species of the elk as well as created other habitat changes caused by human development that have continued to keep the elk's populations low. Now, the habitat is improving and the elk population is growing slowly but steadily. However, some wildlife managers are planning to reintroduce mountain lions to the region. They plan to bring in several families of mountain lions into the area. The elk population is just beginning to rebound and you are concerned about the effects of the mountain lion introduction on the continued growth of the herd.

Scenario 2: You have the opportunity to move the elk herd and reintroduce it to a new, more favorable habitat. The new area is a deserted island in the arctic region. There is a lot of food (no animal has filled the elk's niche for many years) and there are no natural predators. The island has 41 square miles of good habitat for the population.

Which of these scenarios would produce the fastest growth of the elk population?

Which would potentially provide the healthiest long-term situation for the elk?

Activity 8: Bats and Endangered Species

Subject: Endangered Bat Species

Grade Level: 6th – 8th grades

Duration: one class period

Brief Description: In this lesson the students will learn and review information about bats by reading informational text, holding class discussions, and participating in a trivia game.

Educational Standards:

Common Core: CCSS.ELA-Literacy.RI.6.1, CCSS.ELA-Literacy.W.8.4

Next Generation: **MS-ESS3.C** Earth and Human Activity, **MS-LS2.A** Ecosystems: Interactions, Energy, and Dynamics

Objectives:

At the end of this lesson, students will be able to:

- List facts about bats
- Recognize that humans impact bat populations
- Name bat species that are in danger of becoming extinct

Essential Lesson Questions:

1. Do all continents have bats?
    a. No
2. What percentage of American bat species in on the endangered species list?
    a. 50%
3. What are some benefits that bats provide?
    a. They pollinate plants, and they eat bugs and mosquitoes.
4. Do all bats eat insects?
    a. No, but all do eat nectar.
5. What are some species of bats in the United States?
    a. Silver-haired bats, Hoary bats, red bats, Pallid bats, free-tailed bats, and others

Evaluation:

Performance Task	**Other Assessment Opportunities**
Students understanding will be assessed on their response to the questions provided during the Trivia Game. These questions are answered in a group setting so the teacher will need to keep an eye out for students that do not respond or look to their teammates for answers at all times instead of responding independently.	The students are to make questions to add to the trivia games. The teacher will be able to look at these questions and determine if they understand the information about bats or if they still need more help with this topic.
Self-Assessments	**Other Evidence of understanding**
Students will need to work together collaboratively before answering any questions to make sure that they are able to gain as many points as possible. This will help to make sure the students truly know and understand the concepts and ideas completely.	As the students are answering questions the teachers can listen for understanding and collaboration between the each group of students. They can also watch for a misunderstanding among the whole class to fix problems before they become habits.

Key Vocabulary:

1. Bat: a small animal, like a mouse, with wings that flies around at night.
2. Echolocation: a type of sonar system used by bats to navigate and to find food.
3. Endangered: animals or plants that are at risk of going extinct.
4. Mammal: an animal that is warm-blooded, gives birth to live young, has hair, nurses its young with milk from mammary glands, and has a backbone.

Material Needed:

- Markers and chart paper for KWL chart
- Selection from Bat Conservation International: Saving America's Bats (see Appendix A)
- Bells or buzzers for trivia game
- Trivia questions

Lesson/Learning:

To start have the students make a connection between bats and their lives. Ask questions that bring forward thoughts about bats and past knowledge of bats.

Example Questions:

1. Have you ever seen a bat in real life?
2. What was the bat doing?
3. Where was the bat?

Next have the students complete a KWL chart.

After they are finished filling out the KWL chart, divide the students into groups of four-five students. Provide a copy of the Bat Conservation International handout (in Appendix A) for each group. Give the groups time to review the information.

After the students have all completed the reading section bring the class back together to do a knowledge check. Ask simple questions from the reading like “Are bats aggressive?” and “What are some advantages to living near a bat colony?” This will help you determine if the students read and comprehended the information provided.

Next review the rules for the bat trivia game.

1. Each team will have to buzz in.
2. Team with the quickest response gets the first shot at answering the question.
3. All answers must be given in correct form.
4. No one is to buzz in while the question is being read.

Bat Trivia Questions (correct answers highlighted)

1. The World’s smallest mammal is the bumblebee bat. It weighs…..
    a. As much as an orange
    b. About the same as a half dollar
    c. Less than a penny
2. The Flying foxes of SE Asia and Australia are the world’s biggest bats. Their wings can span as much as……
    a. 1 Foot
    b. 3 Feet
    c. 6 Feet
3. A single little brown bat can eat how many mosquitoes on an hour?
    a. 250

b. 600

c. 1000

4. Many bats have unusual features like huge ears and strange nose flaps. These features help the bats to……

    a. Fly

    b. Attract mates

    c. Navigate and find food

5. Female bats usually give birth while hanging upside down. They normally give birth to how many babies?

    a. One

    b. Five

    c. Ten

6. Worldwide, there are nearly how many species (kinds) of bats?

    a. 10

    b. 100

    c. 1000

7. The common little brown bat can live as long as….

    a. 30 days

    b. 1 year

    c. 30 years

8. The wing of a bat is most similar to your

    a. Nose

    b. Hand

    c. Shoulder

9. Chiroptera is the name of the order of bats. It means

a. Hand-wing

b. Night flyer

c. Fuzzy little creature

10. Bats find their food using

a. Their sense of smell

b. Echolocation

c. Night vision

11. Bats eat the equivalent of half their body weight each night. That is like a person eating how many pizzas?

a. Five

b. Thirty

c. Fifty

12. Most bats in the United States eat….

a. Insects

b. Fish

c. Fruit

13. Some bat's hearing is so keen that they can hear the footsteps of an insect walking on sand more than six feet away.

a. True

b. False

14. Vampire bats are the only mammals that feed on nothing but blood.

a. True

b. False

15. Bats hang by their toes.

a. True

b. False

16. Bats get tangled in your hair.

a. True

b. False

17. All bats live in attics or caves.

a. True

b. False

18. Bats make up which percentage of all mammal species?

a. Over ½

b. Nearly ¼

c. Less than 1/3

19. Which of the following require bats to survive?

a. Bananas

b. Cashews

c. Dates and figs

d. Cacti

e. All of the above

20. Vampire bat saliva might be used as

a. Axle grease

b. An anticoagulant (to stop blood clotting)

c. Disinfectant

21. How high and how fast can Mexican free tailed bats fly?

a. Up to 2 miles high and 60 mph

b. Over 9 miles high and 60 mph

c. Up to 6 feet high and 12 mph

22. Vampire bats adopt orphans and have been known to risk their own starvation in order to share food with roost mates.

    a. True

    b. False

23. What percentage of American bat species is in severe decline or already listed as endangered?

    a. 10%

    b. 50%

    c. 95%

24. Which continent has no bats?

    a. Australia

    b. North America

    c. Antarctica

Extensions:

After the trivia game is complete and you have a winner, ask each group to come up with two new questions that can be added to the game for future use.

Other Resources:

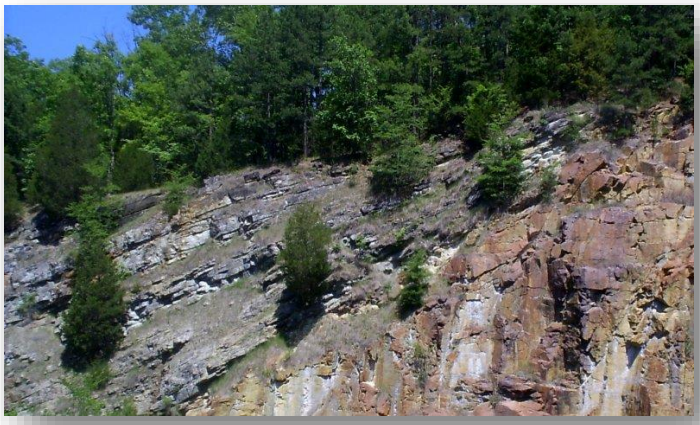
http://batcon.org/index.php/all-about-bats/intro-to-bats.html

Section C: Science

The following activities introduce glades and aquatic plants to students.

Nature and science abound at Ozark National Scenic Riverways. For more information visit http://www.nps.gov/ozar/naturescience/index.htm.

Activity 9: Glades



Subject: Glades

Grade Level: 6th – 8th grades

Duration: two class periods

Brief Description: In this lesson the students will be learning about glades. They will learn about how a glade is an ecosystem, what some dangers to glades might be, and what animals might live in glades. The students will also be creating a diorama of a glade to show understanding of glade ecosystems.

Educational Standards:

Common Core: CCSS.ELA-Literacy.SL.6.1 CCSS.ELA-Literacy.RST.6-8.7

Next Generation: **MS-LS2** Ecosystems: Interactions, Energy, and Dynamics

Objectives:

At the end of this lesson, students will be able to:

- Describe a glade ecosystem and the interdependent relationships that exist in that ecosystem

Essential Lesson Questions:

1. What ecosystems can be found in Missouri?
    a. Forests, woodlands, savannas, prairies, glades, cliffs, stream edges, wetlands, caves
2. What are the components that are found in ecosystems?
    a. Biotic and abiotic factors
3. How does energy flow through an ecosystem?
    a. Sun to producer to consumer to decomposer to soil
4. What is glade?
    a. An open exposed bedrock area dominated by drought-adapted herbs and grasses in an otherwise woodland or forest matrix

Evaluation:

Performance Task Students find examples of each level of the food web to create a model of a food web in a glade ecosystem.	**Other Assessment Opportunities** Students must provide answers to questions about their glade ecosystem dioramas.
Self-Assessments Students complete an exit ticket to assess their knowledge of the concepts.	**Other Evidence of Understanding** Monitoring progression of students as they build their glade dioramas.

Key Vocabulary:

1. Consumer: depends on producers for their energy and synthesis needs.
2. Decomposer: uses energy from wastes or dead organisms and so complete the cycle by returning nutrients to the soil or water, and carbon dioxide to the air and water.
3. Food Web: a community of organisms where there are several interrelated food chains.
4. Glade: an open exposed bedrock area dominated by drought-adapted herbs and grasses in an otherwise woodland or forest matrix.
5. Producer: uses energy from the sun and nutrients from the abiotic environment (carbon dioxide from the atmosphere or water, other nutrients from the soil or water) to develop by means of photosynthesis.

Key Material:

- Materials to build diorama
- Facts about Glades Handout (available in Appendix B)

Lesson/Learning:

Review with students the idea of food webs and the flow of energy in an ecosystem.

Provide students with the Facts about Glades handout. Have them read this information to themselves.

Review the information as a class with some of the following questions:

1. What are some of Missouri's terrestrial natural communities?
    a. *Forest, woodland, savanna, prairie, glade, cliff/talus, stream edge, wetland, cave*
2. What is a glade?

    a. *An open exposed bedrock area dominated by drought-adapted herbs & grasses in an otherwise woodland or forest matrix*
3. What is bedrock?
    a. *A general term for the solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface as outcrops*
4. What are the types of bedrock?
    a. *Igneous, Sandstone, limestone, dolomite, chert*
5. What are some characteristics of glades?
    a. *Very shallow soil (0-20 inches deep), steep slopes, high temperatures, sunny, dry in growing season, diverse flora (lots of plants; >400species!)*
6. Where are glades found in the United States?
    a. *Glades are found in many regions of North America, usually where prairie joins woodland. Glades are found in Minnesota, Texas, Louisiana, Missouri, Tennessee, Georgia, Alabama, and Virginia. There are several glades in Ozark National Scenic Riverways.*
7. How are glades classified?
    a. *Glades are classified by rock type. (Limestone glade, Dolomite glade, Chert glade, Sandstone glade, Igneous glade)*
8. How many glades are in Missouri?
    a. *It is estimated that historically there were 400,000 acres of glades in Missouri. The majority of the glades are now substantially degraded due to overgrazing (causing erosion of the fragile soil layer), decreased species (numbers and diversity), and land development.*
9. What types of glades are there in Ozark National Scenic Riverways?
    a. *Igneous, sandstone, and dolomite*
10. How many plant species have been found on glades in Ozark National Scenic Riverways?
    a. *365 species*
11. What types of plants are found on glades?
    a. *Perennial (comes back every year) and annual grasses and forbs, sedges, shrubs, and vines (also mosses which are nonvascular plants)*
12. What are some natural and human (anthropogenic) disturbances that have altered glades?
    a. *Fire, drought, frost upheaval, grazing animals (native, non-native, or domesticated)*
13. What are some exotic species that have invaded glades?
    a. *Sericea lespedeza, yellow sweet clover, common teasel, crown vetch, meadow fescue, tall fescue*
14. Where did these exotic species come from?

    a. *Highway right of way plantings, domestic livestock/wildlife/human transport*
15. What are some threats to glade ecosystems?
    a. *Exotic species, homebuilders/developers, illegal recreational activities (horseback riding, ATVs, mountain biking, illegal harvest of plants/roots)*
16. What can we do to protect or manage glade ecosystems?
    a. *Removal of invasive Red Cedar by cutting; Prescribed fire; No livestock grazing; Remove invasive plants by herbicides (chemicals), prescribed fire, or by physical removal; reseeding/planting native grasses/forbs (this can also reduce exotics by competition for resources); Gain more knowledge about glades through research and trial and error management.*
17. What are factors that determine what organisms live in glade ecosystems?
    a. *Extremely dry conditions, Solar Qualities (sunny), Available energy and nutrients*

Have students design a diorama that shows the relationships of organisms in a glade ecosystem. The dioramas should include organisms that represent each level of the food web: producers, first consumer, secondary consumers, and decomposers.

During the next class have students present their glade ecosystems and tell which organisms fit each level.

As the students present their dioramas ask students questions such as: What if you remove the producers from your glade ecosystem? What if you introduced an exotic species to your glade ecosystem?

Extensions:

Instead of group/individual dioramas, have students each (or in groups) come up with examples of each level of the food web, and compile all organisms onto one large white sheet of paper or bulletin board to create a class compilation glade ecosystem. Indicate which organisms belong to each level (could use different color push pins or tape). Have the class "connect" the web using string or markers to draw lines between organisms.

Additional Resources:

The Terrestrial Natural communities of Missouri. Paul Nelson. 1985. Missouri Natural Areas Committee.

http://www.stateoftheozarks.net/NaturalHeritage/Hills_Hollows/Glades.html

Explore glade restoration using the “Collared Lizards Benefit from Fire Management” by Angela Smith located at http://www.nps.gov/ozar/naturescience/lizards.htm.

Activity 10: Aquatic Plants

Subject: Aquatic Plant Life in Pond/Lake Ecosystems

Grade Level: 4th grade

Duration: one-two class periods

Brief Description: In this lesson the students will learn how to tell the difference between plants that are good for ponds and lakes and plants that are causing problems in a lake or pond. The students will then be asked to create a pond with plants that are good for the pond and describe why these plants are good.

Educational Standards:

Common Core: CCSS.ELA-Literacy.RI.4.7 , CCSS.ELA-Literacy.RI.4.4

Next Generation: **4-LS1**.AFrom Molecules to Organisms: Structures and Processes, **4-ESS2.E** Earth's Systems

Objectives:

At the end of this lesson, students will be able to:

- Recognize the importance of plants in ponds and lakes
- List the positive and negative effects plants can have on ponds and lakes
- Determine whether or not specific plants are a nuisance

Essential Lesson Questions:

1. Name some plants that you can find in a pond or lake.
    a. filamentous algae, Chara, Coontail, Water Milfoil, Naiads, Pondweeds, Duckweeds and Watermeal, Water Shield, Water Lily, American Lotus, Cattails, Water Primrose
2. How can you determine if a plant is a nuisance in a pond or lake?
    a. Evaluate the pond or lake for percentage of coverage of plants. For example, fishing pond should have 10-20% of the bottom or surface occupied by aquatic

plants. Ponds with more than 20% have excessive vegetation. Also evaluate where the plants are in the pond and what kinds of plants are there.

3. What are the positive or negative effects plants can have on a pond or lake?
    a. Benefits include oxygenating the water, providing food, cover, and nesting sites, and stabilizing shoreline and bottom, and being the first link in the food chain and a place for young to hide from predators. Negatives include too much cover for young fish, too many plants can cause fish kills, and physical interference for recreational activities.

Evaluation:

Performance Task The students will work together to make decisions to plan their own pond's vegetation using provided materials.	**Other Assessment Opportunities** Students will research one plant per each group to determine the effects that plant has on the ecosystem it lives in. Each group will present their research to the class.
Self-Assessments Students will participate in group work to collaborate their ideas on plants in ponds.	**Other Evidence of understanding** As the students complete this activity you will be able to determine the student's depth of knowledge using multiple strategies. The students should all be working in groups to allow for collaboration. As the students work together you can get some overt responses by listening to their conversations, by looking at their work as the produce it, and by watching how the students interact with each other during this activity.

Key Vocabulary:

1. Algae: organisms or living things that are found all over the world. Algae are very important, because they make much of Earth's oxygen, which humans and other animals need to breathe. Some algae, such as seaweed, look like plants. However, algae are actually neither plants nor animals. Instead they belong to a group of living things called protists.
2. Aquatic vegetation: plants that grow in water.
3. Biologist: a scientist who studies living organisms.
4. Ecosystem: a community of living and non-living things that work together.
5. Nuisance plants-plants that are annoying or troublesome (cause problems).

Material Needed:

- Nuisance Aquatic Plants in Missouri Ponds (Barbara Bassett, Donna Meadows, Craig Gemming; Missouri Conservationist 1993, pgs. 16-26, http://cdm.sos.mo.gov/cdm4/document.php?CISOROOT=/moconserv&CISOPTR=8674&REC=1)
- Aquaguide: Floating Leaf Control in Missouri Lakes and Ponds, http://forestkeepers.org/wp-content/uploads/2013/05/Floating-Leaf-Guide.pdf
- Aquaguide: Submerged Plant Control in Lakes and Ponds, http://mdc.mo.gov/sites/default/files/resources/2010/05/4931_2876.pdf

Lesson/Learning:

Divide class into groups of three-four.

Facilitate class discussion. Ask students if anyone likes to fish or swim in lakes or ponds. Then ask them to talk about what they like about that activity. What do they not like about fishing or swimming in lakes or ponds?

From here lead the conversation to plants in ponds. Ask the students what they think about plants in ponds and lakes. Are the plants there for a reason?

Provide each group with the PDF handouts listed above. Give the groups time to read over the handouts and discuss.

Activity:

1. Give each group a sheet of large paper. Have each group design a pond of their own keeping in mind the information in the handouts. Set guidelines. The pond must be large enough for three types of plants to live together without harming the pond life.
2. Give each group one type of plant as provided in the information that goes along with the article. Have each group research this plant to find what some of the good qualities are and some downfalls.
3. Have each group present their pond and the information they found out about their plant in their research.

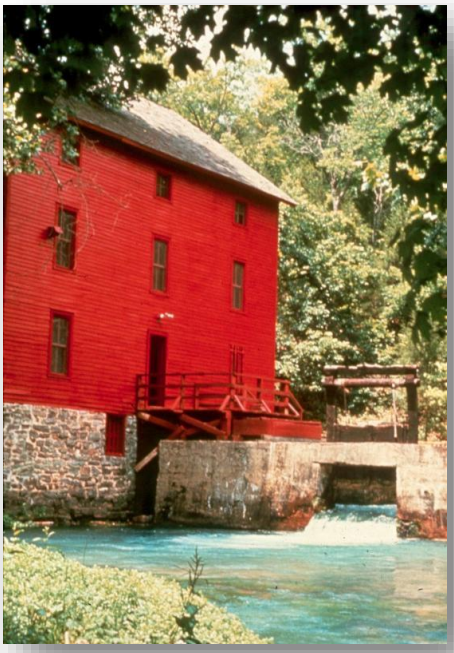
Additional Resources:

Water Plants for Missouri Ponds. J.R. Whitley, B. Bassett, J.G Dillard, R.A. Haefner. Missouri Department of Conservation. 1990, 1999.
http://www.mdcnatureshop.com/product.php?productid=267

Section D: Life in the Ozarks

Alley Spring is located in Shannon County, Missouri. It rises in a deep basin at the base of a bluff of Eminence Dolomite and flows past the turbine-well of the Alley Spring Mill before discharging into the Jacks Fork River, about half-mile away. The spring and grounds formerly were Alley Spring State Park, but are now part of the Ozark National Scenic Riverways.

The story of Alley is a tale of nature, people, and a century-old mill sitting at the heart of a beautiful Ozark scene.



A mill was vital to community life, where grain was ground to provide daily bread. The present building was constructed in 1894 by George Washington McCaskill as a merchant mill and was equipped with modern machinery that utilized steel rollers for grinding. It was larger than most mills in the Jacks Fork area and replaced an earlier grist mill on this same site that was built by 1868. Originally unpainted, it was first painted white with green trim, then later the famous red color associated with Alley Mill today.

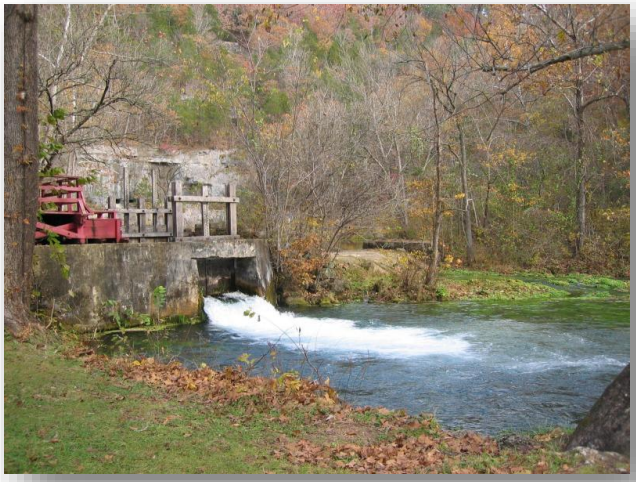
The process of converting wheat into flour was lengthy and time-consuming, while grinding corn was relatively easy. The farmer brought his wheat or corn to the miller, who made an agreement to either buy or make a trade for the grain. If the farmer brought the grain to be milled for his own consumption, the miller would often take a “toll” or percentage of the grain in exchange for grinding.

Since the water supply of Alley Spring was constant, it seemed to be an ideal place for a mill. Whereas an exterior water wheel powered the mill stones in a traditional grist mill, a submerged turbine powered the machines in a steel roller mill. Free water power was especially alluring for the owners of Alley roller mill; however recurring floods made the operation only marginally successful.

The Alley roller mill was a very progressive business venture for its time and place. The complex design and machinery could only be provided by specialized factories such as Richmond City Mill works, which also supplied a master millwright to oversee construction. However, this type

of mill was designed to process wheat flour for commercial markets in an area where corn was the main crop. This marketing error presented another setback for mill owners.

Activity 11: Alley Mill



Subject: Water Energy (mills)

Grade Level: 5th grade

Duration: two class periods

Brief Description: In this lesson the students will create a model of a mill after watching a video, reading, and talking about mills and how they work.

Educational Standards:

Common Core: CCSS.ELA-Literacy.SL.5.5 , CCSS.ELA-Literacy.SL.5.6, CCSS.ELA-Literacy.L.5.3a

Next Generation: **3-5-ETS1.a** Engineering Design, **5-ESS2.c** Earth's Systems

Objectives:

At the end of this lesson, students will be able to:

- Recognize that mills had a purpose and impact historically and culturally
- Explain the components of a mill
- Explain hydroelectric power

Essential Lesson Questions:

1. How can you get energy to use from water?
    a. By capturing and releasing water at a rapid rate
2. How does the wheel spinning at a mill transfer energy?
    a. By the turbine and the belts
3. What are sources of hydroelectric power?
    a. Mills, dams
4. What are advantages and disadvantages of mills?
    a. Answers will vary.

Evaluation:

Performance Task	Other Assessment Opportunities

Students build a model of a mill.	Students present their mills orally.
Self-Assessments Students complete an exit slip.	**Other Evidence of Understanding** Teacher observes students as they work on models and how much detail, understanding of depth, is included.

Key Vocabulary:

1. Energy: the capacity (as of heat, light, or running water) for doing work.
2. Hydroelectric power: energy from falling water.
3. Mill: a building equipped with machinery for grinding grain into flour.
4. Model: a small but exact copy of something.
5. Power: force or energy that is or can be applied to work.
6. Turbine: an engine whose central driving shaft is fitted with a series of blades spun around by the pressure of a fluid (as water, steam, or air).

Material Needed:

- Variety of model building materials, including: boxes, glue, scissors, toothpicks, construction paper, cardstock, etc.

Lesson/Learning:

To start this lesson off have the class watch the "Alley Spring and Mill" video to introduce them to the concept.

http://www.nps.gov/ozar/photosmultimedia/park-videos.htm

Ask students questions about this information.

Example Questions:

1. What is the purpose of a mill?
2. What kinds of things are produced at the mill?
3. How does a mill work?

Explain to the students that they will be making a model of a mill. They need to represent in their model different parts of a mill such as a water wheel, chutes, and milling machines.

Provide students with (or have them bring) various materials to build their models with. They can use a small box as their mill building and place the parts inside the box to "build" their mill.

Allow students time to build their models.

At the next class have students present their mills. They should explain the parts they have represented in their models and the function of each part.

Have student write down three things they learned about mills before they leave class.

Extensions:

Take the class on a field trip to Alley Spring Mill for tour of the mill and how it works.

Additional Resources:

Water Mills of the Missouri Ozarks. George G. Suggs, Jr. University of Oklahoma Press, 1990. (This book is for sale at Ozark National Scenic Riverways and is also in their library.)

Activity 12: What is Rafting?

Subject: History of lumbering in Van Buren

Grade Level: 4th grade

Duration: one-two class periods

Brief Description: In this activity the students will read a non-fiction story about working as a rafter for a timber company. They will then write a journal pretending to be a rafter for the company as they float timbers down the river.

Educational Standards:

Common Core: CCSS.ELA-Literacy.RI.4.6, CCSS.ELA-Literacy.RI.4.3, CCSS.ELA-Literacy.W.4.2d

Next Generation: **4-ESS3** Earth and Human Activity

Objectives:

At the end of this lesson, students will be able to:

- Explain some of the historical uses of the river
- Describe what a day of rafting was like

Background Information:

Timber rafting is a log transportation method in which logs are tied together into rafts and drifted or pulled across a water body or down a flatter river. It is arguably the second cheapest method of transportation of timber, next after log driving. Both methods may be referred to as timber floating.

Rafting was a principal method of transporting timber in the southeastern United States but, except on the Mississippi River, rafts were necessarily smaller than those described above. On Georgia's Altamaha River, for example, the maximum width was about forty feet (12 m) that being the

widest that could pass between the pilings of railroad bridges. Maximum length was about 250 feet (76 m), that being the longest that could navigate The Narrows, several miles of the river that were not only very narrow but also very crooked. Each raft had two oars forty to fifty feet long, one in the bow, the other at the stern. The oars were for steering, not propelling, the raft. The minimum raft crew was two men, the pilot who usually manned the stern oar, and his bow hand. Rafts usually had a lean-to shack for shelter and a mound of dirt for a hearth to warm by and cook on.

Essential Lesson Questions:

1. What is different about lumbering now compared to lumbering in the 1900s?
    a. In the 1900s the timber was cut and floated down the river; now the timber is cut and loaded on a truck.
2. What is involved in floating or rafting timber down a river?
    a. The timber has to be connected to form a raft. Then people stood at the front and back of the raft to help guide it down the river and control where in the river it went.
3. Why did people not just put the timber in the river and let it float by itself?
    a. Because it would not be controlled and could get stuck along the way, creating hazards or losing some of the timber altogether.
4. What are some of the hazards to floating timber down the river?
    a. Rocks, bluffs, changed currents, blockages, swift waters, etc.

Assessment Evidence:

Performance Task	**Other Assessment Opportunities**
The students are going to be making a journal about their trip down the river rafting. This activity will show understanding of the time period and what was involved in rafting.	After the student read over the story they will participate in some class discussion and questioning. This will help the teacher determine the depth of understanding in this topic.
Self-Assessments	**Other Evidence of understanding**
The exit slip will provide the students with the opportunity to judge what they learned.	As the students are reading over the material the teacher should be moving from group to group to monitor understanding and make connections with the students to the story.

Key Vocabulary:

1. Lumbering: the trade or business of cutting and preparing lumber.

2. Rafting: log transportation method in which logs are tied together into rafts and drifted or pulled across a water body or down a river. It is arguably the second cheapest method of transportation of timber, next to log driving. Both methods may be referred to as timber floating.
3. Ties: to bind, fasten, or attach with a cord, string, or the like, drawn together and knotted.

Material Needed:

- Paper or journal
- Ozark History Program handout (Available in Appendix C)

Lesson/Learning:

To introduce this activity pass out the Ozark History Program handout, and give students time to read it. Next facilitate a class discussion and ask students for some information from the handout.

Example observations could include:

- The story is from 1979.
- It's about lumbering in Van Buren.
- It's a guy telling a story about what his father did.
- It's non-fiction.
- It's an interview.

Ask the students to describe what rafting is. Help them make the connection between rafting and lumbering.

Facilitate additional discussion by using the following questions.

Example questions:

1. How many people do you think could be on a raft at one time?
2. Do you think that this would or could have been a scary thing to do? Why or why not?
3. What are some of the things that they had to be aware of?
4. What could have happened if they ran into a rock or a tree?
5. How long do you thing this process took?

Next have each student pretend they are rafting a timber load down the river. Have them keep a journal.

- Have each Student take out a writing journal or a few pieces of paper.
- Explain that they are going pretend their job is to raft a load of timber down the current river the way it used to be done.
- Explain that along the way they will journal about their experiences and what is happening.
- Show the students how to keep track of days and then have them write what happened each day.
- Allow them to pretend that anything happened. Tell the class that they can write about what happened to them that day. It's all up to them, but needs to be relative to the time period and needs to be dictated in a journal.
- Students should record three days in their journal.
- As they journal the students can add in drawings or pictures of leafs and rocks to add to the realistic nature of their journal.

After this activity the students should share their journal with other students in the class.

As an exit slip for this activity have the kids write one interesting thing that they learned during this project.

Activity 13: School Then and Now

Subject: History of Schooling in Alley

Grade Level: 5th grade

Duration: two-three class periods

Brief Description: In this lesson the student are going to research schooling systems of the past. They will be asked to compare and contrast the schooling systems of the past with those of the present.

Educational Standards:

Common Core: CCSS.ELA-Literacy.W.5.9a , CCSS.ELA-Literacy.W.5.7 , CCSS.ELA-Literacy.W.5.1d

Next Generation: N/A

Objectives:

At the end of this lesson, students will be able to:

- Describe the similarities and differences between school systems of the past and school systems of the present
- Compare and contrast school systems past and present and make predictions about future school systems

Background Information:

Log schools were furnished with puncheon benches-split logs with legs pegged into the rounded underside. Hard and uncomfortable, they had no backrest. Girls sat on one side of the schoolhouse, and boys sat on the other. Children who misbehaved were moved to the opposite side. Schools were usually heated by a potbelly stove fed with coal, spit wood, or corn cobs. Noon recess meant home-cooked meals toted in sturdy buckets---sandwiches of cold sliced meat, dill pickles, hard-boiled egg, and perhaps a jar of potato salad. Students washed down their lunch with water drawn from a well or nearby spring. Everyone shared a washbasin, soap and towels. Students in early schools relied on quill pens, inkwells, and blotting paper. They wrote in copybooks of blank, unlined pages or on slates made of thin sheets of hard rock. Originally, they used slate pencils and later, soft chalk. Teachers were quick to discipline

students and they were supported by parents, who were disgraced if their children misbehaved. Order was believed to be necessary for learning and the instruments of discipline included hickory switches and dunce caps.

Information from "One-Room School" by Raymond Bial, Houghton Mifflin Company, Boston 1999.

Essential Learning Questions:

1. What are some key differences between school systems now and in the past?
    a. School buildings, transportation to school, food, technology, etc.
2. What are some things about past school systems that were good?
    a. Small student to teacher ratio, opportunities for peer tutoring, community involvement
3. Why do you think the schooling system changed?
    a. Increased human population, advances in technology, changes in expectations, etc.

Evaluation:

Performance Task Students will write a compare and contrast paper about past and present school systems.	**Other Assessment Opportunities** Students research school systems of the past.
Self-Assessments Students write which school system they prefer with justification.	**Other Evidence of understanding** Writing predictions about future school systems.

Key Vocabulary:

1. Contrast: to show noticeable differences.
2. Compare: to examine in order to discover similarities.
3. Potbelly stove: a small round wood burning stove.
4. Puncheon: split logs with the flat side smoothed down.

Material Needed:

- Going to School at Alley handout (available in Appendix D)
- Additional resources, including:
    - http://www.nps.gov/ozar/historyculture/one-room-schools-in-the-ozarks.htm

- http://extension.missouri.edu/greene/documents/ruralschools/Story%20Creek%20School.pdf
- http://extension.missouri.edu/greene/HistoricMissouriSchools.aspx
- http://www.pbs.org/kcet/publicschool/index.html
- http://www.npr.org/series/5178603/america-s-one-room-schools
- http://oneroomschoolhousecenter.weebly.com/

Lesson/Learning:

Begin with a class discussion.

Example Questions:

1. What would it have been like to go to a one-room school?
2. What would be different/same compared to school today?
3. Would you like going to school more than compared to now?

Tell students that today we are going to research what it was like to go to school in the past (1700s-1950s).

Next allow students to work in small groups to research school life from the 1750s to the 1950s. Students can use the internet or other resources.

Have students make a Venn diagram to compile notes comparing schooling in the past to schooling in the present.

After they have compiled their notes they should write a comparison paper comparing schooling then and schooling now, while providing facts and details that they have in their notes. They should state the pros and cons of schooling then and schooling now. They should also include which time they would prefer for schooling and why.

After they finish their papers have a class discussion about their findings and preferences for schooling time period.

Suggested Resources:

Country Life and the Country School. Mabel Carney. Row, Peterson and Company, 1912.

Old-Time School and School Books. Clifton Johnson. Dover Publications, Inc, New York, 1963.

The One-Room Schoolhouse. Paul Rocheleau. Universe Publishing, 2003.

The Old Country School. Wayne Fuller. University of Chicago Press, Chicago and London, 1982.

One-Room School. Raymond Bial. Houghton Mifflin Company, Boston, 1999.

3-R's In the Ozarks. Mabel Cooper. Chilton Pioneer Printing. 1980.

Extensions:

Have students think about how schooling will change in the future (over the next 50 years). Have them complete a writing assignment explaining their predictions.

Additional Environmental Education Resources

Association for Science Teacher Education List
https://theaste.org/resources/environmental-education-resources/

EnviroLink Network
http://www.envirolink.org/

Hands on the Land
http://www.handsontheland.org/

My Environmental Education Evaluation Resource Assistant (MEERA)
http://meera.snre.umich.edu/

North American Association for Environmental Education
http://www.naaee.net/

Sharing Environmental Education Knowledge (SEEK)
http://www.seek.state.mn.us/

Sierra Club List
http://www.sierraclub.org/education/websites.asp

Appendix A: Saving America's Bats

Bat Conservation International – Saving America's Bats

There are nearly one thousand species of bats, inhabiting all but the most extreme desert and polar regions of the world. Their diversity and sophistication challenge our preconceptions. Few groups of animals are more beneficial or more misunderstood. Bats are not birds; they are mammals, and like all other mammals, the females bear live young. Bats form the largest, and most vulnerable, colonies of any warm-blooded animal. They reproduce at unusually slow rates, with females of most species producing only one young per year. Populations of many species are declining.

Relentless persecution threatens remaining populations of bats worldwide. The underlying problem is one of widespread misinformation. If these fascinating and highly beneficial animals are to survive, people must learn to replace folklore with facts about bats.

Bate are the only true flying mammals. Contrary to popular belief, they are not rodents; they belong to their own order – Chiroptera. This means "hand-wing". They are similar to other mammals except that their hands and fingers are elongated to support the tough, stretchy skin membranes of their wings.

Bats basically are tropical animals. However, the 40 species that occur in the U.S. can be seen in flight on warm evenings almost anywhere, from the largest eastern cities to the deserts of the southwest, and from the seacoast to the high mountains. Bats most often are seen feeding over ponds, streams, along forest edges, or around street lights.

In the daytime, bats seek shelter in a variety of places. Many species live in caves or hollow trees, some in buildings, and few roost among the foliage of trees. Window shutters, loose bark, rock crevices, and various other nooks and crannies also shelter bats.

Some bats, mostly tropical species, are highly specialized to feed on nectar and pollen. Many bat-dependent plants offer special high calorie nectar and high protein pollen to sustain bats in their cross-pollination activities. More than 130 genera of tropical and sub-tropical trees and shrubs depend on bats for pollination.

Other tropical bats are adapted to eat fruit. Contrary to common misconception, they seldom damage commercial crops. They prefer strong-smelling, ripe fruit in native forests. Such bats function as nature's most important seed dispersers for tropical plants. In some places they can account for as much as 90% of total dispersal for tree seeds. Many of these plants are of great economic importance.

Products from plants that originally depended on bats include peaches, bananas, avocados, dates, figs, cashews, cloves, vanillin, and carob. Additional commodities include balsa and other valuable timber, kapok for life preservers and surgical bandages, and latex for chewing gum.

Most U.S. bats – and, in fact 70% of all bat species – eat insects. Bats are the only major predators of night-flying insects, including many pests such as mosquitoes. When foraging, bats utter continuous series of ultrasonic cries and locate flying insects by the echoes. Once detected, large insects may be caught in the mouth, but smaller ones are caught in the wingtip, flipped to a cup formed by tail membrane, and then eaten.

Most bats are gentle, highly intelligent, and easily trained for scientific and medical research that benefits man. They have contributed to the development of navigational aids for the blind, to development of vaccines, and to studies of aging, disease resistance and blood circulation.

Bats in our part of the world are small, secretive, and usually seen only at night. If they swoop close to our heads to catch a mosquito, we may wrongly assume that we've been attacked. Our fears have been conditioned by centuries of folklore, sensational news reporting, and more than 130 films about the mythical Dracula. Despite all the cultural bias and bad press, bats are not aggressive and they seldom transmit disease to man. When people are bitten, it is normally because they have foolishly picked up a sick, grounded bat that bites in self-defense. Any bat that can be picked up should be assumed to be sick and avoided. Mortality statistics show that even our own pet dogs are far more dangerous. Contrary to popular misconception, most bats are harmless and highly beneficial. Fewer than half of one percent contract rabies and even these individuals are rarely aggressive. Bats are certainly not scary, dirty, or blind. They do not get caught in peoples' hair; infest homes with bedbugs or attack pets.

In a few instances, large colonies of bats may become a problem if they roost in buildings. When they must be evicted, the only safe, permanent solution is to build them out by sealing roost entranced after the bats nightly or seasonal departure. Windows, doors, vents, and chimneys should be screened and draft guards placed under attic doors to keep bats and other wildlife out of human living quarters. Poisoning bats is ill-advised. Pesticides used against bats are costly, ineffective, and potentially hazardous both to man and the environment.

Their use serves to increase, rather than decrease public health risks. A peaceful coexistence with bats may be advantageous. Many people who have bat colonies claim to have fewer mosquito problems around their homes and enjoy watching their bats hunt for incest.

There are many different kinds of bats in the U.S. This silver-haired bat is one of the most widely distributed of U.S. bats. It is a solitary, tree-dwelling animal that is hard to see because its beautiful black, silver-tipped fur serves as camouflage. It roosts under tree bark or in old woodpecker holes. In winter, it flies south to hibernate in milder climates, often in deep crevices in cliff faces. At least one individual seems to have over-shot its mark when it landed in Bermuda, a 650 mile flight over open ocean.

Hoary Bats are also solitary and migrate south in fall. For several years, one Wisconsin Hoary Bat returned to the same branch of the same blue spruce tree each spring to give birth and rear her young.

The Red Bat hangs by one foot when it sleeps and is easily mistaken for a dead leaf. Red Bats also fly south to hibernate, apparently outdoors in below freezing temperatures; they curl their furry tail membranes down over their bodies to keep warm. In summer, they may be seen feeding above street lights.

Highly specialized nectar-eating bats of the southwest pollinate Saguaro and Organpipe cacti that are important to desert ecosystems. Nectar bats also pollinate the century plants from which we get sisal fiber for rope.

The Pallid Bat, another southwestern species is unique for its habit of catching scorpions, unharmed by their stings. Bats have developed varied food preferences, allowing several species to live in the same area while minimizing competition for food. A few bats forage for prey on the ground. Some glean insects from foliage, while most capture aerial prey.

For bats like these to continue their beneficial services to the environment, large colonies, not mere remnant populations, must survive. But large colonies of bats worldwide are being destroyed.

Appendix B: Facts about Glades

Facts about Glades

- Glades are rocky open and barren areas with drought adapted forbs and grasses.
- Animals found on glades are specially adapted for the extreme conditions.
- They are found as treeless clearings within woodland (or other) landscapes.
- Rock is usually exposed, soils is shallow or absent, and a canopy is usually absent.
- Trees and shrubs only become dominant in a fire suppression regime.
- They are generally found on south and western exposures of high summits, ridges, and knobs.
- Vegetation is usually a prairie mix of forbs and grasses.
- Glades can occur on igneous, sandstone, limestone, dolomite, or chert bedrock.
- During the growing season, temperatures are very high and moisture is scarce.
- Igneous, sandstone, and chert glades favor acid species, while limestone and dolomite favor neutral or alkaline-loving species.
- Glade floral diversity is high, with hundreds of species documented.
- Most glade plants flower at different times than the surrounding woodland vegetation.
- Small woody bushes and trees are found in areas where soil accumulates in cracks in the bedrock.
- Glades have been viewed as xeric (dry) prairie relics or barrens.
- Huge dolomite glades are found in southwestern Missouri, in the White River hills section (near Branson).
- A number of rare species are found there, and many southwestern species reach their northern-most range on the dolomite glades.
- There probably were around 500,000 acres of glades in pre-European times, now about 400,000 acres remain.
- The Ozark highlands has the largest glade complexes.
- There are five different substrate on which glades are found, and they are used to subdivide the glade ecosystems of Missouri.

Natural and Anthropogenic Disturbances

- Fire, drought, frost upheaval, and native grazers were the primary disturbances.
- In the White River section, tree ring data indicates that fires occurred every 3.2 years.
- 300 year-old fire-resistant post oak stands near glades attest to importance of fires to woodlands and glades.

Threats to Glades

- Most Missouri glades are substantially degraded.
- Overgrazing has reduced species diversity, and changed species distribution.
- Red cedar and winged sumac are not common glades, but their presence is the result of overgrazing and fire suppression.
- Without natural disturbances, glades have shrunk away from each other and become islands, preventing animals from mixing between them, resulting in declining populations of such animals as collared lizards.
- Exotic species such as sweet clover and lespedeza, teasel, and fescue threaten glades.
- Home development near glades (for the views they provide) and quarrying operations are also a threat.
- Illegal horseback riding, mountain biking, and ATVs also damage glades, as well as illegal root digging and plant collecting.

Protection and Management

- Often the first step is the removal of red cedar, followed by prescribed burning.
- Domestic livestock grazing is a poor choice since soils are poor and glade plants do not recover will during the hot, dry growing season.
- Herbicides may be needed to control invasive species.

Glade Animals

- Many glade species are ecotonal and transition between woodland and grassland.
- The dryness, solar influx, and available energy/nutrients all determine faunal density.
- The dominant animals on most glades are reptiles.
- Southwestern glades support the eastern collared lizard and the greater roadrunner.

- Other species include the flat-headed snake, eastern coachwhip, eastern collared lizard, narrow-mouthed toad, southern coal skink, six-lined racerunner, great plains rat snake, red milk snake, ground snake, and western pygmy rattlesnake.
- Birds include: field sparrow, brown thrasher, painted bunting, greater roadrunner (west), chuck's will-widow, common nighthawk.
- Mammals include the Texas mouse.
- The lichen grasshopper is glade-restricted, along with the Ozark swallowtail.
- The Texas brown tarantula is highly associated with glades.
- A number of ant species are common on glades.

There are five types of glades on Missouri

- Limestone Glade
    - Vegetation includes forbs, grasses, and sedges, many annuals
    - There are often gnarled and stunted shrubs and trees, to four feet in height
    - Are usually found on dissected hills and slopes, often steep
    - Soils are excessively drained and very shallow, slightly acid to alkaline, silt loam
    - Natural disturbances include drought, frost upheaval, fire frequency depends on the fire regime of the surrounding ecosystem – higher if prairie and lower if woodlands
    - Dominant plants include little bluestem, sideoats grama, Mead's sedge, narrow-leaved bluets, wild onion, prairie dock, Missouri coneflower, asters, Carolina larkspur and more
    - Is found in the Osage plains, southwestern Missouri in the White River drainage, and eastern Missouri along the Missouri and Mississippi river drainages
    - Threats include overgrazing, red cedar invasion, fire suppression, and development
- Dolomite Glade
    - Vegetation includes forbs, grasses, and sedges, many annuals, many common to prairies
    - There are often gnarled and stunted shrubs and trees, to four feet in height
    - Is found on dissected hills and summits, moderate to steep slopes, mostly south and west facing
    - Soils are very well drained, slightly acid to alkaline, silt loam

- Natural disturbances include drought, frost upheaval, fire, grazing by elk and bison
- Dominant plants include little bluestem, sideoats grama, sedge, round-fruited St. John's wort, Mead's sedge, narrow-leaved bluets, wild onion, prairie dock, Missouri coneflower
- Is found in central Missouri east to the Mississippi river
- Threats include development, overgrazing, fire suppression, exotic species invasion
- Dolomite glades are the most common glade type in Missouri

- Chert Glade
  - Forbs, grasses, sedges, and lichens grow to three feet, along with some shrubs and stunted trees along edges
  - Is found on ridges, slopes, and valleys along streams
  - Soils are very well drained and very acidic, gravelly silt loam
  - Natural disturbances include drought stress, frost upheaval, fire
  - Dominant plants include little bluestem, tickseed coreopsis, wild petunia, blazing star, round-headed bush clover, wild hyacinth, rushfoil, eastern prickly pear, widow's cross, sandwort, rock pink
  - Are found in southwestern Missouri and do not possess the species variation that other glades have
  - Threats include development, trash dumping, utility use, recreation use, overgrazing, fire suppression

- Sandstone Glade
  - Annual and perennial forbs, grasses, mosses and lichens dominate and grow to three feet
  - Is found on dissected hills and plains with moderate to steep slopes
  - Soils are very well drained, very acidic, sandy loam
  - Natural disturbances include drought, frost upheaval, fires
  - Dominant plants: little bluestem, Indian grass, broomsedge, poverty grass, goat's rue, blazing star, rough-stemmed false foxglove, wild petunia, small plantain, rushfoil, small bluets, and more

- Is found from the western border to the eastern border, but not in the far north or south of Missouri
- Threats include overgrazing, fire suppression, woody species invasion, exotic species invasion

- Igneous Glade
  - Perennial grasses and annual/perennial forbs dominate to four feet in height along with some gnarled trees and shrubs
  - Are found on shoulders, backslopes, and domes, with moderate to steep slope
  - Soils are very well drained, very acidic, silt loam
  - Natural disturbances include drought (severe enough to prevent woody encroachment), upheaval, fires, elk grazing
  - Dominant plants: black jack oak, post oak, Schneck's oak, service berry, winged sumac, winged elm, farkleberry, aromatic sumac, little bluestem, Indian grass, switchgrass, panic grasses, wild hyacinth, sedges, flowering spurge, wild quine, prairie phlox, blazing star, bush clover
  - Is found only in the St. Francois Mountains region of Missouri
  - Threats include red cedar, lespedeza, and winged sumac invasion, along with shagbark hickory and black oak invasion

This information can be found at http://www2.sluh.org/bioweb/fieldbio/outlines/glade_cliff_talus.htm.

Appendix C: Oral History at Ozark National Scenic Riverways

Oral History Program
Ozark National Scenic Riverways

This is the transcript of an oral history interview conducted with Ray Randolph on January 25, 1979. Ray Randolph was interviewed about his life in Carter County. This transcript is for historical and educational purposes and is a dictation of a time period when his father worked as a rafter.

Interviewer: Can you tell me about the lumbering industry that flourished in the early 1900's? The 1920's?

Mr. Randolph: About the lumber, that was the big industry.

I: Yes.

R: Well, there was a Smalley Tie & Lumber Company. It was a big industry in Van Buren here, and they rafted a lot of logs, ties and all that down the river by raft. It was the only transportation to Van Buren where it was taken to the railroad. They also had branch railroads in the majority of the small valleys and hollows to this area through here that they brought the logs in off of the lumber company. The railroad to Van Buren where they first started to load logs, then they went from there to the big industry of ties. They went all the way to what they call Big Creek down here at the river almost down to the spring and rafter these ties and logs all the way down the river. The way they would set up those raft, they would fasten them together in sections --- about six ties wide and they would tie them together with two-bys across the ties. They would always use hickory poles. That's what they called a hinge in there. It was like a tongue and had plenty of spring, come to place where the rafts would turn. As they floated those rafts down the river, they would have what they called the guide men on the front end, one or two men on the front to keep the front off of the bluffs or big rocks and keep them in their channels; and they had this sledge man…back along the raft with big poles in holes, they had holes in their raft where they'd shove those poles down in and snub those rafts…The poles went into the ground and gravel and drug the whole raft back over to the fast current in the river. Where the front of the raft would slow down is where the men on the front could turn it, maneuver it, like pushing the front end of an old john boat around.

I: Where you on these rafts or tie drives yourself?

R: No. I was very small at the time. My father, he helped put together several rafts at what was known as Brandyweed. It's just a short distance, oh; I would say maybe a mile where Rocky Creek runs into Current River. And they had a big tie yard there. The area pretty heavily populated with people that made ties and load forms, small forms, and made ties and brought them into the big tie yard.

I: Where was this tie yard at again?

R: Brandyweed.

I: Brandyweed?

R: Yes. That's about a mile below where Rocky Creek runs into Current River. They had a Big high bank there where they could rack ties. Stack them to get enough for four of five rafts. Then they would put them together and raft them down the river.

I: Usually, how long were these tie rafts?

R: Well, they kept them…some of them must have been a quarter of a mile long, and some of them were smaller, but then it depended on the size that they put on to take them out, how many ties they had at one yard where they brought ties into the river.

I: Why did they raft them on a tie raft? Why didn't they just float them down the river?

R: Well, they would lose them. They would scatter over the river and lose them and plug the river. By rafting them they could keep them all together and bring them in in a group to where they could take them apart and pull them right out on the banks where they'd load them.

I: How big was each one of these ties? Do you recall?

R: Well, they were what they called 7 x 9's. They would be from seven inches thick, nine inches wide, eight and 16 foot long. We had lost of large, [untouched] timer at that time. The timber was practically all [untouched] timber and they had some fine timber to work from.

This is just an excerpt of an oral history interview of Ray Randolph that was recorded and preserved by the Ozark National Scenic Riverways. The full artifact can be found under Acc. NO. 268 Cat No. 25182

Appendix D: Going to School at Alley

Going to School at Alley

The children came to school equipped with a supply of food not only for lunch but for recesses as well, packed in little tin dinner buckets swinging by the bale at their sides, if not over their heads. Typical lunch fare was big biscuit sandwiches of salty, smoky bacon meat thick as a child's little finger; corn bread spread with butter and sorghum molasses; maybe a sour pickle, even occasionally some store-bought crackers or hard candy. If one were lucky, the whole ensemble would be topped with a slab of pie, sweet potato, dried apple, or dried peach perhaps, in the characteristically pale tan crust compounded of Alley roller mill flour and homemade lard. No fancy waxed paper or other wrapping kept the elements separated. The owner of such a dinner bucket worked down through the layers, beginning with the pie at morning recess, then the biscuits and bacon meat for noon dinner, and finally the molasses corn bread at afternoon recess. Whatever else might have survived the first three hungry onslaughts was sustenance for the homeward journey.

The school drinking water came from the big spring, fetched by the boys as part of schoolhouse chores. The wonderful water of Alley Spring slaked **[to satisfy a desire for something]** the thirst of all fortunate enough to have access to it. Still, a dread diphtheria outbreak occurred at Alley school in October of 1911. The school was closed after "several" cases appeared. Three little girls died, Anna Boyd and Grace Crider, age seven, and Cora Birge, age eight. The vulnerability of Ozarks ground water to pollution from privies and from sink hole and cave dumps was not well understood; nor were the health hazards of such pollution appreciated.

The term of school began in August or September. In the 1880/sit lasted only four months. By 1912 it had been extended to six; but the standard eight month term had not yet been achieved. "They didn't have enough money to pay the teacher, "said Pauline Graham. Like all rural schools of the time and place it was an eight-year graded school. Reading, writing, and arithmetic were the subjects of the lower grades, to which were added history, geography, physiology, grammar, and advanced reading, i. e. "literature, " in the upper grades. There was a pump organ in the school/ and any teacher able to play could accompany the singing, a regular activity. Not all students finished eight grades in eight years, if they completed at all. Roy Graham was unable to begin school until he was 12, and then only part-time. " For the kids that went the whole term, " he said, " it began in August and usually quit I imagine about the first of March….so the kids could help with the crops, but I didn't get to go that much. I had to gather the crop, think I had to quit to get ready for the crops. So I got about three, three and a half

months of school each year that I was there." Work, family obligation, the hardships of the weather, distance and other access problems, frequent family moves, indifference, and the liberty not to attend, all made attendance anything but routine. Monthly school reports sent by teachers from around the county to the Wave (local newspaper) emphasized not only the number of students enrolled but the number of student attendance days.

Excerpt from "Alley, an Ozarks Hamlet 1890-1925" By Robert Flanders Prepared for the Ozark National Scenic Riverways National Park Service by The Center for Ozarks Studies Southwest Missouri State University, Springfield 1985

Appendix E: Round Spring Topographic Map