KARTCHNER CAVERNS STATE PARK
NATURAL HISTORY CURRICULUM

The Kartchner Caverns Natural History Curriculum was developed through a grant by the Arizona State Parks Heritage Fund

Sponsored by the San Pedro Valley Education and Resource Center

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Betty Williamson
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Jim Wolfe
And

Fred Wiegand, for the curriculum idea and Mollie Elizabeth, who was born in the middle of this curriculum development.

Dedicated to cave discoverers, Randy Tufts and Gary Tenen for doing the right thing.

Our goal in creating this curriculum guide is to assist you in conveying the unique story of Kartchner Caverns to your students.

We have developed this curriculum with you, as an educator, in mind. Each activity includes a listing of the objectives, approximate age for which it is suitable, the materials needed, useful information that you need to teach the activity and reproducible pages. A glossary, references, and bibliography can be found in the back of the curriculum guide.

Through the lessons to be learned in these activities, the students will develop an **appreciation** of the geological and biological forces that created such a magnificent cave. We hope, also, to promote an **understanding** of the interrelationship between humans and Kartchner Caverns. We encourage the students to think about the **choices** that were available in the development of the cave and the consequences of each. Finally, and most importantly, we hope that through the use of these activities the learners will gain a sense of ownership and **stewardship** toward this non-renewable natural resource.

We discovered that most teachers, when using the curriculum guide, have added to and enriched the learning experience for the students by incorporating their own interests and strengths. We encourage you to do the same! Please feel free to send us comments, suggestions and, of course, ideas for extensions and additional activities! Have fun, and we'll see you at Kartchner Caverns State Park!

"Managing and conserving natural, cultural, and recreational resources"

Office of the Director
Arizona State Parks
1300 W. Washington
Phoenix, AZ 86007

December 9, 1997

To the educators of Arizona:

It is with great pleasure that I present to you this Natural History Curriculum for Kartchner Caverns State Park. This works represents the dedicated efforts of many people. Their goal is to provide you with interesting and relevant information that will assist you in teaching about Kartchner Caverns.

The original cave discoverers, Randy Tufts and Gary Tennen, exhibited the finest example of stewardship in their exploration of Kartchner Caverns. Through your efforts in the classroom, you are creating the cave stewards of the future! Education is the key to preserving the natural beauty of the cave.

I would like to take this opportunity to thank you for your dedication and continued hard work in educating Arizona's youth about Kartchner Caverns.

Sincerely,

Ken Travous
Executive Director
Arizona State parks

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December 15, 1997

The *Kartchner Caverns Curriculum* will help teachers in southern Arizona give their students a sense of the wonder and fragility of Kartchner Caverns. One of the ways we all can preserve the cave is through children who love it and find ways to care for it. We expect that many children will be inspired by what they learn about the caverns and will be guided by that inspiration into positive activities of all kinds.

Our thanks go to those who wrote this fine curriculum and to those who will use it in their classrooms. Their work is in the best tradition of the cave, which is named after James Kartchner, a teacher.

We are especially grateful because we know that the more people of all ages who love Kartchner Caverns, the better cared for it will be.

Gary Tenen
Co-Discoverer
Kartchner Caverns

Randy Tufts
Co-Discoverer
Kartchner Caverns

CREATE A CAVE

BACKGROUND INFORMATION:
Kartchner Caverns was formed by the **dissolution** of limestone. Limestone is composed of the mineral calcite ($CaCO_3$). Limestone is formed by the accumulation of calcite, which is inorganically precipitated as well as contained in the skeletons of once living sea animals and plants. Pieces of the animal skeletons and plants fell to the bottom of the sea and were later pressed down and cemented into hard rock. Finally, mountain-building forces uplifted these sedimentary rocks from the sea and exposed them to air and the dissolving power of fresh water. Water **seeps** and **percolates** into the soil. Limestone caves are formed when a mild acid reacts with calcite. This acid is carbonic acid (H_2CO_3), produced when carbon dioxide combines with water. Most of the carbon dioxide responsible for the acid that dissolves limestone comes from the soil.

The cave forming process may continue for thousands of years. It can be stopped by only two things: a lowering of the water table, or the introduction of outside air in the cave system by wearing away of the surface. As outside air enters the cave system, the water quickly becomes supersaturated with calcite, ending the dissolving process. This change usually marks the beginning of the **deposition** of calcite in the form of stalactites, stalagmites and other deposits, know as **speleothems**.

The limestone rock in which Kartchner Caverns formed was faulted and created cracks and fractures which allowed water to seep in and begin the dissolution process. The water drains slowly downward and sideways towards a drainage point. As the water dissolved the limestone along the fractures it created passageways that are surrounded by undissolved rock.

SUMMARY:
A "cave" is created when sugar cubes, beneath a layer of modeling clay, becomes saturated with water. **Create A Cave** may be conducted as a whole class activity or you may get more of the materials and have the students work in groups. The groups could then compare their caves.

STEP BY STEP:

1. Organize sugar cubes into a half pyramid, about 3 cubes wide, that fits against the inside of a glass aquarium. The sugar cubes represent the limestone.

2. Seal the cubes tightly with approximately 1/8 inch layer of modeling clay, making sure there are no gaps. The clay represents the top soil. This simulates the limestone hill above Kartchner Caverns.

3. Poke holes through the top of the clay with the tooth pick, making sure the holes go all the way through to the sugar cubes.

4. Have the students make a drawing of the model.

5. Next have the students predict what will happen when water is sprayed over the top of the clay. The water represents rainfall.

6. Use the spray bottle with water and begin spraying the top of the clay. The holes may need to be made a bit bigger to get the water percolating.

7. As the water penetrates the sugar, have the students describe what they are observing.

SUBJECT: Cave Origins

MATERIALS: one box sugar cubes, 2 pounds modeling clay, one aquarium, toothpick, spray bottle, transparency of cave diagram, overhead projector, copies of work-sheet

GRADE LEVEL: K-3

TIME: 30-45 minutes

OBJECTIVES: Students will observe, predict and describe the "passage-ways" which are formed when they create a model of a cave forming by dis-solution of limestone.

CONCEPT: The disso-lution of limestone creates tunnels or passages when cave is formed.

Meets Arizona Department of Education Academic Standards

Language Arts:
W-R1, PO2

Science:
1SC-R1, PO1
1SC-R6, PO1
1SC-R7, PO1
1SC-F2, PO1 & 2
1SC-F3, PO1 & 2
6SC-F5, PO1 & 2

CREATE A CAVE

8. Have the students write what happened as the water began to seep into the sugar cubes and make a drawing of what the cave looked like when finished.

9. Use the transparency of the cave diagram, (pg. 9) and have the students explain how this process is similar to the dissolution of limestone which created Kartchner Caverns.

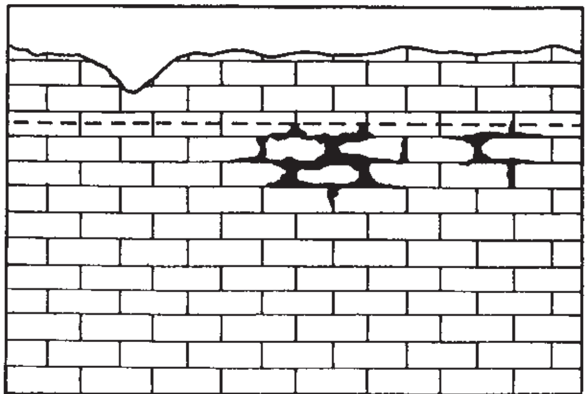
ASSESSMENT:

If this activity is being conducted as a teacher demonstration, discuss the contents of the transparency with the students and have them draw a picture of the process. If using with older students use the worksheet to assess their understanding.

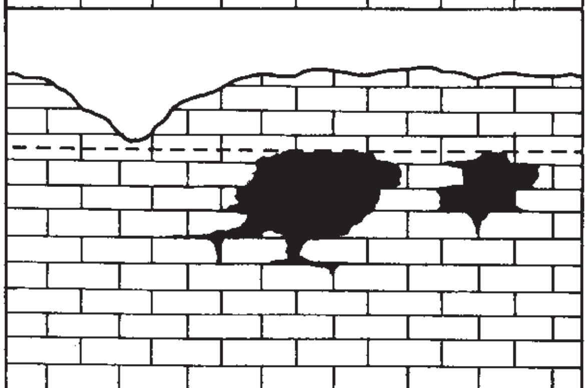
EXTENSIONS:

1. Continue the experiment over a couple of days, noting changes in the cubes and passageways.
2. Repeat with food coloring added to the water and get predictions of what will happen.

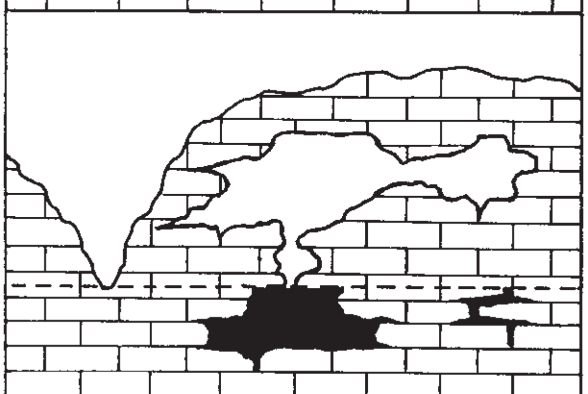
HOW KARTCHNER CAVERNS FORMED



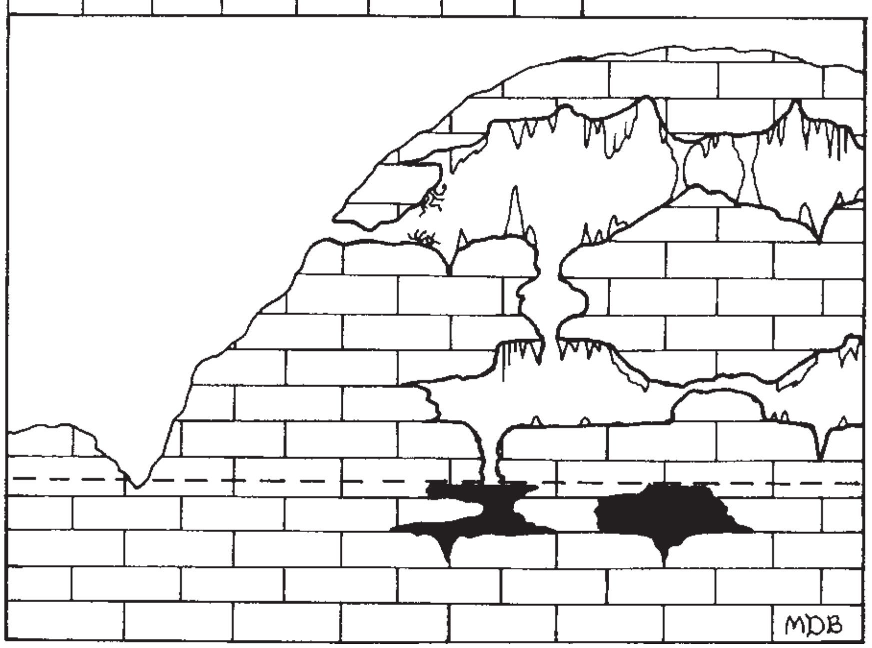
Stage 1: Underground water fills every crack in the rocks below the water table. Kartchner Caverns begins when cracks in the rock enlarge because of slowly moving acidic ground water.



Stage 2: The first large cave tunnels form when large amounts of limestone are dissolved by carbonic acid. Most carbonic acid is simply carbon dioxide (CO_2) dissolved in water. It is the same substance that gives carbonated drinks their "fizz."



Stage 3: As the water table drops, upper level passages become filled with air and lower level passages begin to form. Limestone is now dissolving rapidly because of the large amounts of CO_2 in the cave water and air. The cave has no entrance yet, and no cave decorations.



Stage 4: A small passage in Kartchner Caverns collapses, making an opening to outside air. It is at this point that cave decorations begin to form. Opening the cave is similar to opening a bottle of soda pop; the CO_2 bubbles out. When this happens, the water inside the cave is not as acidic and stops dissolving rock. In fact, minerals already dissolved in the water begin to be deposited. These eventually become stalactites and other cave decorations.

WANDERINGS OF WILLIE WATER DROP

SUBJECT: Underground Atmosphere

MATERIALS: story pages, stapler, crayons or colored pencils

GRADE LEVEL: K-3

TIME: 45 minutes

OBJECTIVE: Students will describe several ways that water affects caves and the importance of water to the cave environment.

CONCEPT: Precipitation and subsequent percolation of water affect the cave microclimate. Kartchner Caverns is directly affected by the watershed of the Guindani and Saddle Washes.

Meets Arizona Department of Education Academic Standards

Language Arts:
R-R1, PO1 & 2
R-F3, PO1 & 2
R-F4, PO2
W-F3, PO1
Standard 3 Readiness Foundations 5

Science:
5SC-F3, PO1
6SC-F5, PO1 & 2

Background Information:
Water is important to living caves. Water enters a cave by **percolating** or seeping through the ground after a rain or snow or when there is a river, stream or wash nearby. The water will seep into the cracks and fractures of rock below the soil surface. If the rock below the surface is made of limestone, the water will, over time, erode the limestone away through both mechanical (cracking and breaking) and chemical (dissolving the rock) action.

Summary:
The teacher reads a story about the "life" of a water drop within Kartchner Caverns, and the students make a book covering the highlights of the story.

Step by Step:
1. First review the water cycle and where water in the cave comes from (in the form of rain, sleet, snow, hail, or from the ground, rivers and lakes).
2. Discuss how water created both the cave and the formations within the cave.
3. Hand out the pages with the Wandering Willie Waterdrop drawings on them. (One set per student). Have the students cut the pictures apart along dotted lines.
4. As the students hear the story of Wandering Willie Waterdrop's adventures in Kartchner Caverns, have them put the pictures in the correct order.
5. Have the students color the pictures and staple them into a booklet.

Assessment:
Each student should be able, based on the discussion and hearing the story, to write a sentence on the back of each picture describing what Wandering Willie Waterdrop is doing within the cave.

Extension:
1. Setting up an "evaporation jar" in the classroom for the entire year or semester helps the students understand the concept of evaporation and deposition of minerals that were dissolved in the water. Using a wide mouth gallon jar filled with water, mark the water level in the jar periodically. The children notice the white calcium deposits along the sides of the jar!
2. Older students may, using the basic concepts of seeping, humidity and evaporation, write their own "waterdrop" story on the back of each Willie picture. They could also draw their own story book using Wendy Waterdrop as the main character.

The Adventures of Wandering Willie Waterdrop

One cold winter afternoon, a drizzling rain fell gently on the Whetstone Mountains. Of the many thousands of drops of water that fell on the mountain that day, one would work his magic as only water can and help create the beautiful formations called stalactites and stalagmites in Kartchner Caverns. Our story is about one particular drop of water whose name was Wandering Willie Waterdrop and this is the story of his adventures in the cave.

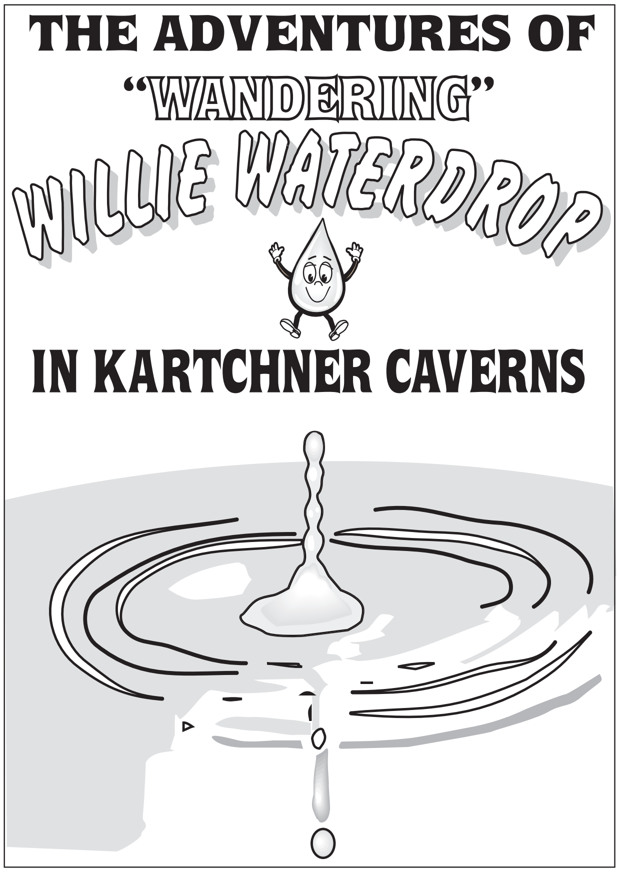
Some water never soaks into the Whetstone Mountains. It runs off the hillside back to the San Pedro River. But today was special. When Willie Waterdrop fell onto the hillside, he seeped down deep into the soil. Willie seeped into a tiny crack in the hard rock. He squeezed and squeezed through the crack. As he went, he noticed that he was dissolving a tiny, tiny bit of the rock and the crack was getting bigger! Not only that, but he was breaking tiny bits of rock away as he seeped along.

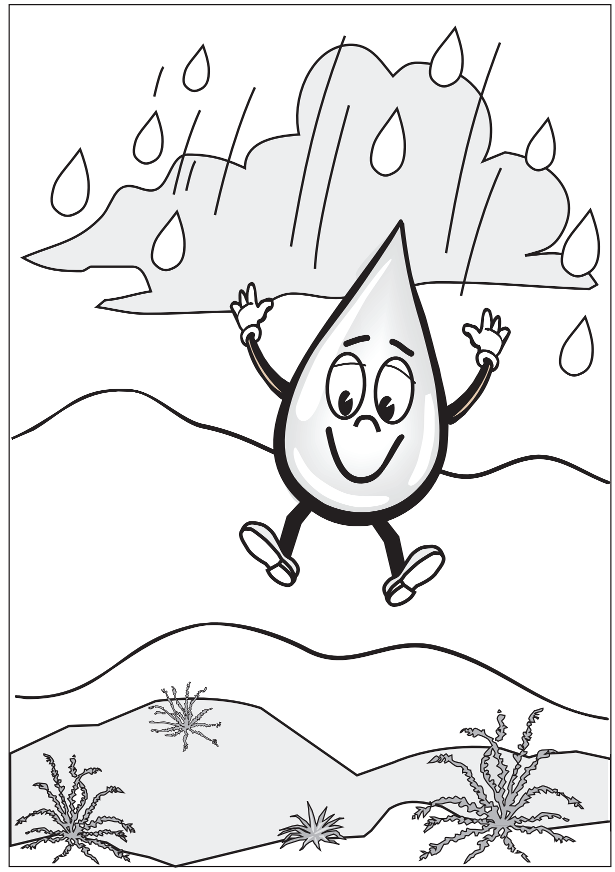
Soon Wandering Willie Waterdrop found himself dangling from the ceiling in a huge cave. It seems that many, many millions of other water drops had been there before Wandering Willie, and they had dissolved and crumbled rock, too. Over many thousands of years, all the water drops had created Kartchner Caverns! But, their work in the cave was far from over!

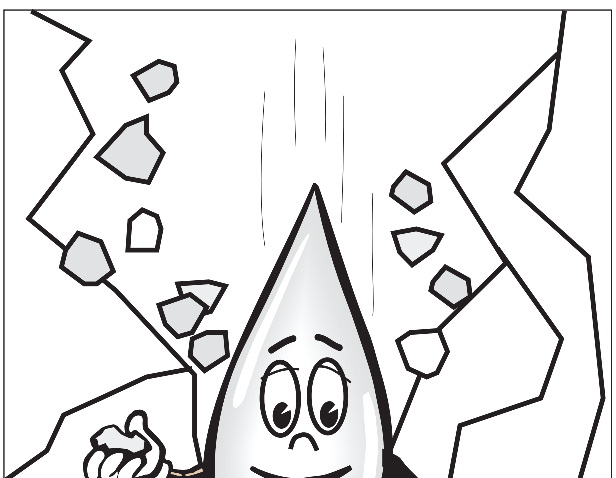
What Willie didn't know was that as he dissolved the rock, he was bringing along some treasures for the inside of the cave. These treasures were called minerals and they would create beautiful and colorful cave formations! As Wandering Willie slipped and slid down a stalactite, bits of the minerals he had dissolved from the rock above were left behind. Lots of other minerals had been left by many other water drops, too. Over a long, long time all these minerals had created the fabulous formations that Willie Waterdrop saw that day! Everywhere he looked he saw stalactites hanging from the ceiling, stalagmites growing up from the cave floor, delicate soda straws, and huge columns which had once been stalactites and stalagmites that had grown together! All these formations and the colors were amazing! Wandering Willie didn't know it then, but the minerals that he and other water drops brought into Kartchner Caverns helped create the beautiful red, yellow, and pure white he saw around him everywhere he looked! Eventually Willie dripped off the end of a stalactite and landing with a splash right on a stalagmite. Willie evaporated off the surface of the stalagmite leaving behind his collection of dissolved minerals. When he evaporated, he became "humidity" or water that floats around in the air. Willie floated around the cave bumping into many other water drops who had taken the same journey. Humidity is very important to Kartchner Caverns. It keeps the cave wet and allows formations and living creatures to grow.

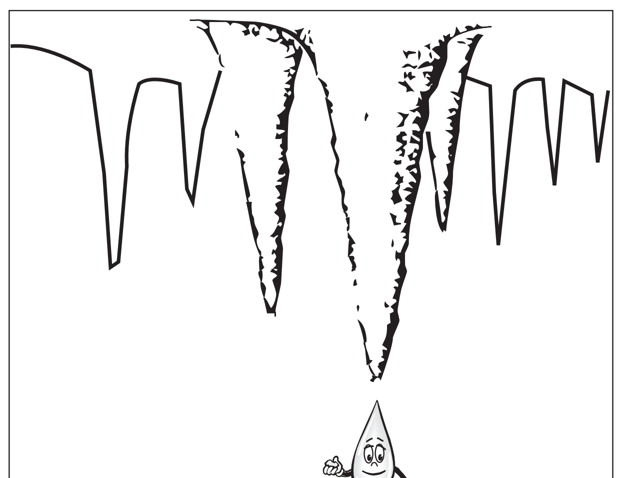
When the temperature in the cave cooled slightly, Wandering Willie condensed and once more became a water drop This time Willie found himself trapped deep in the sticky mud of the cave floor! Mud is very important to the cave because it is a storehouse for Willie and other water drops. During dry years these water drops evaporate again and become humidity to keep the cave moist and in wet years, waterdrops can hang around and make nice, gooshy mud.

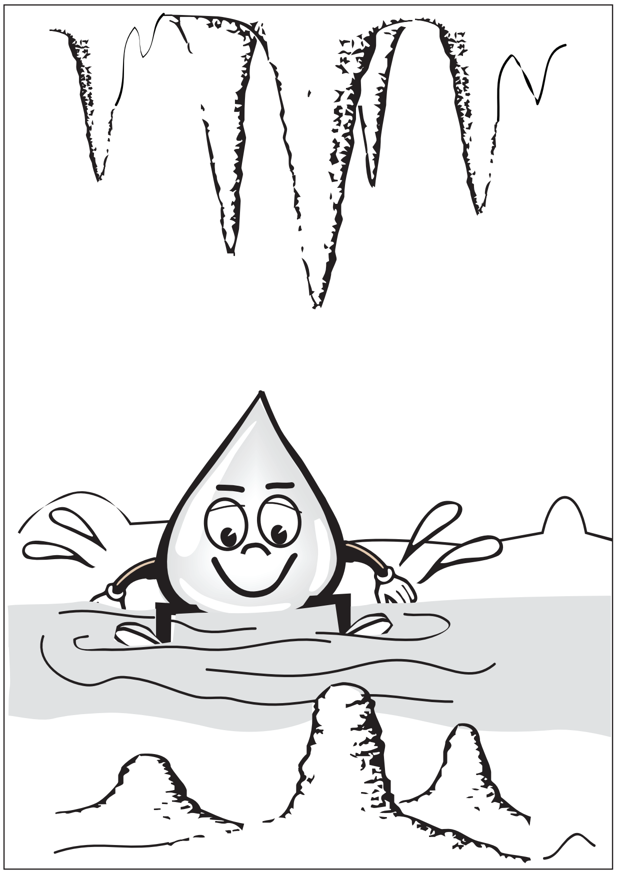
This year was a wet year and Willie wasn't needed as humidity. In fact there was so much water in the cave Willie began to seep down through rock cracks again. This rock was much harder and Willie couldn't dissolve it. After a long journey wandering down through many rock layers, Willie found himself packed in with millions of water drops in the water table deep underground. Soon, he and the other waterdrops would find themselves part of the San Pedro River. During his journey down the San Pedro River, where water from Kartchner Caverns eventually goes, he met another water drop named Wendy Waterdrop. She was evaporating from the river and was about to become rain that would fall over Kartchner Caverns! What adventures do you think Wendy will have?

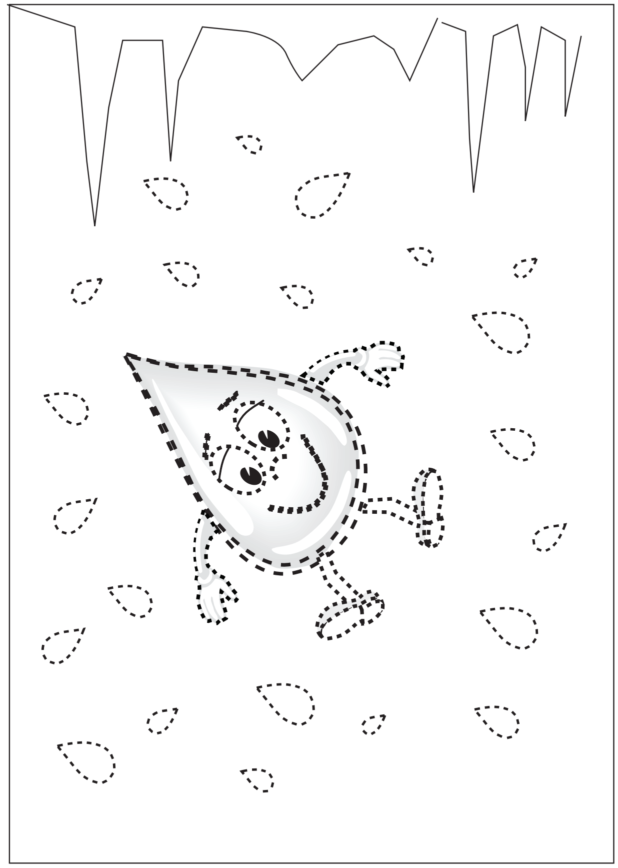

THE ADVENTURES OF
"WANDERING"
WILLIE WATERDROP
IN KARTCHNER CAVERNS

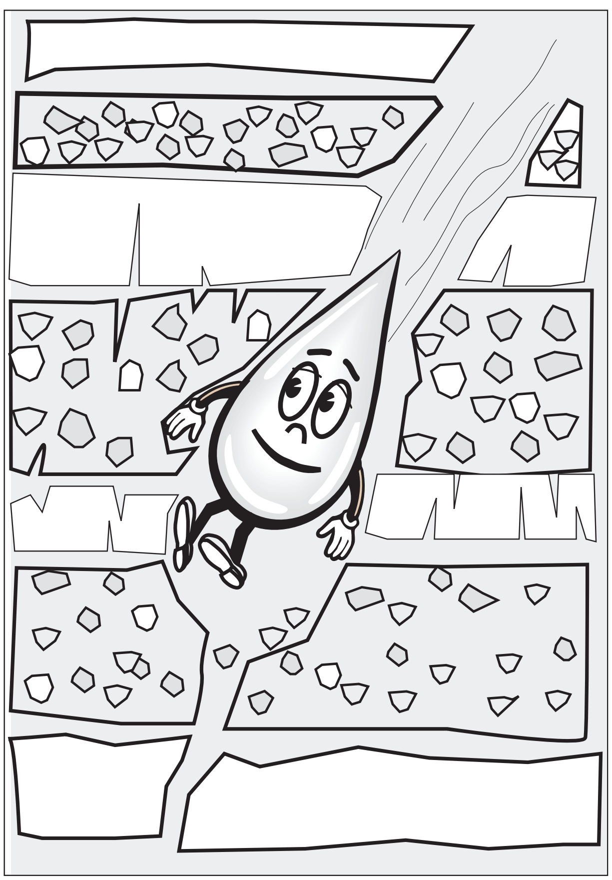


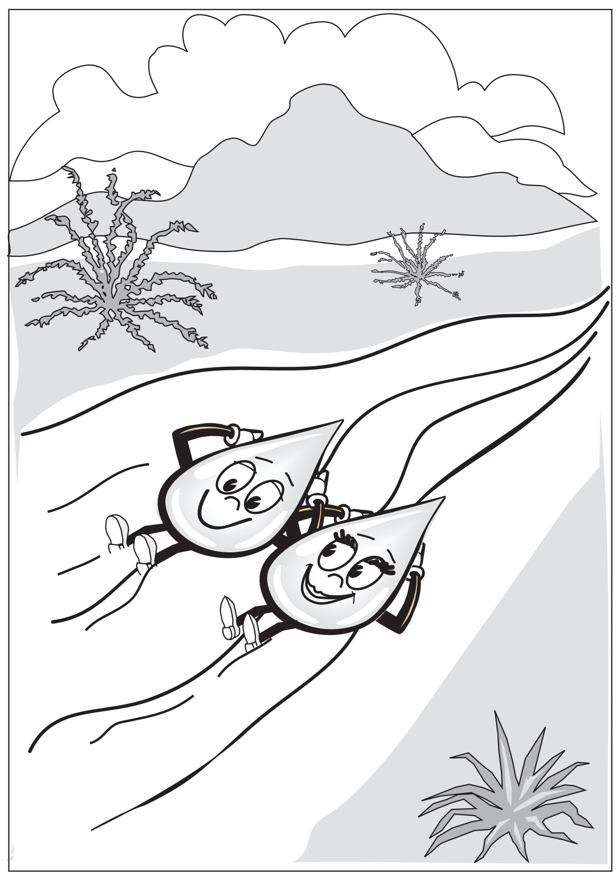












CAVE CONCENTRATION

Background Information:
Kartchner Caverns is known for its beautiful cave bacon, shields, soda straws and other cave formations. Cave formations are referred to by geologists as ***speleothems***, *spelaion* (cave) and *thema* (deposit). Speleothems include formations such as stalactites, stalagmites, soda straws, columns, draperies, flowstones, rimstone, cave bacon, helictites, and shields. Speleothems take thousands of years to form. Speleothems are made when rainwater percolates through the ground. As the water seeps through the cracks found in many limestone areas calcite is dissolved. When it reaches the cave, the water drops hang from the ceiling or dribble down a wall. The speleothem may be found on the floor, hanging from the ceiling or along the walls of a cave.

Summary: The students will play a teacher-prepared card game of Concentration to develop a knowledge of speleothems found in Kartchner Caverns.

Step by Step:
1. Before the lesson, make a large copy or a transparency of the speleothem sheet for a reference. You will also need to make enough copies of the sheet to make 40 cards per 2 students.
2. Cut tagboard into 2” by 2” squares, enough for 40 cards per group of 2 students.
3. Glue each speleothem drawing onto a square. Laminate to save pieces for later use.
4. Ask the students what they might see inside a cave. Students may respond with mud, bats, bugs and hopefully stalagmites or stalactites.
5. Display the Speleothem Sheet. Point to and say the name of each speleothem having the students repeat them. You may want to repeat this several times.
6. Tell the students that they will learn names of the speleothems and be able to identify the different types found in the cave by playing a card game.
7. Each pair should have their 40 2” square cards.
8. Have the students shuffle their cards and lay them picture side down on the floor or table.
9. The students take turns flipping over one card and then another trying to find a match. Each time they flip a card over they must say the name of that speleothem. If the second card does not match the first they must turn the cards face down and it is the next person’s turn. If the students get a matching pair they keep that pair and may repeat their turn until they do not have a matching pair.
10. Play until all of the cards have been matched. Students with most matched pairs wins!

Assessment:
Have the students choose five of the Common Cave Decorations to incorporate in their own drawing of the inside of a cave.

Extension:
If the students are not able to play the concentration game try a form of BINGO.
Make enough copies of the speleothem sheet for each student. Have the students choose and cut out nine of the speleothems and glue onto a 6 1/4” by 6 1/4” card. Have a cut set of speleothems to pull from a grab bag. The students can use scrap paper or some other item as a marker.

SUBJECT:
Cave Features

MATERIALS:
2 copies of Common Cave Decorations per four students, heavy construction paper or tagboard for 40, 2” squares, glue, scissors

GRADE LEVELS:
K-3

TIME:
30 minutes

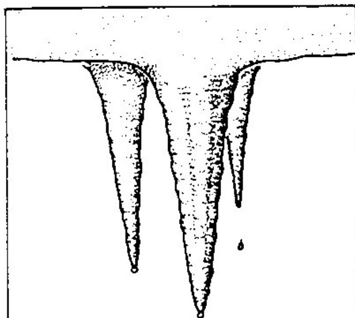
OBJECTIVES:
Given a set of Common Cave Decoration cards students will be able to identify
and distinguish the different speleothems found within Kartchner Caverns.

CONCEPT:
Speleothems are decorative features within a cave that grow and change over time.

Meets Arizona Department of Education Academic Standards

Science:
1SC-R3, PO1
1SC-R6, PO1 & 2
5SC-R1, PO1 & 2

Mathematics
2M-R1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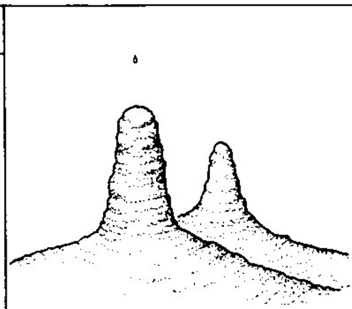
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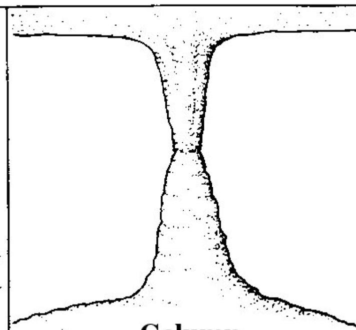
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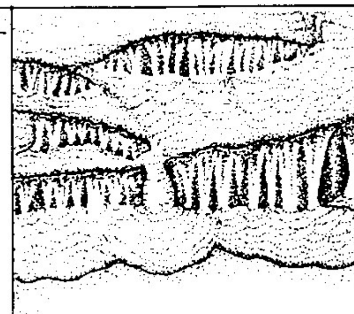
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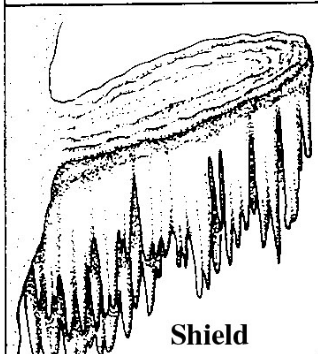
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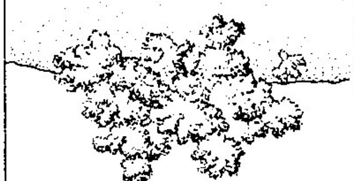
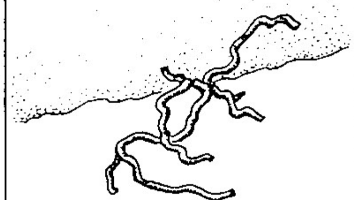

Cave Popcorn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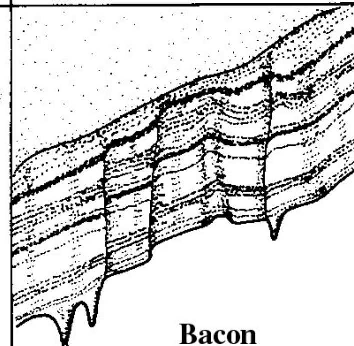
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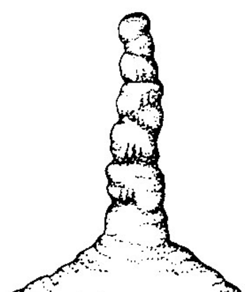
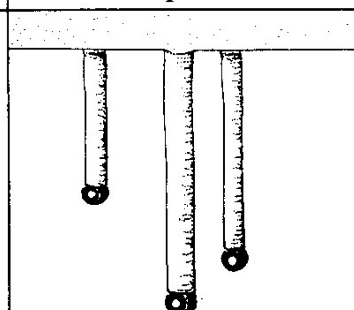

Totem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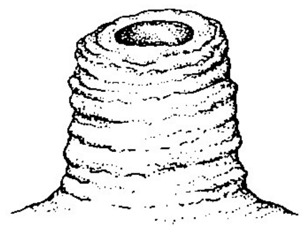
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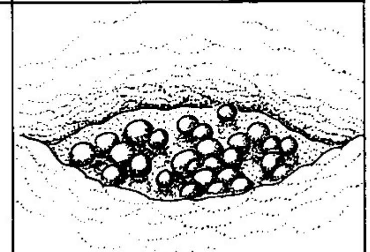
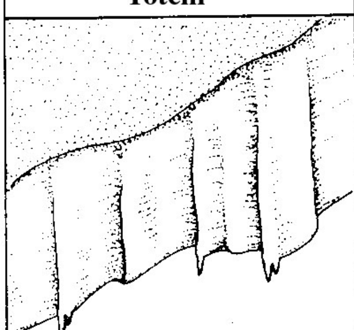
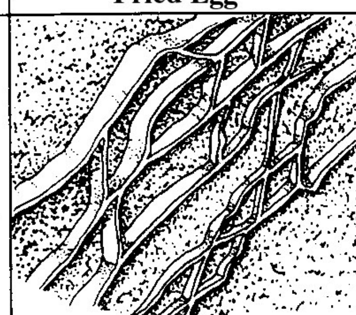

Cave Pearls


Draperies


Bird's Nest
Quartz Needles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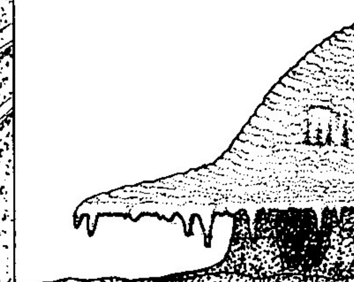
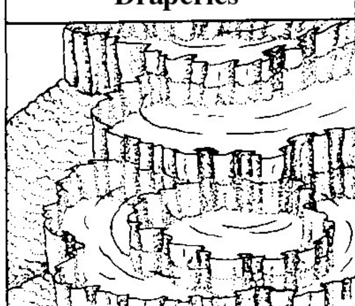
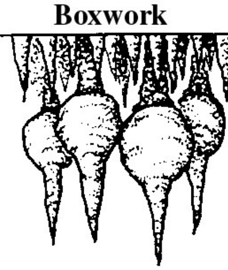
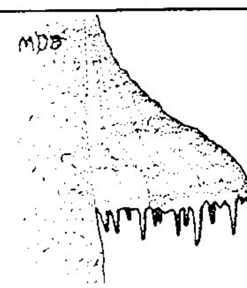

Canopy


Rimstone Dams


Cave Rafts & Shelfstone


"Turnip Welts"


Baldacchio Canopy

HANDS OFF!

Background Information:
The speleothems within Kartchner Caverns range in age from 194,000 years to as young as 16,500 years. The 2nd longest known soda straw in the world is found in Kartchner Caverns. It is 21 feet and 2 inches long. This soda straw grows 1/64th of an inch a year. It took 16,500 years to obtain its current length! If any of the formations are touched or broken, it will stop the growth of the speleothem. Oil and dirt from people's hands can damage the speleothems. When a speleothem is touched, oils are left behind. Since speleothems are formed with water, oil from people's hands can create a barrier that does not allow dissolved minerals to continue to deposit. Touching a speleothem can also dull its color or stain it. In Kartchner Caverns, great measures have been taken to keep the atmosphere constant to encourage continued growth of formations.

Summary:
Many children will touch things, especially if they are instructed not to touch something. This activity is a practice in not touching. It encourages the students to use other senses such as observing and smelling.

Step by Step:
1. Have the variety of items displayed on a table and cover with butcher paper or a sheet during the discussion. Set the mirror or sheet of glass aside for the end of the non-touching session. (Have individually wrapped food items set aside for a snack later.)
2. Ask students to think of a time when they were told not to touch something. Then ask them what they did. Let a few students share their experiences.
3. Tell them that during this activity they will not be able to touch anything that is on the table. Have them discuss ways in which they could resist the temptation. Suggest they put their hands in their pockets or clasp their hands behind their back.
4. Take the cover off of the items and have the students walk around the table to look at all the items. Give everyone a chance to see the items and have them all sit down.
5. Ask them if they can find ways to describe what is on the table, using texture, color, and smell.
6. Set the mirror out and ask each student to touch it.
7. Have the class look at the mirror with all of the fingerprints on it. Explain that the oil and dirt from their hands leaves their fingerprints on the mirror. Tell them that if everyone touched the speleothems the oil and dirt would be left behind.
8. Holding the mirror at an angle, pour water slowly over it. Initially, the water will form a sheet as it goes over the glass, but have the students watch closely and notice how the fingerprints begin to repel the water. Explain that if this were a speleothem, it would now stop growing forever.

Assessment:
Have students review the speleothems in the cave (from Cave Concentration) and have them predict what could happen if these formation were touched by one or all the visitors of the cave. The students will make a sign or poster explaining the consequences of touching formations.
(As a reward, if none of the items were touched, distribute the edible goods for a snack!)

Extension:
The older students can get into partners and list the items on the table. Before a group discussion have the partners write descriptive words about five or more of the items on the table. Then have the whole class get together and share descriptions.

SUBJECT:
Cave Features and Stewardship

MATERIALS:
a collection of objects students find irresistible to touch, stuffed animals, sand paper, clay, corn syrup, popcorn, M & M's, etc., plastic wrap, drawing paper, crayons, markers, colored pencils, mirror or glass with smooth edges

GRADE LEVELS:
K-3

TIME:
30 minutes

OBJECTIVES:
While using their sense of seeing and smelling, instead of touching, students will explain why it is important not to touch speleothems.

CONCEPTS:
Human activity within a cave affects the speleothems. A cave is a non-renewable natural resource. If a speleothem is broken it is gone forever.

Meets Arizona Department of Education Academic Standards

Language Arts:
W-R1, PO3
W-F3, PO1

Science:
1SC-R2, PO1
1SC-R4, PO1 & 2
1SC-R6, PO1
5SC-R1, PO1 & 2

Mathematics
5M-R1, R2
5M-F1, PO1 & 2
6M-R1, R2

GOIN' ON A SLOTH HUNT

Background Information:
Inside one of the remote areas of Kartchner Caverns, the bones of a Shasta Ground Sloth were discovered during cave mapping expeditions. The bones were found to be 86,000 years old! Shasta Ground Sloths have been extinct for about 11,000 years. The one found in Kartchner was about 9 feet long and stood on all four legs. It's back was about 3 feet high. It probably weighed about 300-400 pounds.

Sloths ate plants that wore down their teeth. They had teeth that never stopped growing, so they didn't have to worry about wearing their teeth out! Sloths seemed to prefer living in caves and used them whenever they were available. It is believed that the sloth had found his way into the cave through a now-closed entrance.

Summary:
The purpose of this activity is to get the students to begin to think about the sights and animals they might have encountered exploring inside Kartchner Caverns. Using a flannel board and characters may help the younger students remember the verses to the song.

Step by Step:
1. Trace character shapes onto felt fabric and cut out shapes.
2. Have a transparency of the song to put up on an overhead.
3. Begin a discussion about the the discovery of the Shasta Ground Sloth fossil. Give the students some natural history information about the ground sloth.(see pg 45)
4. Introduce the story board characters; ground sloth, flashlights, airlock door, mud puddle, hanging bat, "sh" whisper, stalactites, stalagmites, soda straws, don't touch, fossil of sloth, claw, tooth, not afraid, and plant.
6. Tell the students to repeat the verses after you. As you sing each verse put the character on the flannel board. Eventually, have the students sing without the flannel board.
7. Sing the song several times. The students might enjoy singing the song throughout your unit. Older students may like sharing the song with younger students.

Assessment:
Have children discuss what other animals might like to live in a cave. Why would a cave be a good place to live if you were a wild animal? Would they like to live in a cave? What would be the benefits of living in a cave? What would be the drawbacks?

SUBJECT: Biology

MATERIALS: song sheet, picture of ground sloth, story board characters, flannel board, felt.

GRADE LEVEL: K-3

TIME: 30 minutes

OBJECTIVE: Students will role play cave explorers finding the ground sloth fossil by singing a song about a trip into Kartchner Caverns.

CONCEPT: Caves provide habitat for permanent and visiting animal populations.

Meets Arizona Department of Education Academic Standards

Language Arts:
Standard 3 & Foundations

Arts:
1AM-R2, PO2 & 3
1AM-F3, PO3
1AM-F4, PO2
1AM-FQ

Science:
6SC-F8, PO2 & 3

Goin’ On A Sloth Hunt

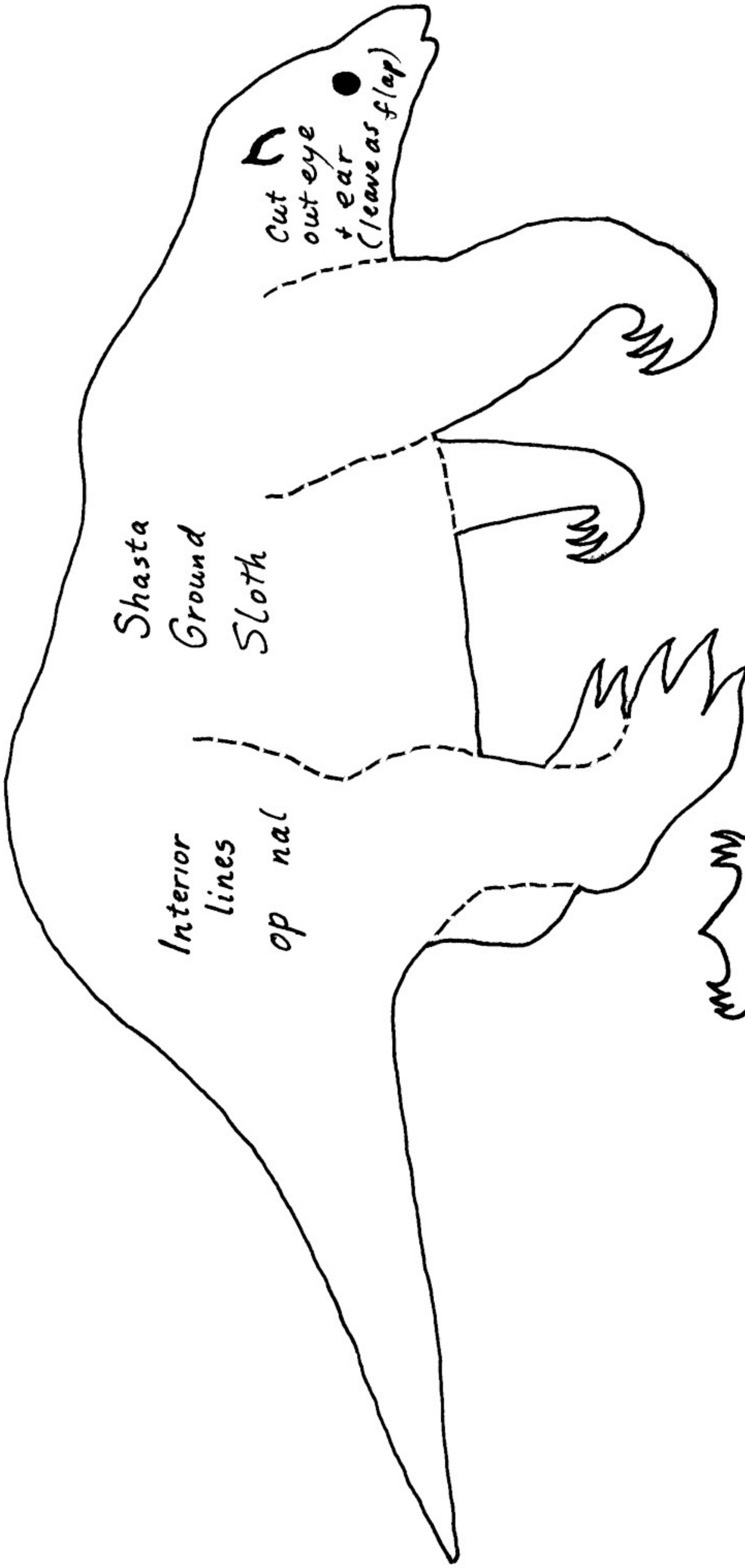
(to the rhythm of “Goin’ on a Lion Hunt”)

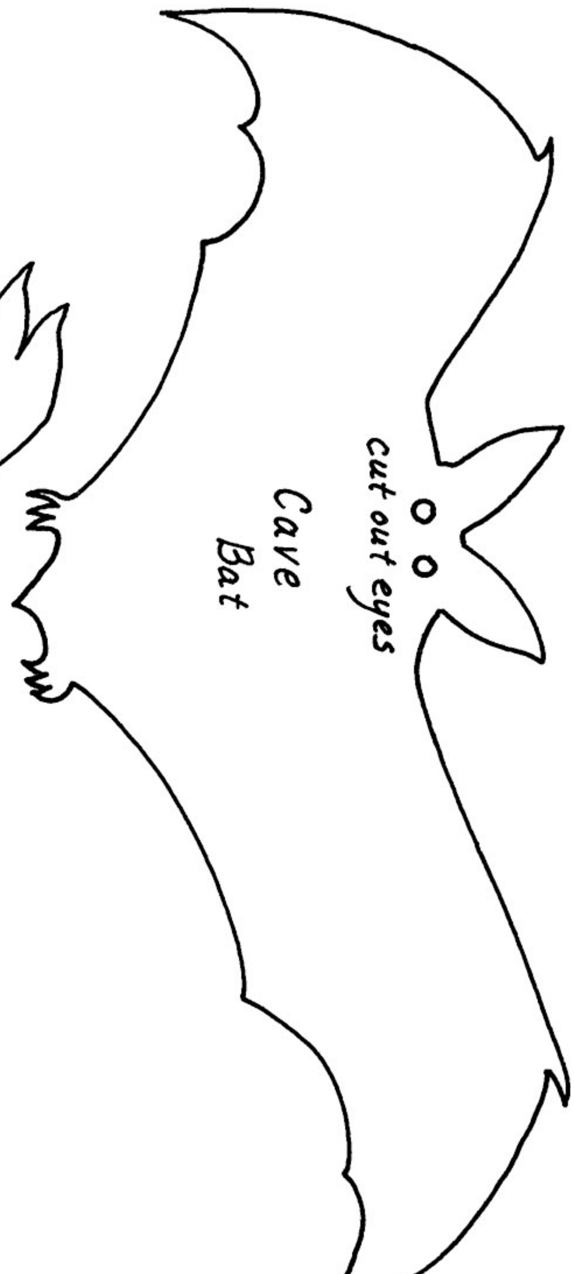
(The teacher leads the song and the students repeat each verse after the teacher. Have the students follow the teacher’s actions)

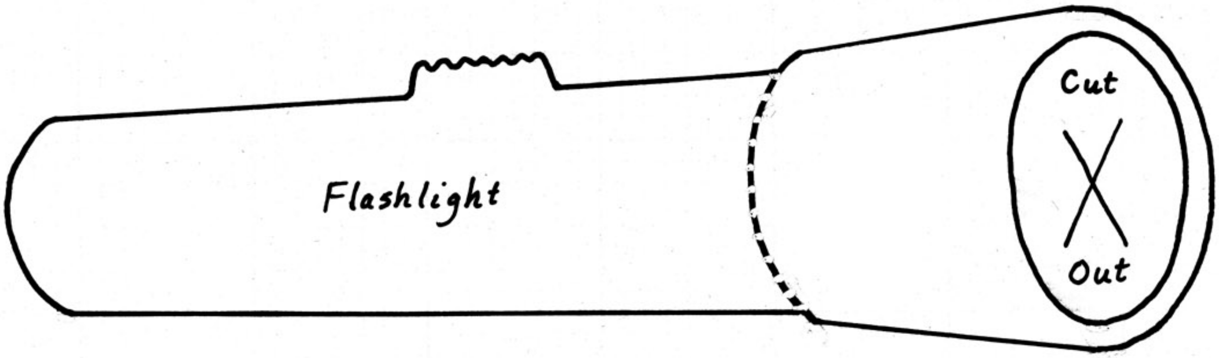
Goin’ on a sloth hunt	*(alternately slap hands on thighs, continue through-out song)*
Shasta Ground Sloth	
Got my flashlights	*(hold up pretend flashlight)*
Through the airlock	*(open and close pretend door while making creaking sound)*
Walking through the mud. Sloosh, sloosh, sloosh	*(alternately tromp feet)*
Look! A bat!	*(Point upwards)*
Sh, sh, sh whisper	*(place finger over lips in whisper sign)*
Keep your head low	*(duck head)*
Stalactites! Stalagmites! Soda Straws!	*(have students point up and down.)*
OOO! Don’t touch	*(waggle finger in “no-no” form)*
There it is! On the floor!	*(have students point toward floor)*
The Shasta Ground Sloth fossil!	
Look at those claws!	*(make ‘claws’ with fingers of both hands)*
And those teeth!	*(grimace to show teeth)*
But we’re not afraid..They eat plants!	*(shake heads “no”)*
Grrrr...what’s that noise?	*(hold hand to ear in listening fashion)*
Are ground sloths really extinct?	
Let’s get out of here!	*(pointing with thumb over shoulder)*

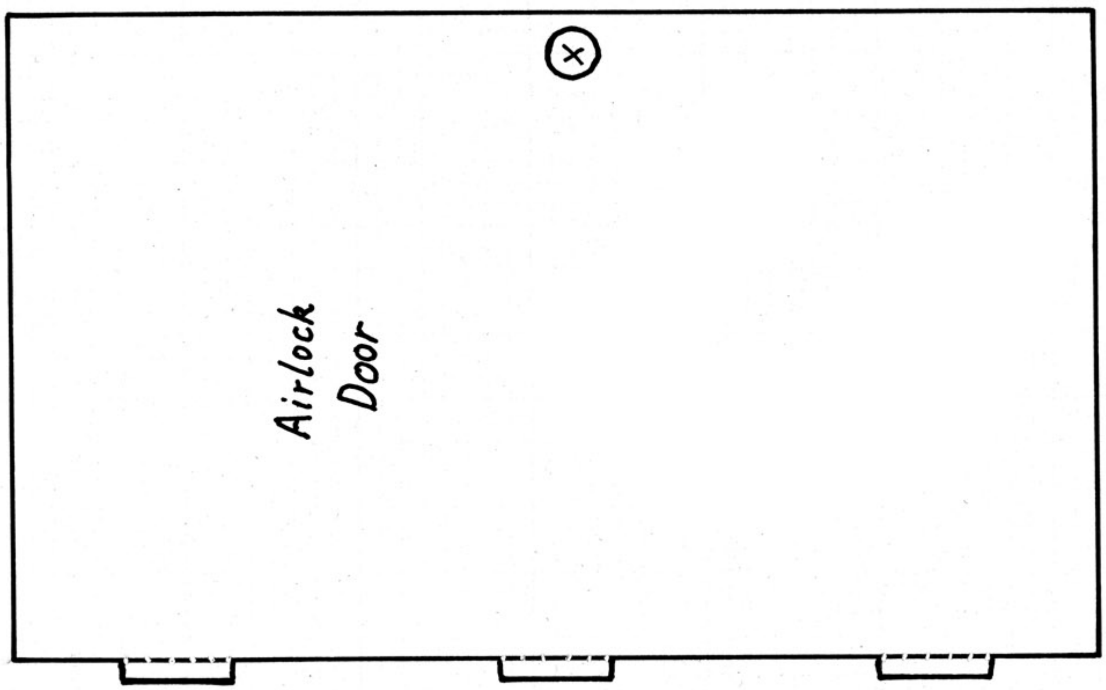
(Sing reverse adventure (below) very fast until out in the sunlight)

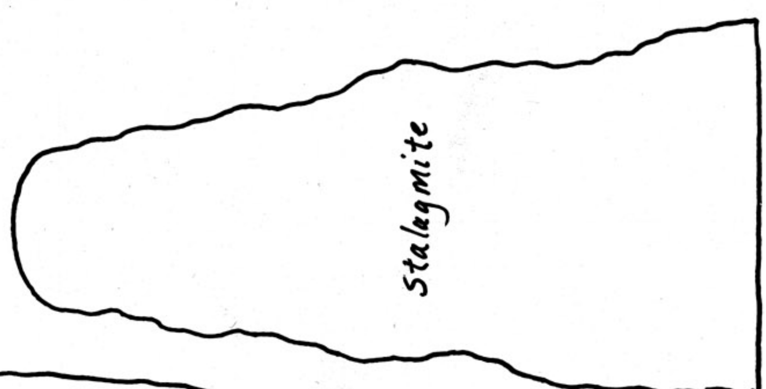
But we’re not afraid..They eat plants!	*(shake head “no”)*
And those teeth	*(grimace to show teeth)*
The Shasta ground sloth fossil!	*(point to floor)*
OOO! Don’t touch	*(waggle finger in”no-no form)*
Stalactites! Stalagmites! Soda Straws!	*(have students point up and down)*
Keep your head low	*(duck head)*
Sh, sh, sh whisper	*(place finger over lips in whisper sign)*
Look a bat!	*(point upward)*
Walking through the mud. Sloosh, sloosh, sloosh	*(alternately tromp feet)*
Through the airlock	*(open and close pretend door while making creaking sound)*
Ah, sunlight!	*(throw arms open wide and SMILE!)*

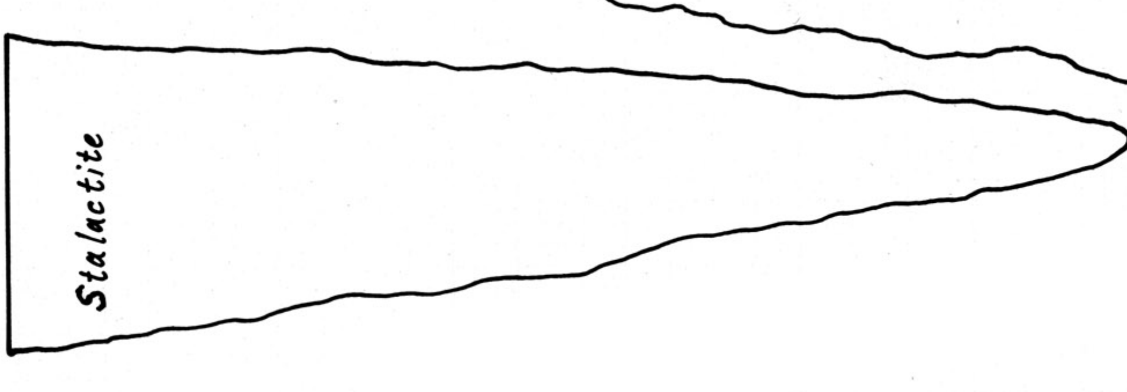

Shasta
Ground
Sloth
Interior
lines
op nal
Cut
out eye
+ ear
(leave as flap)

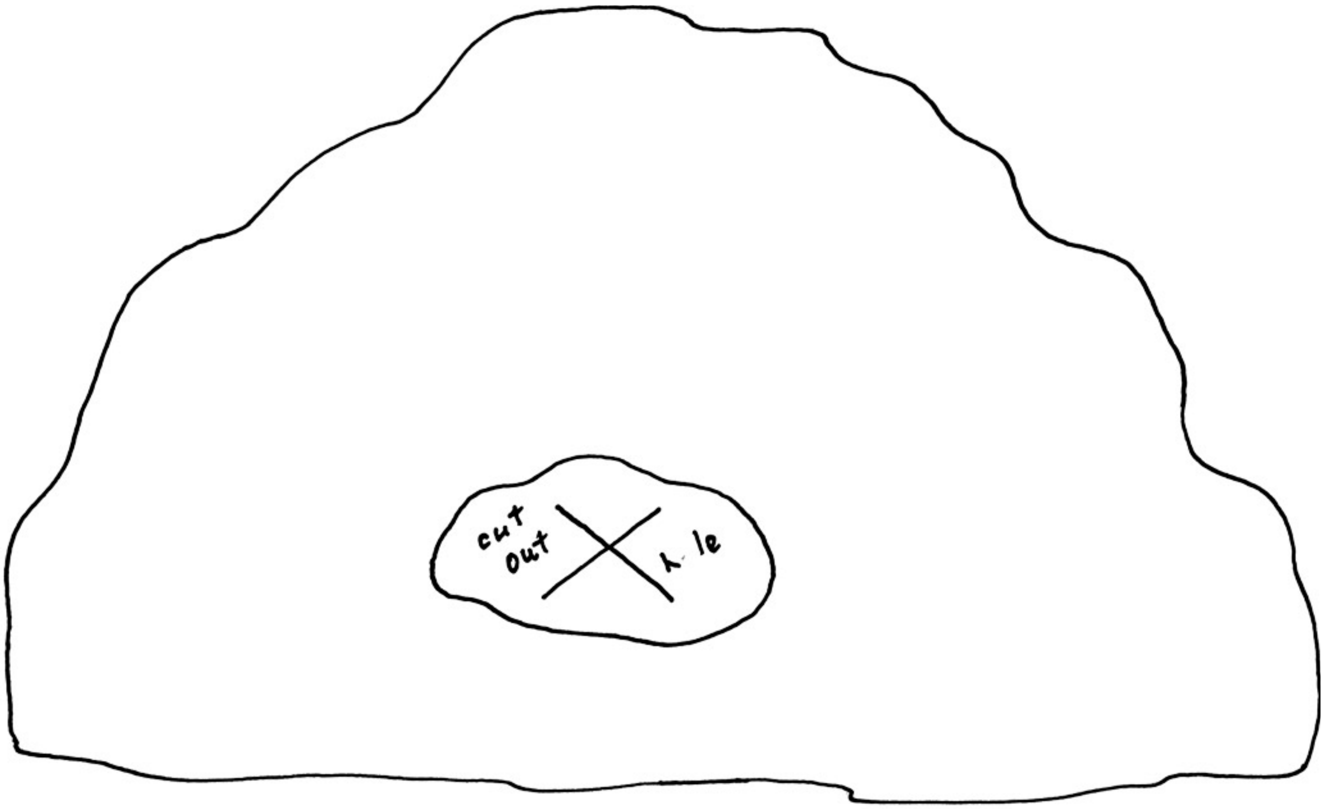

Cave
Bat
cut out eyes

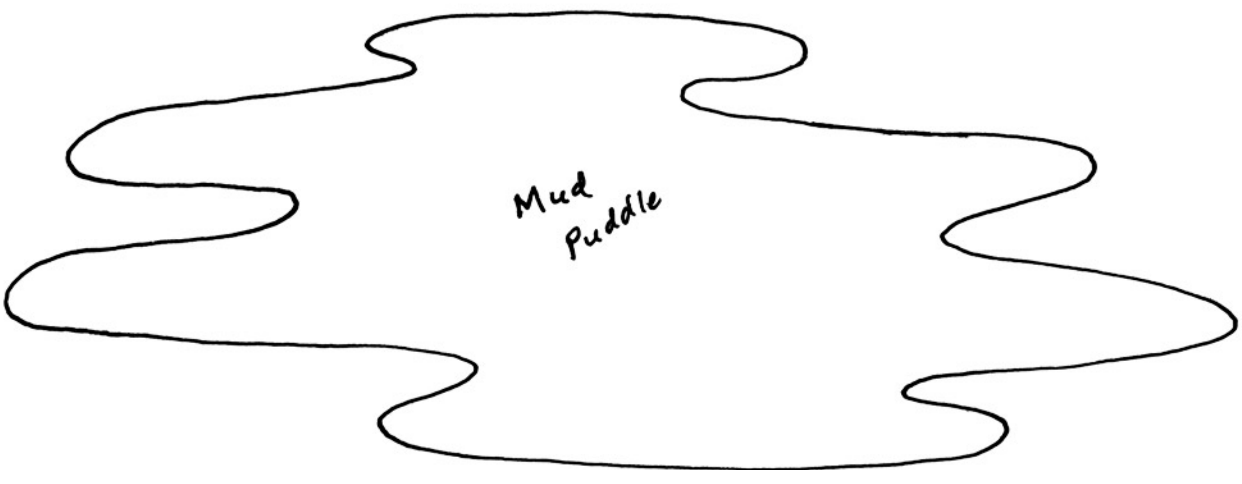

Flashlight
Cut
Out

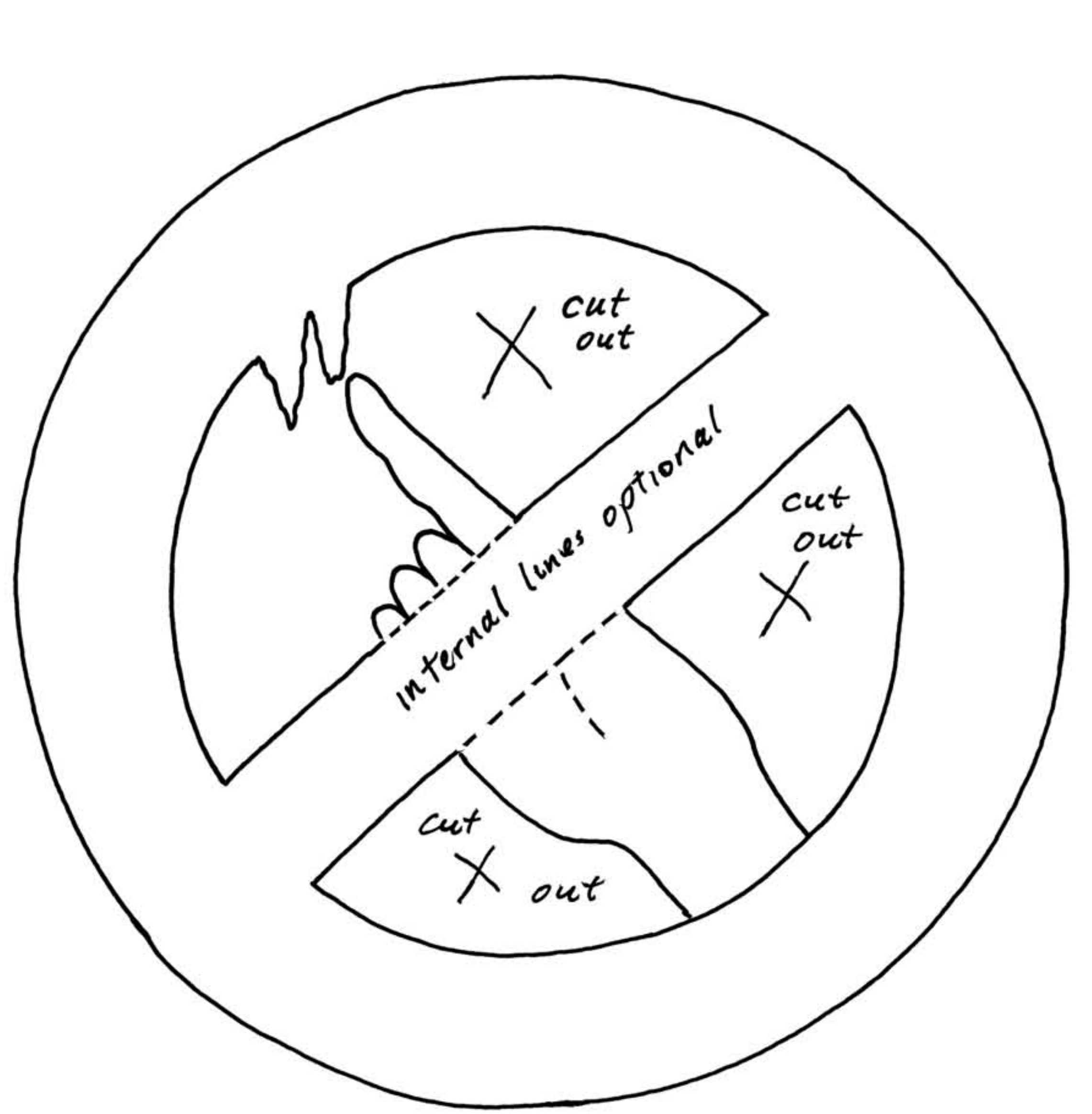

Airlock
Door

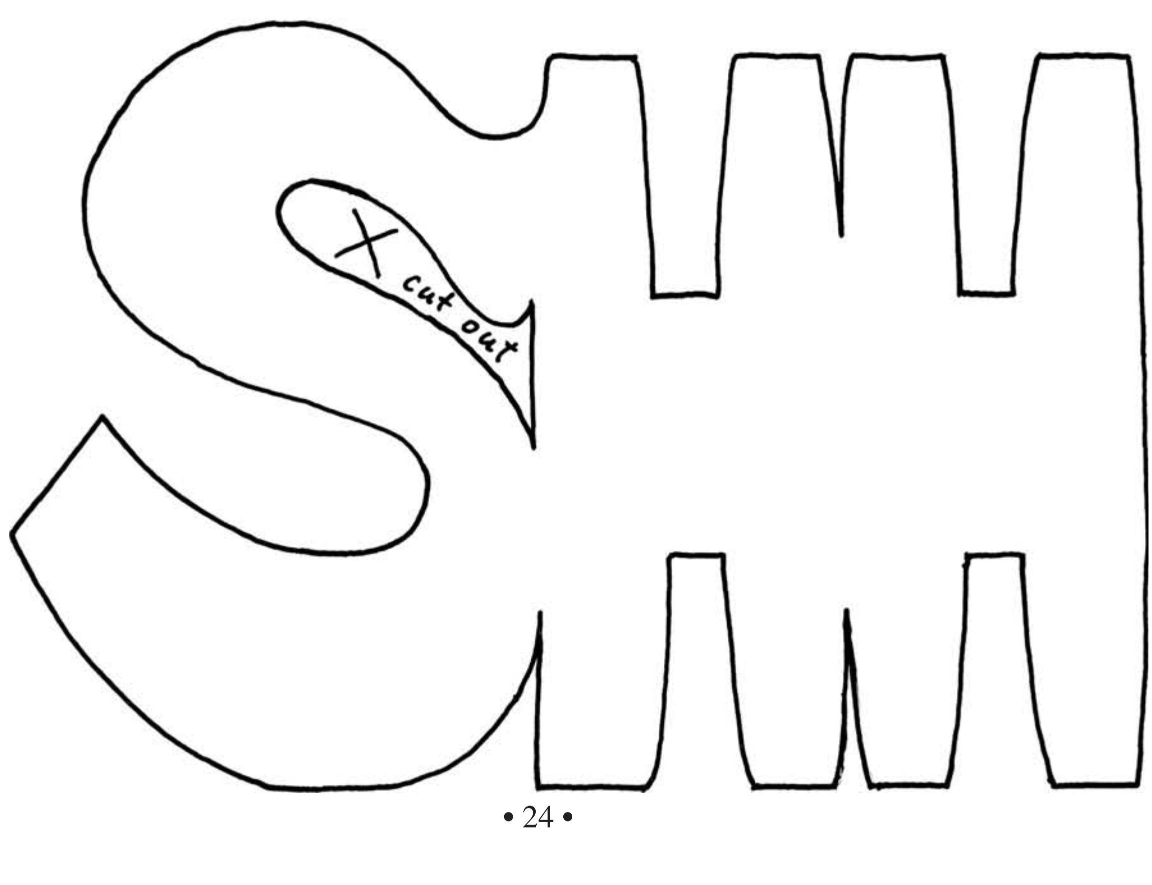

Stalagmite

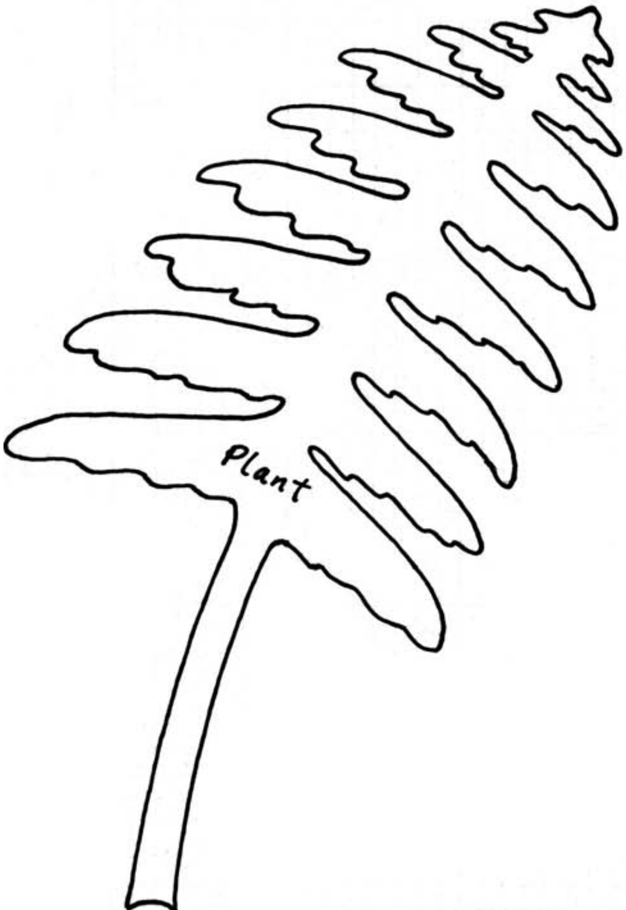

Stalactite

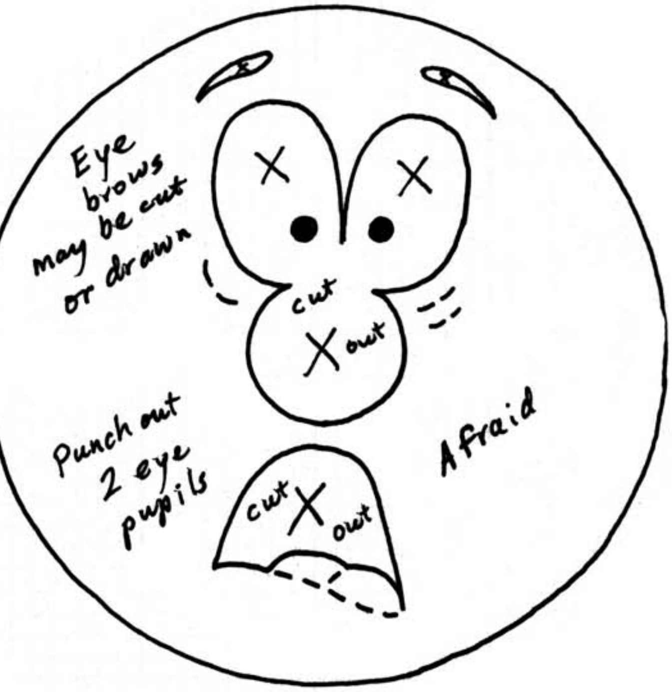

cut out
hole

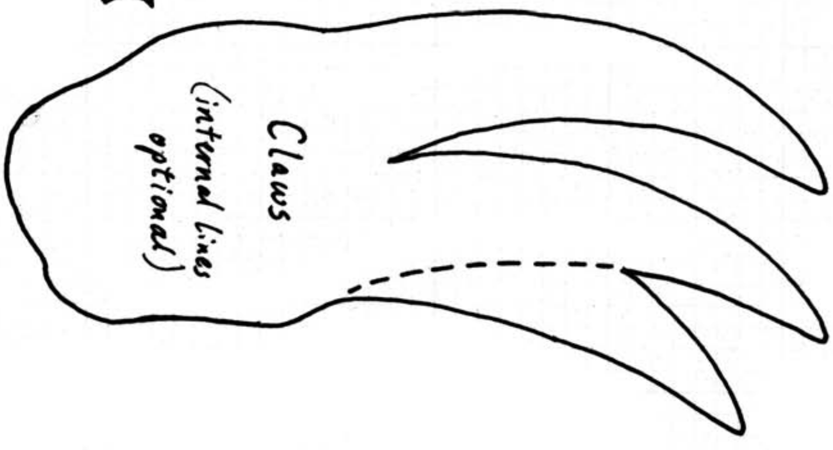

Mud
Puddle

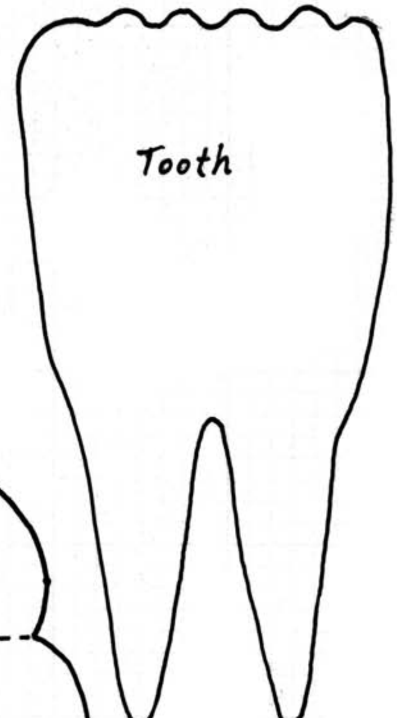

cut out
internal lines optional
cut out
cut out

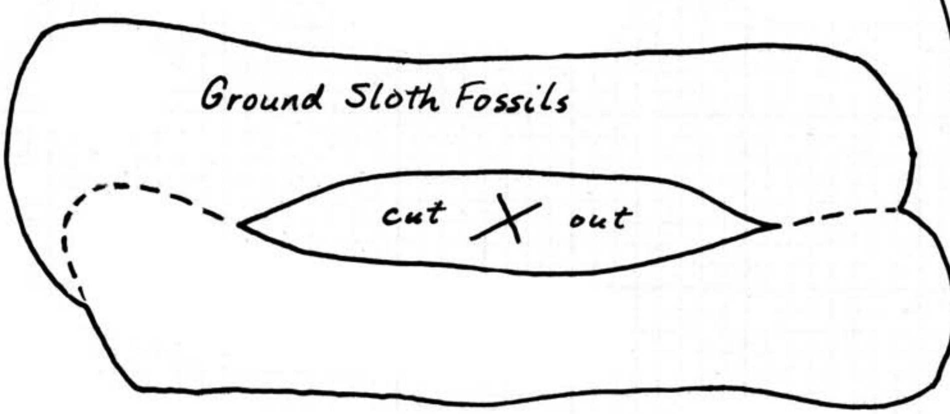

cut out

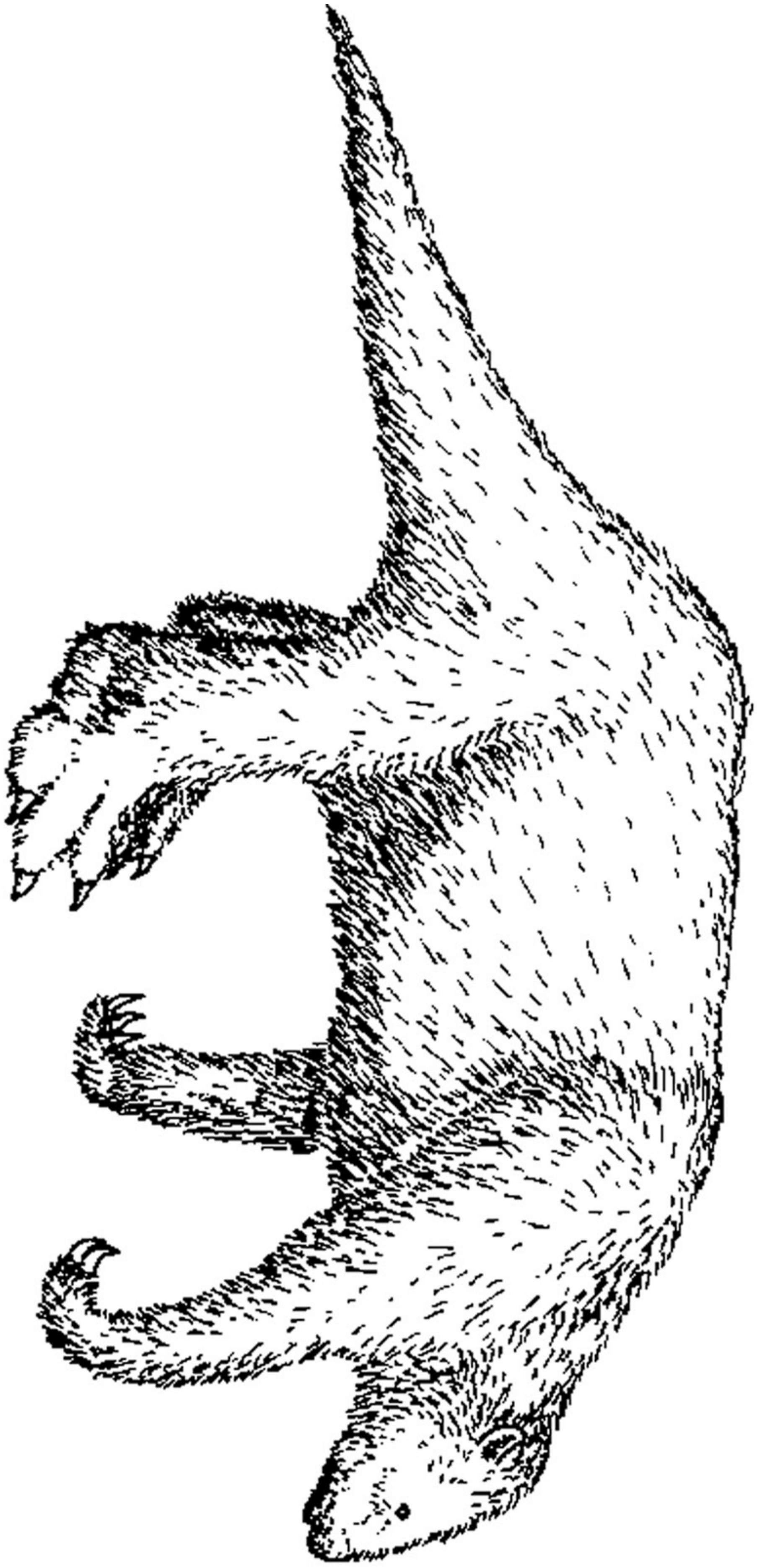

Plant


Eye brows may be cut or drawn
cut out
Punch out 2 eye pupils
Afraid
cut out


Claws
(internal lines optional)


Tooth


Ground Sloth Fossils
cut out



CAVING EQUIPMENT

SUBJECT:
Stewardship

MATERIALS:
brown and yellow construction paper, glue, scissors, tape, patterns for caving equipment

GRADE LEVEL:
K-3

TIME:
45 minutes

OBJECTIVE:
Students will develop an understanding of a spelunkers equipment by making headlamps and flashlights to simulate caving experiences.

CONCEPT:
Human activity affects the cave habitat and wildlife. The cave is a non-renewable natural resource that is being protected by Arizona State Parks.

Meets Arizona Department of Education Academic Standards

Arts:
1AV-R1, PO3
1AV-R5, PO3 & 4
1AV-R6, PO1
1AV-F3, PO2

Language Arts:
Standard 3 Readiness & Foundations

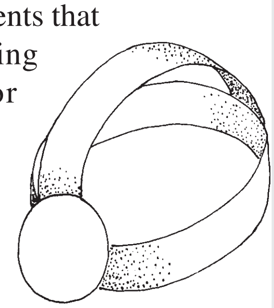
Background Infromation:
Randy Tufts and Gary Tenen were experienced spelunkers who used special equipment to aid in their crawling, climbing, rappelling (lowering yourself down a steep cliff or hill with ropes) and squeezing into the cave. Their most important tools were lights and helmets. Three light sources are a must and come in the form of a headlamp and two flashlights. Other equipment includes gloves, knee and elbow pads, ankle-high boots, seat harness, nylon ropes, carabineers and water.

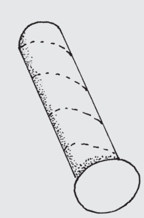
Summary:
Students will make construction paper equipment to help them imagine they are spelunkers. If this activity is conducted before "Cave Crawlin," the students will be able to use their "equipment" to crawl through the "cave."

Step by Step:
1. Prior to teaching the lesson, it will save time to have the brown construction paper cut into 4" by 24" strips. You will need 2 per student. These strips will become the helmet. Cut several tagboard circles approximately 3" in diameter for the students to use as patterns to trace. These become the headlamp and flashlight beam.
2. Discuss the term *spelunker*, with the students. Tell them they will make two pieces of equipment that spelunkers use when a cave is being explored.
3. Pass out 2 strips of brown paper, and one sheet of yellow construction paper per child. The teacher will need to measure each child's head with one or two brown strips and staple or tape to the correct size.
4. The teacher will model the rest of the construction: adding the strip from front to back, tracing 2 circles onto the yellow paper using the patterns provided and cutting them out, and attaching one circle to the front-to-back strip on the helmet. The other circle will be used on the flashlight.
5. With the larger, 9" x 12" brown construction paper, have the students roll a tube to create the flashlight body. They may staple or tape to hold tube together.
6. Next, have the students cut 6 evenly spaced slits approximately 1/2" deep into one end of their flashlight body. They will bend these tabs outward and place a dab of glue on each. Place the remaining yellow circle on the glue and hold until dry. If time permits, the students can use crayons or markers to decorate the outside of their "flashlights."

***Be sure everyone puts their name on their cave equipment!**

Assessment:
Have the students discuss what purpose a helmet with a light and a flashlight might serve. What would happen if a spelunker didn't wear a helmet? Why would it be a good idea to have more than one source of light? Remind the students that they will be using these items for future activities.





CAVE CRAWLIN'

Background Information:
When Randy Tufts and Gary Tenen discovered Kartchner Caverns it was not just a hole in the ground they could walk into. Mr. Tufts explains his discovery in the "History of Kartchner Caverns." (see next page for narrative) The explorers did a lot of crawling on their bellies, stooping, squeezing sideways through cracks, walking on slippery surfaces and sticky mud! The discovery of all of the rooms and wonderful speleothems took an entire year!

Summary:
The students will listen to the discovery of Kartchner Caverns and help the teacher set up a "cave" to simulate their own discovery of the cave. If using with younger students, the teacher may want to set "cave" up before reading narrative.

Step by Step:
1. Have the students help clear a large area in the classroom or use the cafeteria, if available.
2. You can use the headlamps and flashlights from the Caving Equipment activity.
3. Read the entire "Cave Crawlin" narrative to the students. Explain that they are going to build a model cave to explore, similar to the discovery of Kartchner Caverns.
4. Read the story on page 33 slowly stopping to stress each numbered section. Have 2 or 3 students bring the necessary equipment and place it on the gym mats roughly according to the diagram on page 32.
5. Continue until all steps of cave building have been completed.
6. Have students help cover areas with blankets and sheets.
7. Turn out lights and allow students to crawl through the "cave" a few at a time. Just as the cave discoverers were very careful to not disturb the cave, the students should be careful not to bump into their "cave walls."
8. Once all students have "discovered the cave," read the story once more and emphasize to the students that the actual process took many hours over several days to accomplish.

Assessment:
Divide students into groups of about 4-5 students each. Using about 5 feet of butcher paper per group, have each group design a room within an imaginary cave. Each "cave" should have an entrance tunnel, cave formations, water, and bats!

Extensions:
Open up cave to other classes and have your students give tours. Have the students map the cave crawl on paper bags. Crumple and soak the bags in water. Use colored chalk to draw the map. When maps dry they appear to be old and ragged. Discuss the need to make good maps and to keep good records when exploring.

SUBJECT:
Stewardship

MATERIALS:
masking tape, cardboard, blankets, sheets, desks, chairs, measuring tape or yardstick, butcher paper (about 25 feet)

GRADE LEVELS:
K-3

TIME:
30-45 minutes

OBJECTIVES: Students will simulate the discovery of the cave by measuring and tracing the path the explorers made the first time in the cave.

CONCEPT:
A continuous process of problem solving ensures proper management and preservation of the cave.

Meets Arizona Department of Education Academic Standards

Language Arts:
W-F4, PO1 & 3
Standard 3 Readiness & Foundations

CAVE CRAWLIN' NARRATIVE

from

HISTORY OF KARTCHNER CAVERNS

by Randy Tufts, 1989

It was an overcast, cool November afternoon. Gary Tenen and Randy Tufts bypassed the sinkhole and headed for the tunnel. It ducked back into the hillside, splitting into two branches. The chambers were tight and dusty and filled with cactus. They squirmed between loose boulders as far back as they could and even tried to move some of them but to no avail. Major excavation would be required for this entrance to go anywhere.

Walking back to Wade's Cave they knew the chances here were slim since Tufts had already checked it. Nevertheless, deciding to try again, they dropped down inside. Soon they were in the small breakdown chamber that Tufts had visited earlier. The graffiti was unchanged, the floor still a litter of dung and dust. The narrow crack between the rocks seemed roughly the same to Tufts' eye, although it was hard to tell after seven years. In one of the rocks was the beginning of a drill hole, the kind used to place climbing bolts. Perhaps the gap was wider, but he couldn't be sure. But something was different than it had been in 1967. This time the air was moving. There was a breeze coming up from between the rocks, through the crack. Not just any breeze, it was warm, moist and smelled like bat guano. This was new and compelling evidence. "There has got to be a cave here," Tenen remarked.

With this unanticipated incentive, they twisted their way through the gap, nearly turning a somersault on the way. Five feet down and off to one side, not visible from above, was a chamber about the size of a typical living room. Tenen saw it first. His words were "Well, it has stalactites and stalagmites." This opening had obviously been known before; there were broken formations and footprints in the dry, dusty floor. Next to it, linked by a short crawl, was another room of similar floor area and character but with generally a lower ceiling. Its prominent feature was an eight-inch stalactite which expanded at the tip like a footpad from the Apollo Lunar Excursion Module (LEM). This complex was a true limestone cave and considering what the two generally found, was intriguing in itself. Nevertheless, there was the matter of the breeze and small volume of the two rooms could not account for it.

Tenen and Tufts inspected every square inch of the two chambers. In the corner of the second, they came upon a tunnel ten inches high and two feet across that twisted back into the darkness. It was from there that the breeze came. Tufts led in and crawled on his stomach for twenty feet until the passage stopped abruptly at a rock barrier. Wind blasted through a six-inch oval hole in the center. The hole was only large enough to look through with one eye. Shining his carbide lamp through the opening he could see that the passage continued but he could not tell how far. His light blew out repeatedly in the swirling air.

With an eight-pound hammer and a chisel, they lay in the crawlway breaking open the rock, slithering by one another to trade off when their arms tired. Tenen noticed that it was particularly awkward swinging the sledge in a constricted tunnel without slamming his forehead.

Tenen was the smaller of the two. After about two hours the hole was large enough to allow him to squeeze through but only after he removed his shirt. He went ahead for a few feet, could see no obvious end and so returned to help widen the orifice a bit further. In another ten minutes Tufts grunted and scraped through the hole, stopping the breeze as he did.

On the other side of the blowhole the crawl was a bit larger. After a few feet they emerged into a right side of a wide, low cavity; the ceiling was three feet high and to their left they could see for tens of feet without encountering a wall. The floor was covered with a carpet of broken hackberry seeds mixed with a brown material they believed was bat guano. Here, the speleothems were more numerous and there was a dampness in the air. There was no sign of any previous human presence.

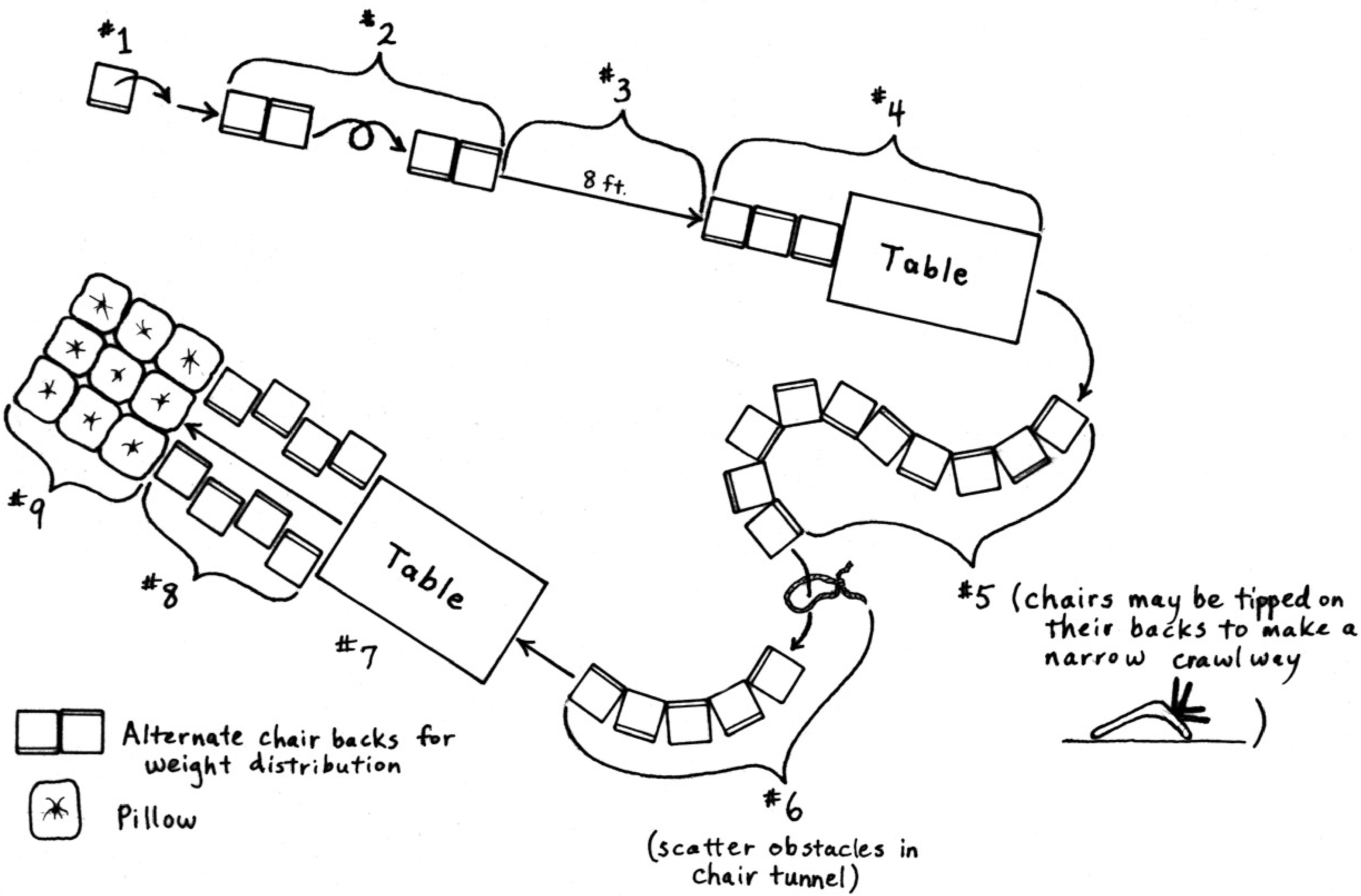
They were able to crawl on their hands and knees now. After twenty feet they reached a narrow fissure crossing their path where they could almost stand up. Crouching, they followed it to the left where it continued, alternately narrowing and widening for about thirty feet. There, they reached a low crawl that skated along a moist flowstone floor to the right. Fifteen feet ahead through that passage they could see a dark void. Crawling to it they found suddenly that they could stand up into a six-foot wide tunnel that went in both directions with no visible end. The walls converged in a narrow fault zone ten feet above their heads. The sloping bedrock, a cherty, crinoidal limestone, was festooned with dripping formations. The air was noticeably humid and they could see their breath.

The tunnel seemed to be a main route. Stalactites, soda straws, and helictites glistened everywhere. They walked along it, moving in a quiet ballet, taking care not to touch a thing. On the left they saw an undulating, three-foot travertine scroll. Passing by a distinctive, sand-covered boulder, they studied the large, gritty stone so they could use it as a marker to guide their trip out. Twenty feet farther on, the passage opened up as it entered the right hand side of a wide room with an arched ceiling and fifteen foot breakdown mound. A narrow, five foot, solitary stalactite hung into the passage, attached by only a half inch blade of calcite. On the floor, a thin sand layer covered a travertine crust. In one spot the crust had collapsed into a hole. The corridor continued on in the same general direction, passing next to a flowstone-draped wall and over a damp, rimstone floor. The wallrock abruptly changed from a light gray limestone to a dark dolomite.

They had no idea how far they had come. The two were so intent on every thing they saw, as if it might all vanish in a moment, that the distance seemed to expand. It seemed like five hundred feet. They couldn't believe it; Tenen kept asking, "It's got to stop, right?"

Ducking under a low ceiling, they entered the biggest room they had seen so far, one that, in their dim lights, appeared to extend ahead of them by a hundred yards. On the right hand wall, streams of orange calcite seemed to flow to the floor. From across the room to the left, a dark oval opening stared. The ceiling curved eight feet above them and , on the floor, there were occasional five-foot diameter piles of guano which they stepped gingerly around. Presently, arriving at a flat expanse of mud, they stopped.

There had been no sign that others had preceded them. Their hearts were beating wildly. They both giggled. But they had violated a cardinal rule of caving-nobody knew where they were. So instead of continuing on, they turned out their lights and sat silently in the darkness communing with their find. After a few minutes they re-lit their lamps. The scene was as it had been, the stones seeming to glow in their lights, the water droplets glistening on dimpled clay, and a shining column connecting the ceiling to the floor. Then they left, carefully retracing their steps, walking slowly out of the cave.



#1
#2
#3
8 ft.
#4
Table
#5 (chairs may be tipped on their backs to make a narrow crawl wey
#6
(scatter obstacles in chair tunnel)
#7
Table
#8
#9
Alternate chair backs for weight distribution
Pillow

CAVE CRAWLIN' SETUP

Narrative	**Set up**
1. Dropped down inside a sinkhole...	Have a sturdy chair that each student will jump off.
2. ...twisted their way through the gap,	Students place 2 chairs with chair legs aligned, nearly turning a somersault along the way...have a small gap large enough to turn a somersault, then
place 2 more chairs. Cover all chairs with sheets or	blankets.
3. ...chamber about the size of a typical living room.	Students pace out 8 feet to beginning of next tunnel portion.
4. ...linked by a short crawl was another low ceiling...	Place 3 chairs and cover them. The students will crawl on hands and knees under chairs to a low table. Cover table. Have the students duck walk under table (may need 2 tables if they're small).
5. ...came to a tunnel 10 inches high and 2 feet across that twisted back 20 feet....	Place 10 chairs in a winding pattern shown in diagram. Cover chairs.
6. ...6 inch oval hole...which they enlarged with chisels and hammers...	Have a rope circle on the floor that the students slip over head and drop down their body and step out. Place 5 chairs in winding pattern.
Then, cover chairs. Place obstacles such as books,	empty milk cartons, etc. under chairs. Students must crawl over and around without disturbing obstacles.
7. ...came into right side of a wide, low cavity...	Cover another table, have students stoop and walk under table.
8. ...crouching, they followed a path that alternately widened and narrowed	Place 2 parallel rows of chairs, 4 chairs per side. ...Cover chairs. Allow enough space between rows
for the students to scoot on their bottoms between	rows. This should be 8-10 ft. long.
9. ...arriving at a flat expanse of mud, they stopped.	Place pillows in a row, as many as you have (8-10 ft. total), have students crawl over to simulate the deep cave mud. Have the students sit on edge of "mud" and wait for the rest of the class to crawl through cave.

HOW DO BATS DO THAT?

(Adapted from "AIMES: Bats Incredible!")

Background Information:
Kartchner Caverns' bat population is predominantly the *Myotis velifer* or common cave bat. These cave bats use Kartchner Caverns as a nursery colony during the summer months. The rooms that provide shelter for the bats are off limits to visitors during the summer months to insure that the bats remain undisturbed.

Inside Kartchner Caverns it is so dark that if you were to turn out the lights and hold out your hand in front of you, you would see nothing. So how do bats find their way in and out of the cave to feed each night? They use **echolocation**. Echolocation is how bats identify and measure the distance to objects in their path. The bats emit short, high-frequency sounds, produced in the larynx, through the mouth or nose. As the sounds come in contact with different objects, they are reflected back to the bat as echoes. With echolocation bats are able to orient themselves in space and to determine the shape, size, texture, speed, distance and direction of movement of prey or other food items. Humans cannot hear most of the noises bats make because they are too high for our ears to detect.

Summary:
This activity may be conducted as a whole class or cooperative group activity. The students will be rolling a ball from three different pre-marked places. When the ball hits the wall the students will be able to determine from which of the pre-marked places the ball was rolled. This simulates a bat echolocating.

Step by Step:
1. Locate a large area with few auditory distractions (gymnasium, all-purpose room).
2. To make sure the rolling of the ball is as consistent as possible, assign one person, student or teacher, to be in charge of this duty.
3. Prior to this activity, have the class practice counting seconds.
4. Tell the students they are going to be bats and use their ears to listen for echoes.
5. Discuss the key question: "How can you use sound to determine distance?"
6. Have the students measure three different distances (2 meters, 4 meters, and 6 meters) from the wall. Use masking tape to mark each distance.
7. Have the students record the distances on their activity sheet.
8. Direct all students to sit down except the ball roller.
9. Have the ball roller stand behind the two-meter line and roll the ball to the wall.
10. As the ball leaves the ball roller's hands, the other students should start counting seconds, and continue until the ball hits the wall.
11. Repeat steps 8 and 9 at each pre-marked distance, making sure the ball is rolled at approximately the same speed each time. Have the students predict what the count will be from each new position. After each roll have the students record the actual count on their activity sheet.

Next session:
1. Now the students are going to be bats. Choose a student to blindfold. This student will be the bat and will determine the distance to the wall by listening.
2. Have the person designated as the ball roller walk the "bat" around the room to disorient him/her then stop behind one of the lines.
3. Instruct the ball roller to roll the ball trying to be consistent with the ball rolls from before. The teacher or another student should tap the "bat" when the ball is being released. The "bat" then begins to count until he/she hears the ball hit the wall.

SUBJECT:
Cave Biology

GRADE LEVEL:
1-6

TIME:
two 30 minute sessions

MATERIALS:
rubber balls, masking tape or chalk, meter stick, blindfolds, an area where balls can be rolled against a wall

OBJECTIVES:
Students will play a game that simulates how bats use echolocation to maneuver within a cave environment and to determine location of potential prey.

CONCEPTS:
Adaptations enable species to live in the cave environment.

Meets Arizona Department of Education Academic Standards

Science:
1SC-R1, PO1
1SC-R2, PO1
1SC-R4, PO1 & 2
1SC-R5, PO1 & 2
1SC-E3, PO1
2SC-F3, PO1
4SC-F3, PO1 & 2
4SC-F4, PO2
4SC-E7, PO2

Mathematics
2M-R2
2M-F1, PO2 & 3
2M-E2, PO1 & 2
5M-E2, PO1, 2 & 3

4. Have the "bat" guess which line he/she is standing behind. Some other students should record this guess on the activity sheet.
5. Remove the blindfold so the "bat" can see the actual measurement.
6. Have the students discuss how close they were able to predict the distances.
7. Repeat the blindfold process with other students.
8. Discuss the experience with using sound to determine distance and echolocation.

ASSESSMENT:
For class Discussion:
How did the counts differ at each position?

What helped the blindfolded students determine their distance from the wall?

How is this activity similar to bat's use of echolocation?

How is this activity different from how bats use echolocation?

What parts of our body helped us in the blindfolded portion of the activity? Compare and contrast our ears and faces with those of bats.

HOW DO BATS DO THAT?
RECORD SHEET

Distance from wall	Count

HOW DO BATS DO THAT?
RECORD SHEET

Distance from wall	Count

WHERE DOES IT GO?

Background Infromation:
There are three forms that water can take; solid, liquid, and gas. When water changes from liquid to gas, it becomes moisture in the air, or humidity. This exchange of water from liquid to gas is called **evaporation.** Inside Kartchner Caverns the evaporation rate averages 0.08 inches per year. Outside the cave, evaporation rates are in excess of 65 inches per year! This means that the evaporation rate outside is 800 times greater than inside the cave!

Summary:
This activity may be conducted as a whole class or as partners. The activity reproduces the actual data collection procedure used in Kartchner Caverns. This procedure includes one open pan with a "roof" over it to prevent drips from the cave ceiling altering results, and the covered pan represents the cave itself, which is sealed with the exception of a few naturally occurring openings. The students collect and record data and use this information for a class discussion.

Step by Step:
1. Discuss with the students that in Kartchner Caverns, park rangers have been studying the evaporation rates for many years using this same procedure that they will use in the classroom.
2. Put both cake pans side by side in a place that can remain undisturbed for a week. (Not in direct sun) Place a known, measured quantity of water in each pan. Use the identical amount of water for each pan.
3. Use a marker to place a line in each pan at the surface of the water . This will aid the children in observing changes in water level.
4. Cover one pan tightly with plastic wrap and poke 2 or 3 *small* holes (with a pin) in the top of the plastic wrap to simulate the natural openings that exist in Kartchner Caverns.
5. Have children observe the pans throughout the week and note any changes they may see.
6. At the end of the 5 days, have the children *carefully* pour the water from the covered pan into the original measuring container and note the amount remaining. Have the children add water with the measuring spoons to return the quantity of water in the measuring container to the original level. Record the amount of water added. Repeat the procedure for the uncovered pan.
7. Discuss with the students that the water turned from liquid to gas and was carried away by air currents. The covered pan has less evaporation because it was not exposed to the air currents and more water remained as a liquid.

Assessment:
For the younger grades, have the children write their observation in a few sentences or a paragraph. For older grades, you may use the observation sheet found on the next page. For all grades, their write up should include where they think the water went and why the covered pan had so much more water at the end than the uncovered pan. Since Kartchner Caverns is like the covered pan, do they predict that a lot or a little water evaporates from it?

SUBJECT:
Underground Atmosphere

MATERIALS:
2 equal size shallow pans (cake pans ideal), plastic wrap, measuring cups and spoons

GRADE LEVEL:
K-6

TIME:
1/2 hour first day, few minutes each day rest of week

OBJECTIVES:
Students will be able to determine that evaporation in a closed atmosphere is considerably slower than that in an open atmosphere.

CONCEPT:
Relative humidity, temperature, and airflow create the microclimate of the cave.

Meets Arizona Department of Education Academic Standards

Science:
1SC-R1, PO1
1SC-R4, PO1 & 2
1SC-R5, PO1 & 2
1SC-R6, PO1 & 2
1SC-R7, PO1
1SC-F3, PO1 & 2
1SC-E1, PO3 & 4
1SC-E3, PO1 & 2
5SC-F3, PO1 & 2
5SC-E4, PO3
6SC-E6, PO1 & 2

WHERE DOES IT GO?
OBSERVATION SHEET

Observer's Names: ____

Pan A = covered with plastic wrap
Pan B = uncovered

Quantity of water placed in pans: ____________

OBSERVATIONS: PAN A PAN B

Day 1: ____

Day 2: ____

Day 3: ____

Day 4: ____

Day 5: ____

PAN A RESULTS:
Original quantity of water: __________

Water left after 5 days: (-) __________

Amount of water evaporated: (=) __________

PAN B RESULTS:
Original quantity of water: __________

Water left after 5 days: (-) __________

Amount evaporated: (=) __________

CONCLUSIONS:
Which pan had the greater evaporation? Why?

Where did the water go?

Explain which pan is most like Kartchner Caverns. What do you think would happen to Kartchner Caverns if it was opened up to outside air currents and heat?

NO MISSING PIECES

Background Infromation:
Kartchner Caverns has a history of animals that have been dependent upon the cave. The fossilized remains of a ground sloth were found embedded in the floor of one of the rooms. This skeleton has been dated to 86,000 years old. Bat guano piles have dated to 49, 340 years ago. A coyote skeleton was discovered to have been 100 years old. Bats, raccoons, ringtails, rattlesnakes, coyotes, spiders, crickets, scorpions, mites, and book lice are some of the animals that are now in or near the cave.

Summary:
This is a "jig saw" activity where students are responsible for reading given information about the animals which have been found to live in the Kartchner Cavern area. After reading about their specific animal the students teach their fellow group members. Information can be found on pages 43-46.

Step by Step:
1. Break students into groups of 4, letter these groups A, B, C, D. Assign each group A member a number 1 through 4. Do the same for group B, C & D members.
2. Have all the ones, twos, threes, and fours get together in a new group. Tell the students that they will be given a sheet of paper with information/facts about an animal or animals found in or around Kartchner Caverns. Their job is to read the information to themselves within the group (about 5 minutes).
3. They discuss what they read with the other students in that group (about 10 minutes). The students need to make sure that each student in that group knows and understands the information they have just read because they will be teaching the people in their first group the information.
4. After the students have discussed their animal, have them return to their original group.
5. Have the students select a timekeeper. Each student will have three minutes to share the information about their animal. When three minutes are up, go on to the next person until all of the animals have been discussed. The groups will be discussing all four of the different animals.

Assessment:
Monitor all of the groups while they are working. Organize a "Jeopardy" or "Steal the Bacon" game to have the groups earn points for the information they have just learned.

"Jeopardy" questions.
- Most numerous animal found in Kartchner Caverns. **What are mites?**
- An animal that lives on or in another animal. **What is a parasite?**
- The era of time at the end of which most large herbivores and carnivores became extinct. **What was the Pleistocene Age?**
- The fossils of this large plant-eating mammal were found in Kartchner Caverns. **What is a Shasta Ground Sloth?**
- This arthropod feeds upon plant material found outside of the cave. **What is a camel cricket?**
- This mammal can be found in mines, tunnels and cave. There are approximately 1000 in Kartchner Caverns during the summer months. **What is a Common Cave Bat?**
- This material is deposited by bats and is a food source for many invertebrates. **What is bat guano?**

SUBJECT:
Biology

MATERIALS:
copies of the four different animal
natural history sheets on different colors of paper, butcher paper for each group

GRADE LEVELS:
4-6

TIME:
two 45 minute sessions

OBJECTIVES:
After reading, discussing, listening, and recalling given information, students will be able to identify the animals which occur or have occurred in Kartchner Caverns.

CONCEPTS:
Caves provide habitat for permanent and visiting animal populations.

Meets Arizona Department of Education Academic Standards

Science:
4SC-E7, PO1 & 3

Language Arts:
R-E2, PO1, 3 & 6
Standard 3 Essentials

NO MISSING PIECES

Or

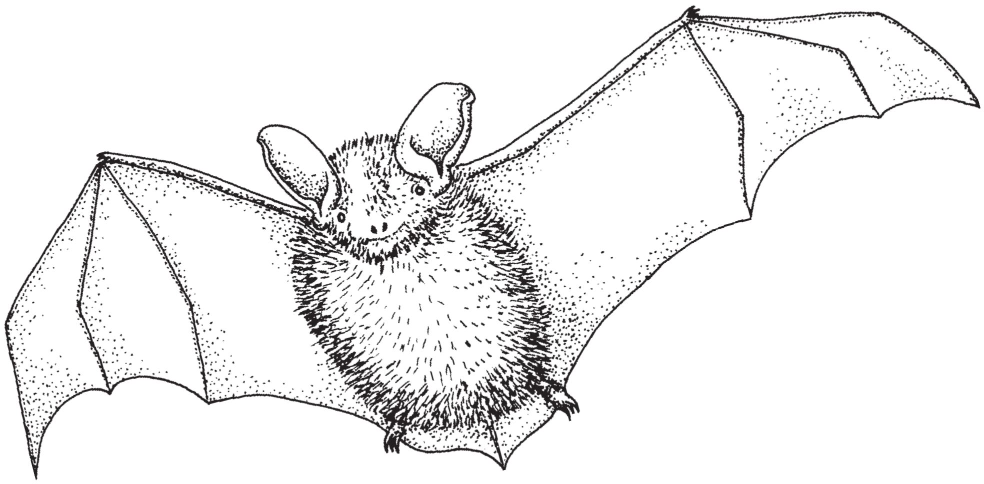
"Steal the Bacon"

Have the students remain in their A, B, C, D groups, but number the students from one on up to the last student. Tell them that their group can now earn points in a 'question and answer game.' Write one of the questions on the board. Let the students discuss the answer within their group. Then call one of the numbers, (keep track of the numbers called on a piece of scrap paper) and have that student answer the question. If the student answers the question the group receives a point. If that student does not answer the question correctly call another number. Repeat until questions have all been answered.

Questions:

1. **Name three places cave crickets can be found.** (caves, cellars, under logs, under stones, other dark places)
2. **Cave crickets eat only other crickets. True or False** (False-they eat plant material)
3. **Name three animals which prey on cave crickets.** (bats, raccoons, lizards, birds, scorpions, vinegarroons, other arthropods)
4. **When do cave crickets feed?** (during the night)
5. **Which animals do the cave crickets fool by digging a false hole for eggs?** (blind beetles)
6. **What are bats never too far from?** (water)
7. **When are the bats in Kartchner Caverns?** (May through September)
8. **All of the bats in Kartchner Caverns are very old.** True or False (false- it is mostly a nursery colony)
9. **Do the cave bats in Kartchner Caverns eat fruit or insects?** (insects)
10. **What do bats leave behind in the cave?** (bat guano)
11. **How long have bats lived in Kartchner Caverns?** (40,000 to 50,000 years)
12. **The end of the Pleistocene was the end of the large carnivores and herbivores. True or False** (true)
13. **The ground sloth walked on all four feet. True or False** (true-they stood on their two hind feet to eat but walked on all fours)
14. **Name the type of ground sloth whose fossil was found in Kartchner Caverns.** (Shasta Ground Sloth)
15. **How long ago had the ground sloth inhabited Kartchner Caverns?** (80,000 years ago)
16. **How long was the ground sloth?** (3 meters long)
17. **What is the most numerous animals found in Kartchner Caverns?** (mites)
18. **There are 50 to 500 individuals every- cubic yard, cubic inch, cubic meter?** (cubic inch)
19. **The Geolaelaps is usually found where in the cave?** (in bat guano)
20. **This animal spends its larval stage on the Cave cricket.** (mite)

Common Cave Bat
Myotis velifer



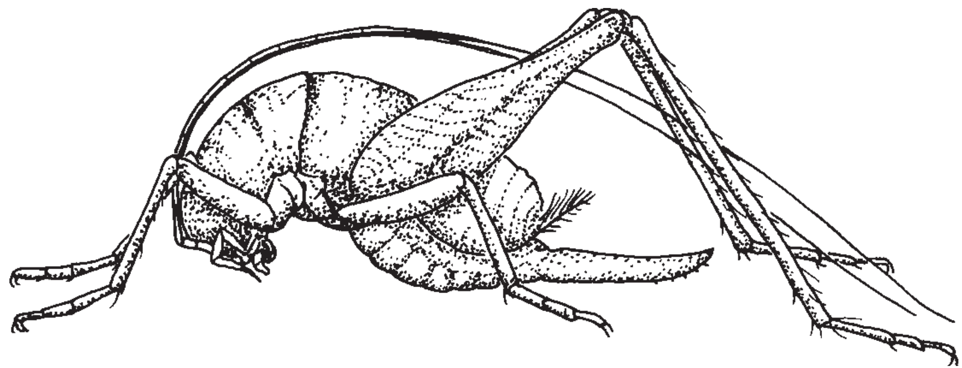
Common Cave bats are found in mine shafts, caves, tunnels and under bridges. They are never too far from a water source such as creeks, canals or cattle tanks. Common Cave bats are usually in Arizona during the summer months when they have their young. These bats go south for the winter months.

The bats live in Kartchner Caverns from May through September. This is a nursery colony. The young are born from mid-June through August. When evening comes, bats leave their roosts and hunt insects by flying low over plants. Some of the insects they eat are small moths, flying ants and mosquitoes. Bats 'talk' with each other by making twittering noises.

Within Kartchner Caverns the cave bats hang from the ceiling in clusters in the Big Room. Bat guano (bat droppings) is a rich food source for other animals that occupy the cave. An ancient guano pile was found in the Throne Room which shows bats lived in the cave as long as 40,000 to 50,000 years ago. One bat skeleton has been encased in a calcite formation for 50,000 years.

Bats are important to Kartchner Caverns because they are an educational experience for the visitor, they act as a natural insecticide (eating one-half ton of insects every summer), and the guano supports the ecosystem of the cave.

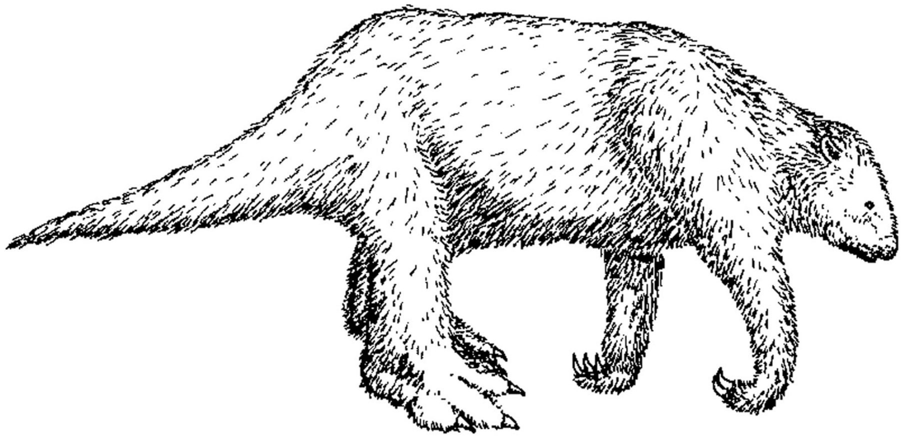
Cave or Camel Cricket



Cave or Camel Crickets can be found in caves, cellars, under logs and stones, and in other dark, moist places. They are brownish in color and somewhat humpbacked. Their hind legs are large, and the antennae extend almost twice as far back behind. The cave crickets have a chewing mouth part. They feed mainly upon plant material found outside of caves and other shelter. The cave cricket may be prey to bats, raccoons, lizards, birds, scorpions, vinegarone, and other arthropods.

You may see cave crickets on the cave floor or hiding in cracks on the walls and ceiling. On warm, moist nights, many cave crickets hop out to feed near the cave entrance. Before the sun rises, they are full and go back inside. Their eggs and droppings or waste feed other animals, such as blind beetles, that never leave the cave. Blind beetles use sensors near their mouths to smell cricket eggs, which they dig up and eat. Crickets try to fool the beetles by digging false holes that have no eggs.

Shasta Ground Sloth

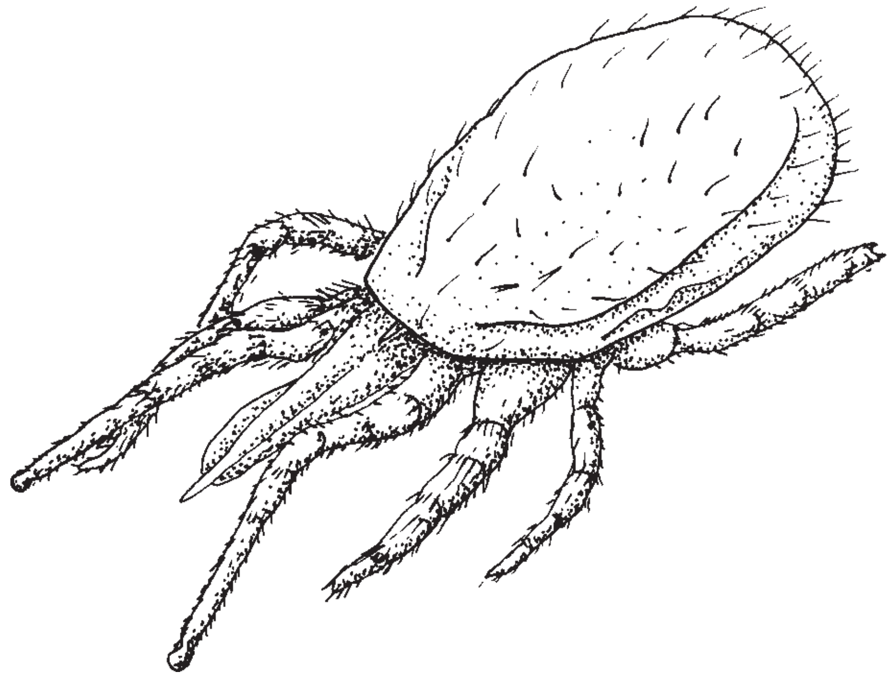


The end of the Pleistocene was marked by a major extinction event that affected most of the large herbivores and carnivores. The cause of this extinction is not fully understood. According to one idea, the extinction occurred due to over-predation by early human hunters. Another popular theory is that the extinction was caused by the rapid change from the Wisconsin glacial climate to the warm-cold season change that we have today. In any case, the extinction of the large carnivores occurred at the same time as the disappearance of their prey, the large herbivores, such as Shasta ground sloths and mammoths.

The Shasta ground sloth ranged over much of the Southwest but seem to have been particularly common in Southeastern Arizona and Southern New Mexico, north to the Grand Canyon and in Southern Nevada. The plant-eating sloth was a browser who fed on woody vegetation in forested upland areas or grassy savannas. Their teeth are termed 'hypsodont'-meaning ever-growing. No crown and no roots, but also no enamel. There is bone evidence that they had a long tongue and some sort of prehensile lips to aid in eating. The ground sloths probably walked on all four legs but stood on the hind legs to feed.

The Shasta ground sloth found in Kartchner Caverns has been dated to be 86,000 years old. It may have used the cave to live in or give birth in if the cave had been easily accessible. Based on a completely articulated skeleton still held together by tendons and sinews and including patches of skin and hair, the animal was over 3m long (nose to tip of tail) and stood (on all fours) over 1 m at the withers. A full-grown animal must have weighed between 135 and 180 kg (300-400lbs).

Invertebrates



The invertebrate fauna of Kartchner Caverns is unique, with several new species that may be found only in Kartchner Caverns. Mites are the most numerous invertebrates in Kartchner Caverns; there are at least 10 species. Nearly all of the mites are dependent upon the annual renewal of the bat guano deposits in the Big Room for survival. *Sancassania*, a fungivore, is the most common mite in fresh guano, with 50 to 500 individuals per cubic inch of fresh guano. The primary predator in the bat guano is the *Geolaelaps*. This mite is usually common in fresh bat guano where they prey upon the *Sancassania* and other small arthropods. Most of the remaining bat guano mites-orbatids and *Eustigmaeus*, are usually found in guano piles that receive only small amounts of fresh guano each year.

Only one species of parasite (an animal that lives on or in another animal) was found in the guano piles within Kartchner Caverns. It is a mite that spends its larval stage as a parasite of the camel cricket. This parasitic larva does not seem to have an effect on the cricket host, as nearly all camel crickets in Kartchner Caverns have these parasites.

CAVE CREATIONS

(Adapted from Adaptation Artistry, Project Wild)

Background Information:
Animals are adapted to their environment in order to survive. Many of the animals that live in and around caves have special features that give them advantages for survival in that area. These adaptations have evolved so that these animals are better suited for their environments and lifestyles. See following page for examples of major adaptations.

Summary:
The students will study the Animal/Adaptation/Advantage sheet, make their own "ultimate" cave animal that can survive in a cave, give it a name, and write a description of that animal. Kartchner Caverns has some of the animals described in this activity. However, this activity uses animals that may be found in caves all around the world.

Step by Step:

1. Ask the students to think of animals with which they are familiar. What characteristics help these animals catch and eat their food, move around, and protect them from predators? (Giraffe has a long neck to eat the leaves on tall trees, tortoises have a hard shell to protect themselves from predators.) Define **adaptation** as the process of making adjustments to the environment.

2. Show and discuss the Animal/Adaptation/Advantage sheet with the students. Tell them that these animals are found in and around caves. They may want to add to the list of animal/adaptation/advantage.

3. Using this list, have the students work independently or in groups to design an animal with at least six of the adaptations from the list. The adaptations need to aid in the animal's survival.

4. Encourage creating imaginary animals! The students can draw their animal with markers, crayons or pencils.

5. When the animal is complete, have the students write a description of the animal. Make sure they describe the adaptations and purpose.

Assessentment:
Have students share their animal and description. Make sure that their animal has at least 6 adaptations.

SUBJECT:
Biology

GRADE LEVELS:
4-6

TIME:
Two 45 minute session

MATERIALS:
crayons, markers, drawing paper, pictures of animals, transparency of Animal/Adaptation/Advantage sheet

OBJECTIVES:
Students will be able to identify and describe adaptive advantages of animals found in and around caves.

CONCEPTS:
Adaptations enable species to live in the cave environment.

CONCEPTS:
Caves provide habitat for permanent and visiting animal populations.

Meets Arizona Department of Education Academic Standards

Science:
4SC-E5, PO1 & 2
4SC-E7, PO2 & 3

Arts:
1AV-E1, PO1
3AV-E1, PO1
3AV-E2, PO2

Language Arts:
W-E1, PO1-5

Animal/Adaptation/Advantage

Animal	Adaptation	Advantage
bat	1. echolocation	maneuver through darkness
	2. tiny, sharp claws	hang from ceiling
	3. fur	hold in moisture
cave cricket	1. long antennae	feel around in the dark
	2. long back legs	escaping from predators
flatworms	1. eyeless	
	2. regenerates tail or head	continue living
	3. extended tube as mouth	sucking up small organisms
	4. adhesive organ	able to stick to walls and other slick surfaces
	5. flat body	able to float on water
cave spider	1. makes webs in cracks	able to catch mites and flies along walls and under rocks
mites	1. microscopic in size	live on a host
scorpion	1. large pedipalps	grasping crickets
	2. venomous sting	paralyzes prey
blind catfish	1. vibration receptors scattered over its skin	to detect faintest vibrations and guide swimming to food source
cave salamander	1. breathe through the skin	permits the exchange of carbon dioxide and oxygen
crayfish	1. exoskeleton	protection from predators
	2. claws	grasp prey
remipedia	1. many fin-like legs	moving in mud or water (cave swimmer)
bear	1. hibernation	sleep through the coldest part of winter
	2. claws	to dig into dirt of cave
	3. fur	maintain body warmth
ringtail cat	1. long body	enter small cave entrances
	2. large eyes	better vision in darkness

ADAPT A BAT

SUBJECT: Cave Biology

MATERIALS: construction paper (black and brown will be needed most), pictures of bats, glue, scissors, patterns of bat features on tagboard, manila envelopes

GRADE LEVEL: 4-6

TIME: 1 1/2 hours

OBJECTIVE: After a discussion about bat adaptations students will make masks of bats, found in Arizona, from patterns of bats' unique facial features.

CONCEPT: Adaptations enable species to live in the cave environment. Caves provide habitat for permanent and visiting animal populations.

CONCEPTS:
Caves provide habitat for permanent and visiting animal populations.

Meets Arizona Department of Education Academic Standards

Arts:
1AV-E1, PO1
1AV-E2, PO1 & 2
3AV-E7, PO1

Language Arts:
WE1, PO1-5
WE5, PO1-3
WE8, PO1

Background Information:

The primary bat species found in Kartchner Caverns is the Cave Bat along with an occasional Townsend's Big-eared Bat, Fringed Myotis, Big Brown Bat, California Myotis, Western Small-Footed Myotis, Pallid Bat, Lesser Long-Nosed Bat and Mexican Long-Tongued Bat.

There are 28 different species of bats in Arizona. Each species has unique adaptations that allow them to thrive in their environment. A very obvious adaptation is different sized ears that help in locating prey. The Cave Bat (*Myotis velifer*) and other *Myotis* genus bats have small round ears that are able to receive the higher frequency sounds from their prey. In contrast, the Pallid Bat has large ears which helps in receiving echolocation sounds bouncing off their prey. Another adaptation is that the large ears can fold down to minimize heat loss when the bat is hibernating. Some bats have a "leaf" shape on their nose that aids in emitting and receiving sounds. There is discussion that the leaf shape on the nose is also for socialization; to help find and attract a mate.

Other adaptations that distinguish different species of bats are related to what they eat. Insectivores or insect-eating bats, have very sharp teeth for breaking through the hard "shells" or exoskeletons surrounding most insects. In contrast, Longed-tongued bats have long noses and tongues which enable them to lick the nectar from long, tubular flowers, such as the Saguaro.

Bats are not blind but many insect-eating bats have small eyes. When flying at night they generally rely on their echolocation to navigate, not their eyes. Most of the fruit-eating bats have large eyes to help them locate fruit.

Some adaptations are common to almost all species. These include very tiny, sharp claws which enable them to hang from the ceilings of caves, wooden beams and other roosts. Although we may not understand the reason for the physical and behavioral adaptations of bats, they serve them well in their environment.

Summary:
The students will use the patterns to outline, on construction paper, the features of a bat. The features will be cut and pasted to create a mask. This activity allows the students to make a bat that may be found in the Kartchner Caverns area or in other parts of Arizona. The patterns are of a Cave Bat, Southern Yellow Bat, Townsend's Big-Eared Bat, Lesser Long-Nosed Bat, and Ghost-Faced Bat.

**** See the end of the activity for a bibliography on bats.**

Step by Step:

1. Make tag board patterns from copy sheets. It is helpful to have several patterns of each bat. Clip all of the pieces for a particular bat together with a paper clip and slip each species into a manila envelope.
2. Before the lesson make each of the bat masks. Save one of each to put up on board as examples. To create a 3 dimensional effect fold on dotted lines and glue on edges where patterns show the word "glue."
3. Begin a discussion about bats and the term "adaptation."
4. Demonstrate how to trace a pattern on folded paper to save construction paper and time.
5. Next, show the students where to fold face, lower jaw, nose, eyebrows and the ears.

ADAPT A BAT

Bat Conservation International

Bat Conservation International (BCI) is recognized as the leader in conservation and educational initiatives that protect bats and their habitats. Efforts by BCI have resulted in protective legislation for bats and cooperative projects with federal and state agencies to secure some of the most significant bat populations. In addition, BCI's educational endeavors have reached millions worldwide.

Bats play key roles in maintaining the balance of nature and the health of human economies. Worldwide, they are primary predators of vast numbers of insect pests that fly at night, and others pollinate flowers and disperse seeds from rain forests to deserts. Some are so essential that without them, many other animals and plant species may die out, threatening entire systems of life. Yet despite their importance, bats are among the world's least appreciated and most endangered animals.

If you would like to learn more about these amazing animals and how you can help save them, please join us. Members of BCI will learn of the vast diversity of bat species through our magazine, BATS, have opportunities to participate in eco-tours and workshops, receive discounts on catalogue items, and gain the satisfaction of seeing how their contributions are making a difference. For membership information contact BCI at the address below. For a donation in any amount, BCI will send you a copy of the *Bat House Builder's Handbook*.

Bat Conservational International
P.O. Box 162603
Austin, TX 78716-2603
512-327-9721
512-327-9724 fax
http://www.batcon.org
1-800-535-BATS
(for orders)

6. Glue pieces onto head. Tell the students to look at your examples when they are gluing their own bat masks.
7. Have students look at the examples and decide which bat they want to make. Have materials on supply table and have the students collect what they need.
8. Monitor students and help with the folding if necessary. Encourage students to be creative by adding bugs or moths in the bat's mouth or by having bugs/scorpions attached to claws.
9. When the students glue on the wings watch for the mistake of gluing the wings upside down.
10. Have the students discuss the adaptations and how they may benefit the bat.
11. These masks make great decorations in a classroom.

Assessment:
Have the students research and write a description of other bats. Their description should include where the bat roosts, what it eats, special features such as long ears, long nose, leaf nose and other facial markings.

Bat resources:
Bat Resource Trunk, available from the Arizona Game and Fish Department-Phoenix office. With the box comes, Guide to the Bats Resource Trunk. (A wonderful box of everything you would need to teach students about bats!) You may also attend a Bat Workshop offered by the department each summer. Call #602-789-3220 for more information. Also available through Arizona Game and Fish: *Bats of Arizona* poster.

"Bats of America" video available from Bat Conservation International or nature shops.

"Bats: Myth and Reality" video available from Bat Conservation International or nature shops.

Graham, Gary L., Bats of the World , A Golden Guide. Golden Press, New York. Western Publishing company, Inc. Racine, Wisconsin 53404. 1994.

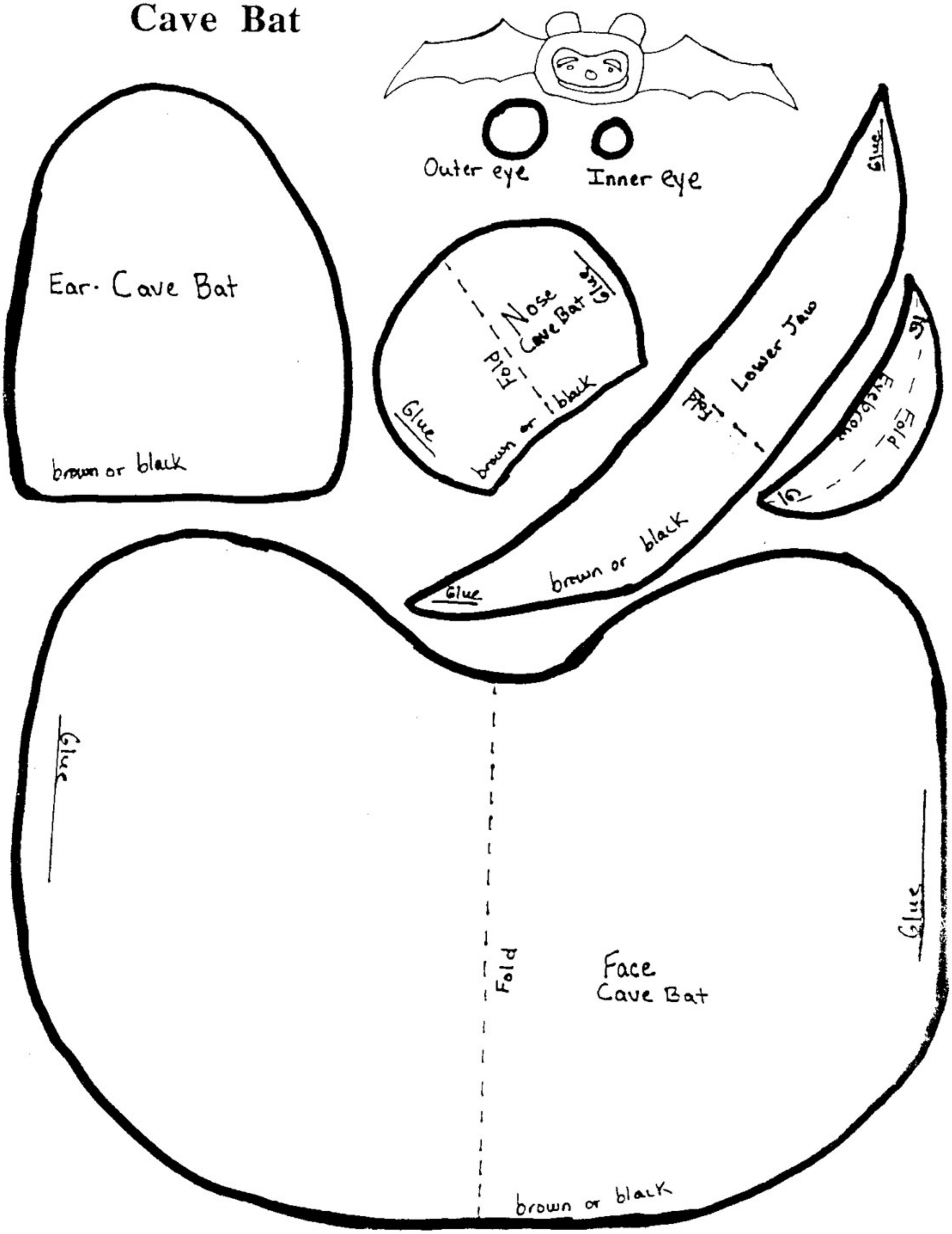
Julivert, Maria A, The Fascinating World of Bats Barron's Educational Series Inc. New York. 1994.

Lovett, Sarah Extremely Weird Bats. John Muir Publications, Santa Fe, New Mexico. 1991

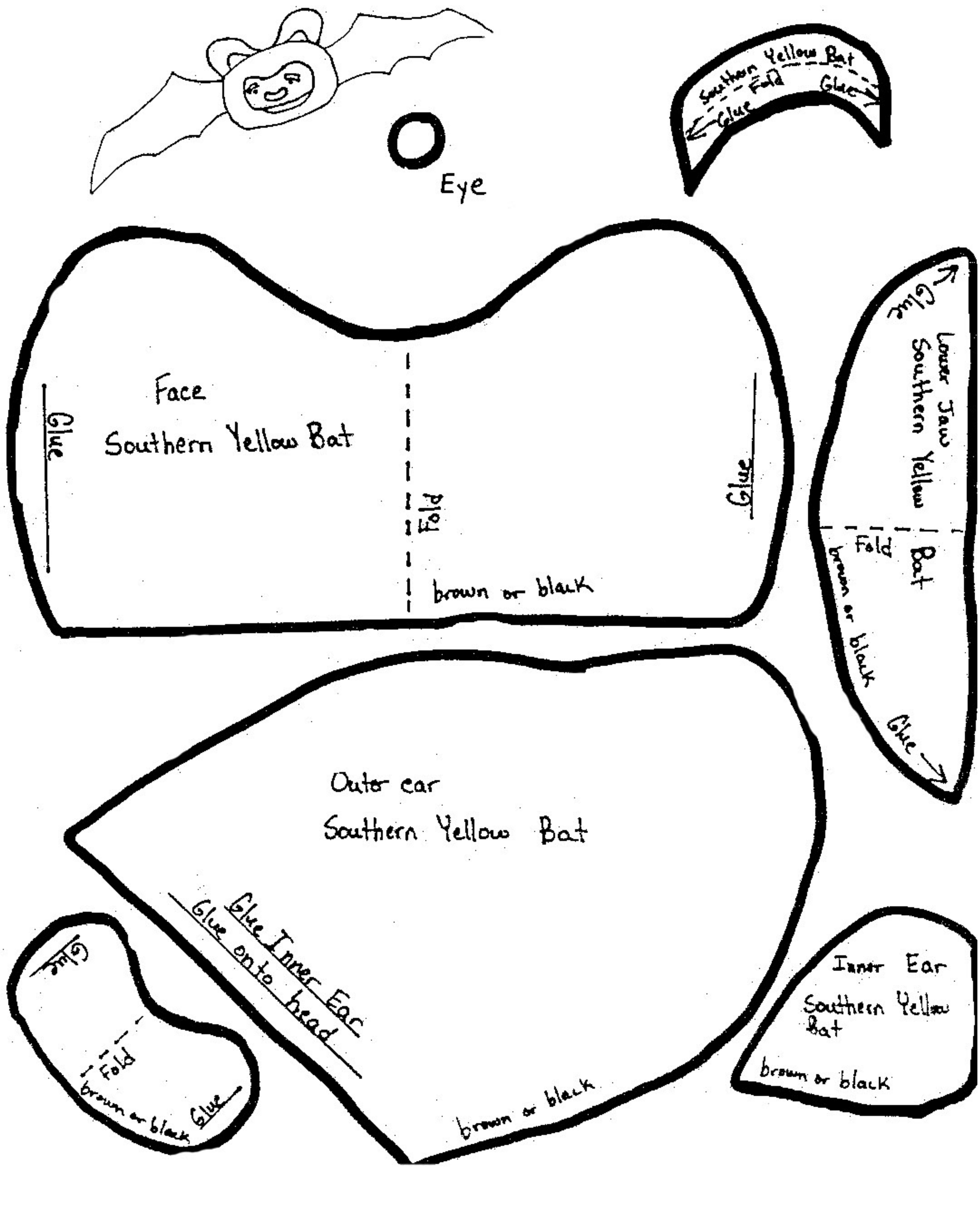
Pringle, Laurence, Batman: Exploring the World of Bats Scholastic Inc. New York. 1991.

Bat Conservation International, P.O. Box 162603, Austin, Texas, 78716-9721. 1-800-538-BATS

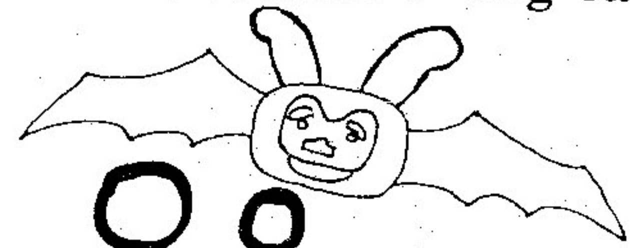
Cave Bat


Outer eye
Inner eye
Ear· Cave Bat
brown or black
Nose
Cave Bat
Glue
Fold
Glue
brown or black
Lower Jaw
Fold
Glue
brown or black
Eyebrow
Fold
Gl
Glue
Glue
Glue
Fold
Face
Cave Bat
brown or black

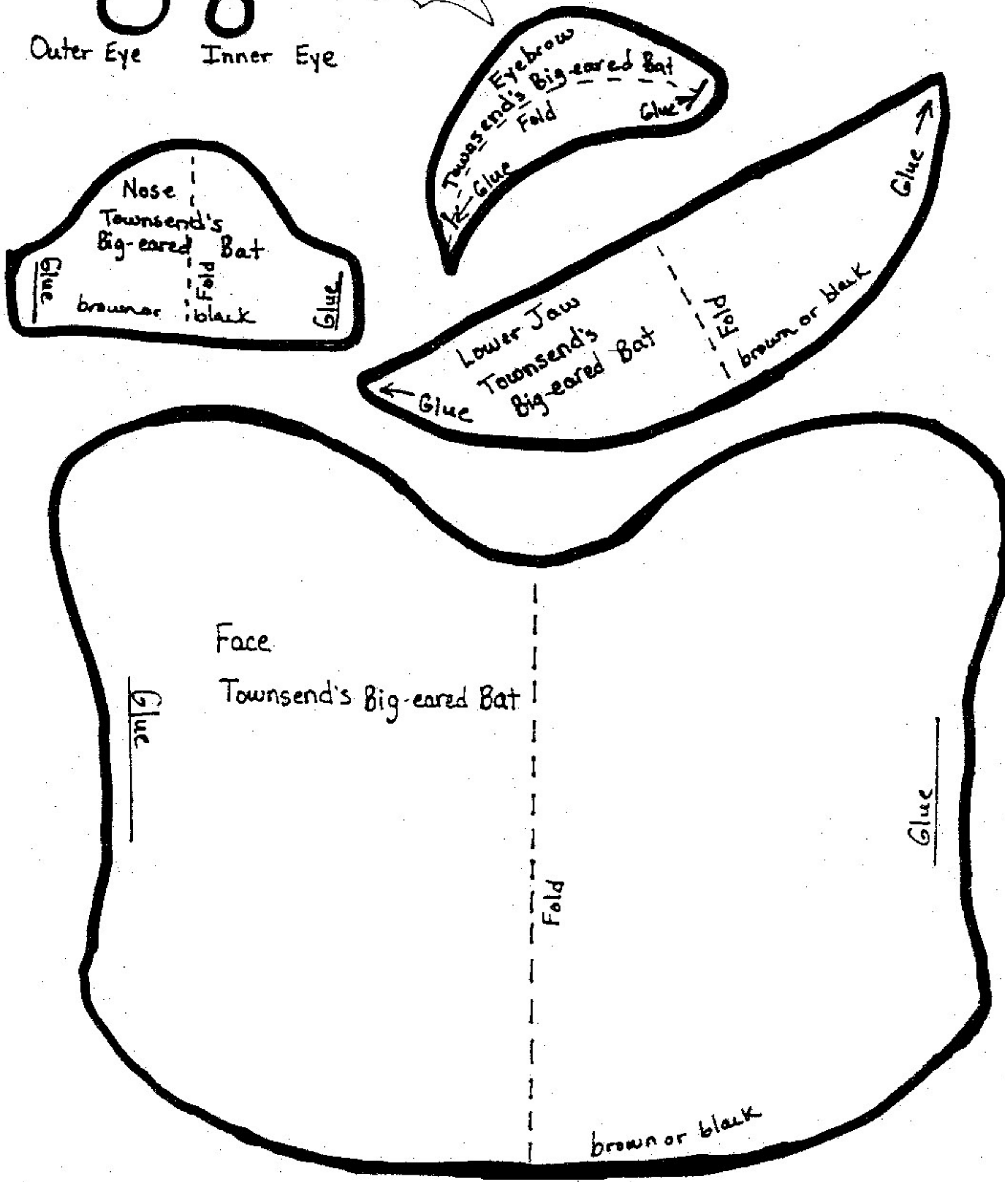
Southern Yellow Bat

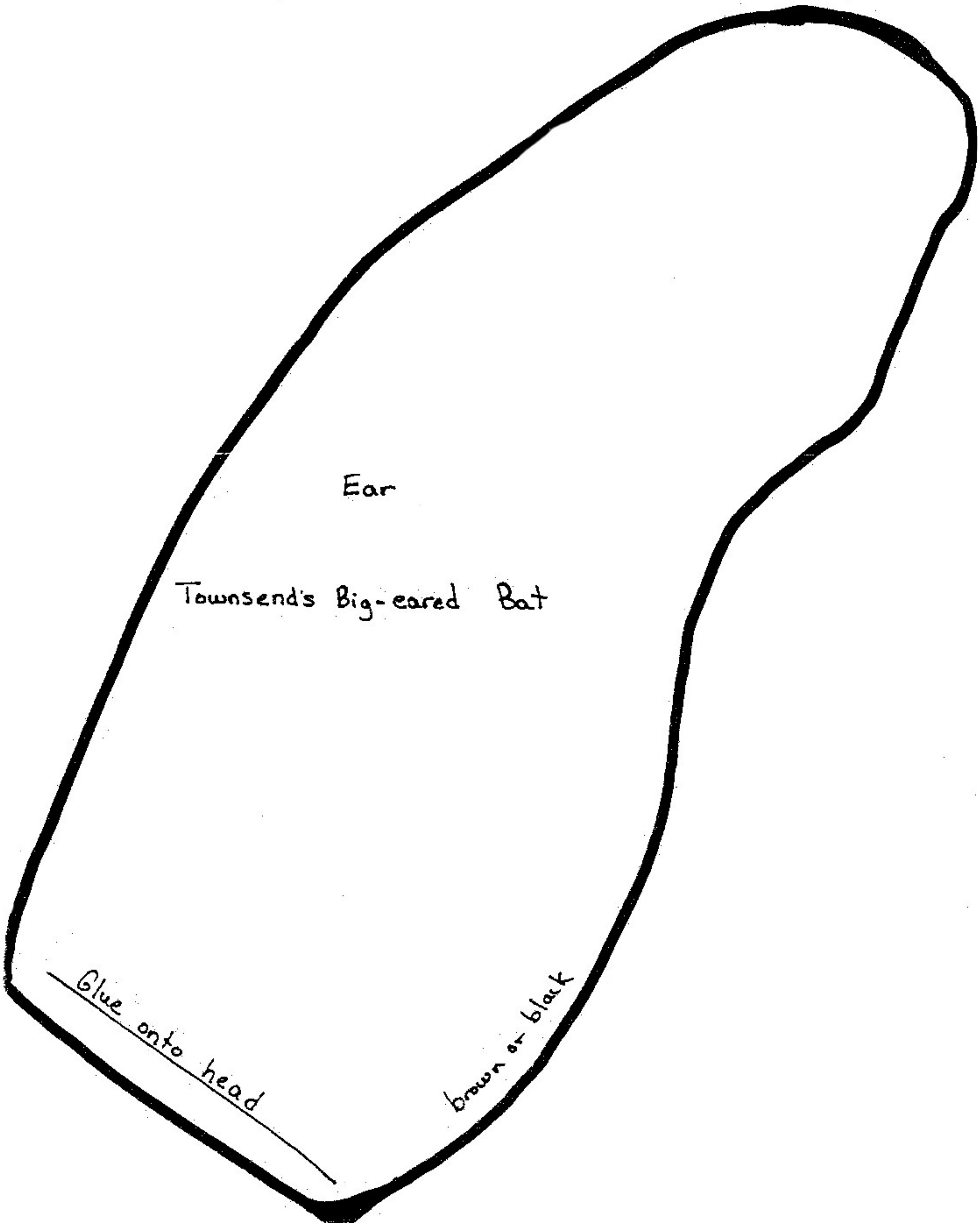


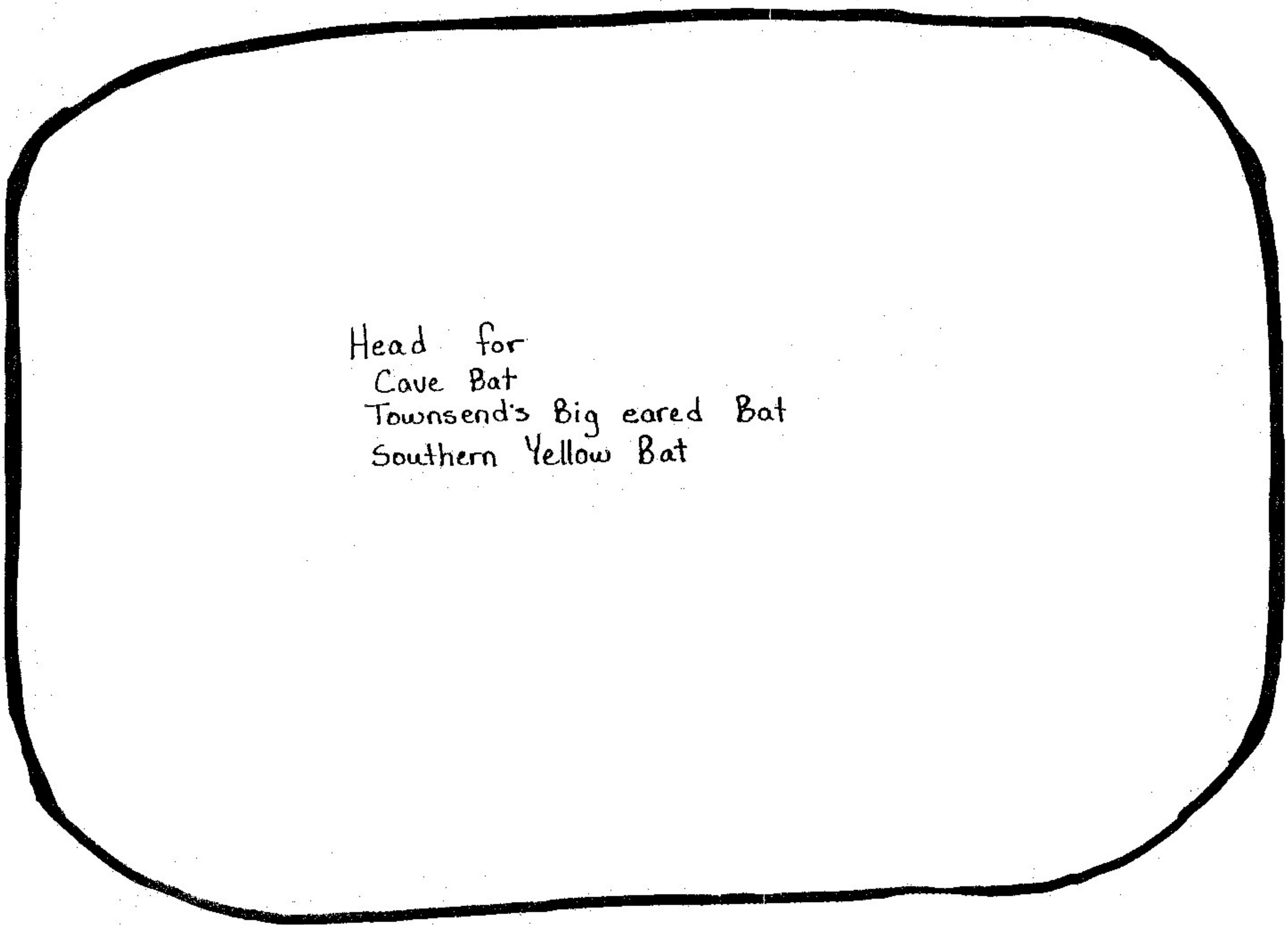
Townsend's Big-eared Bat



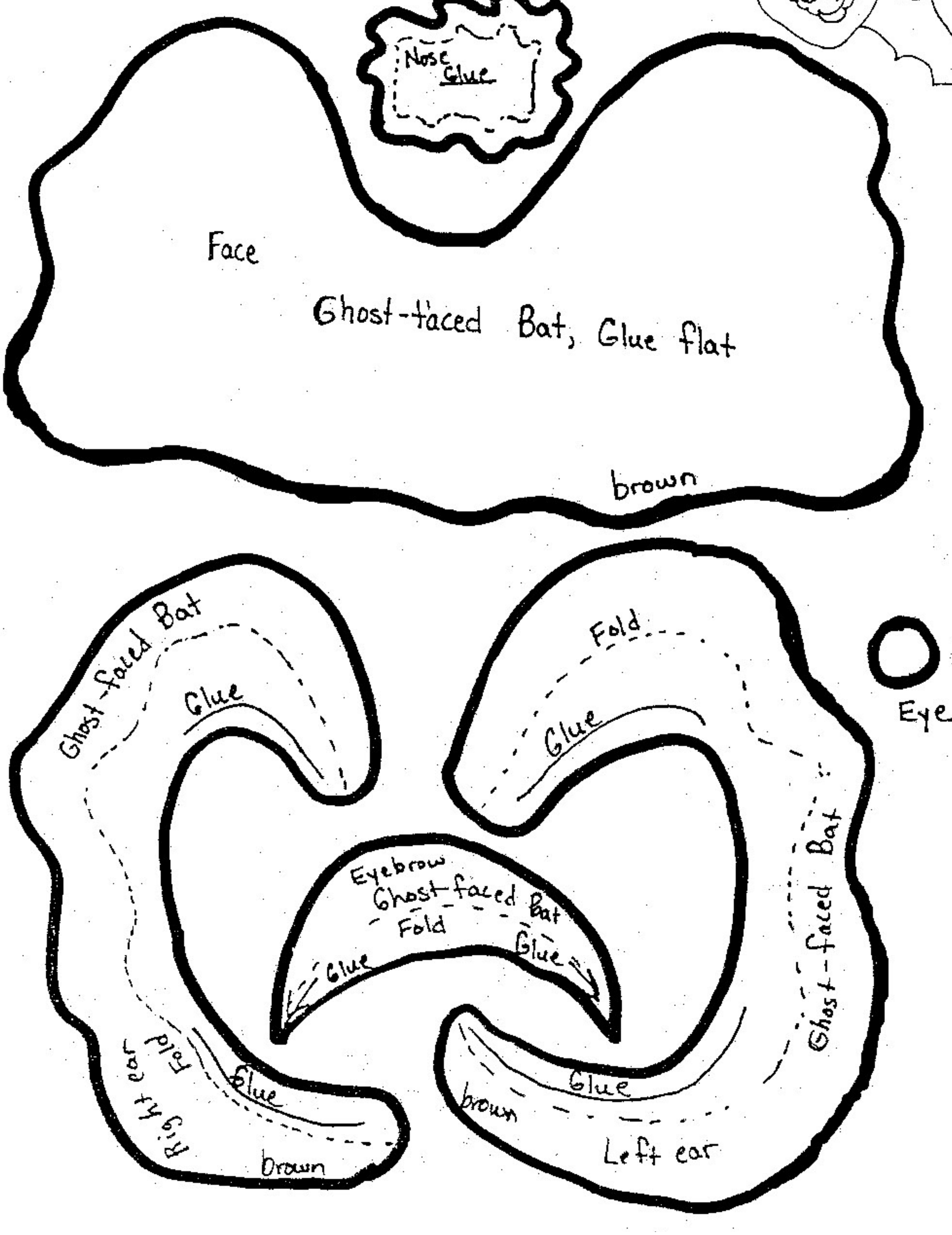
See following page for ear.

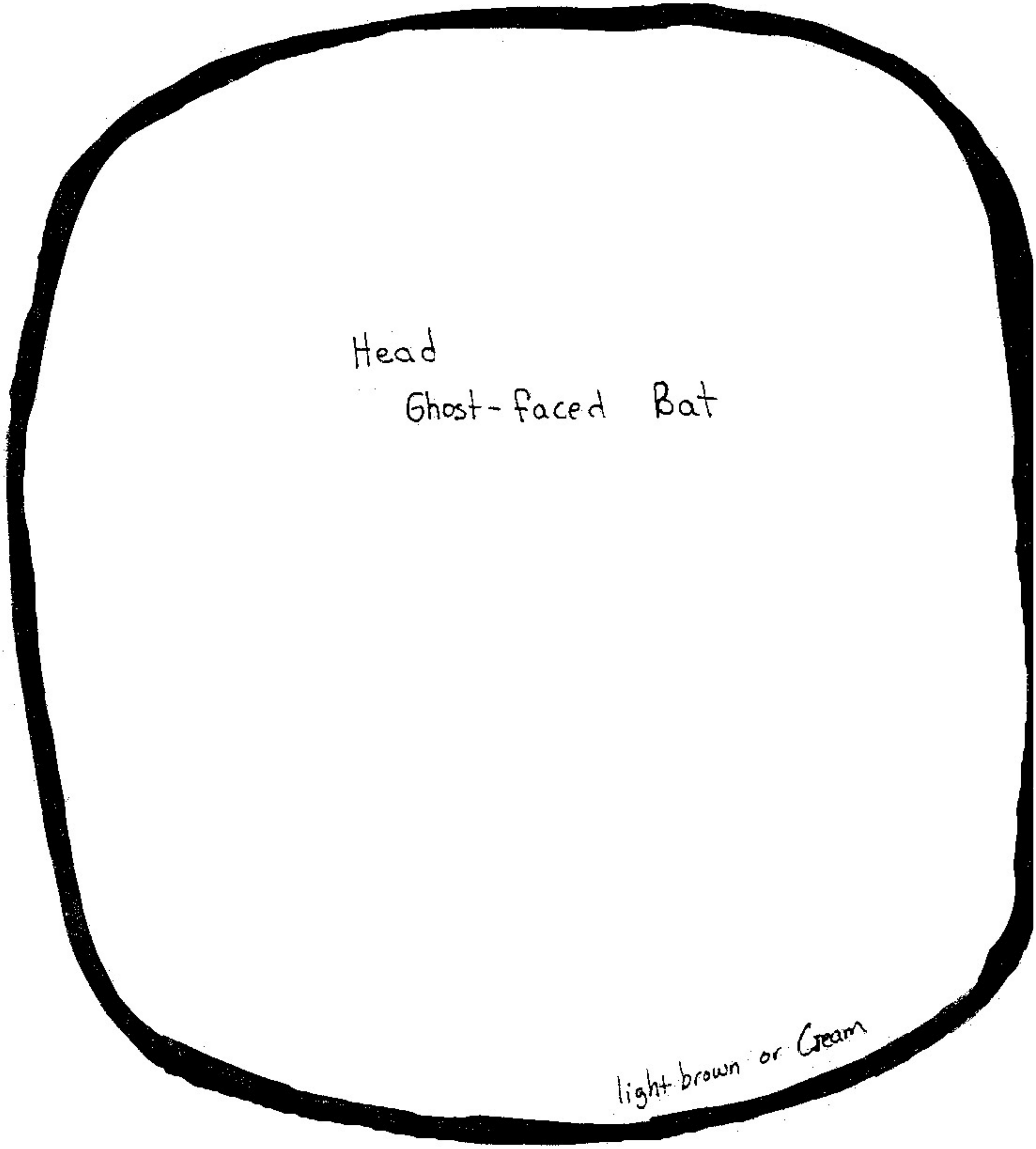



Ear
Townsend's Big-eared Bat
Glue onto head
brown or black

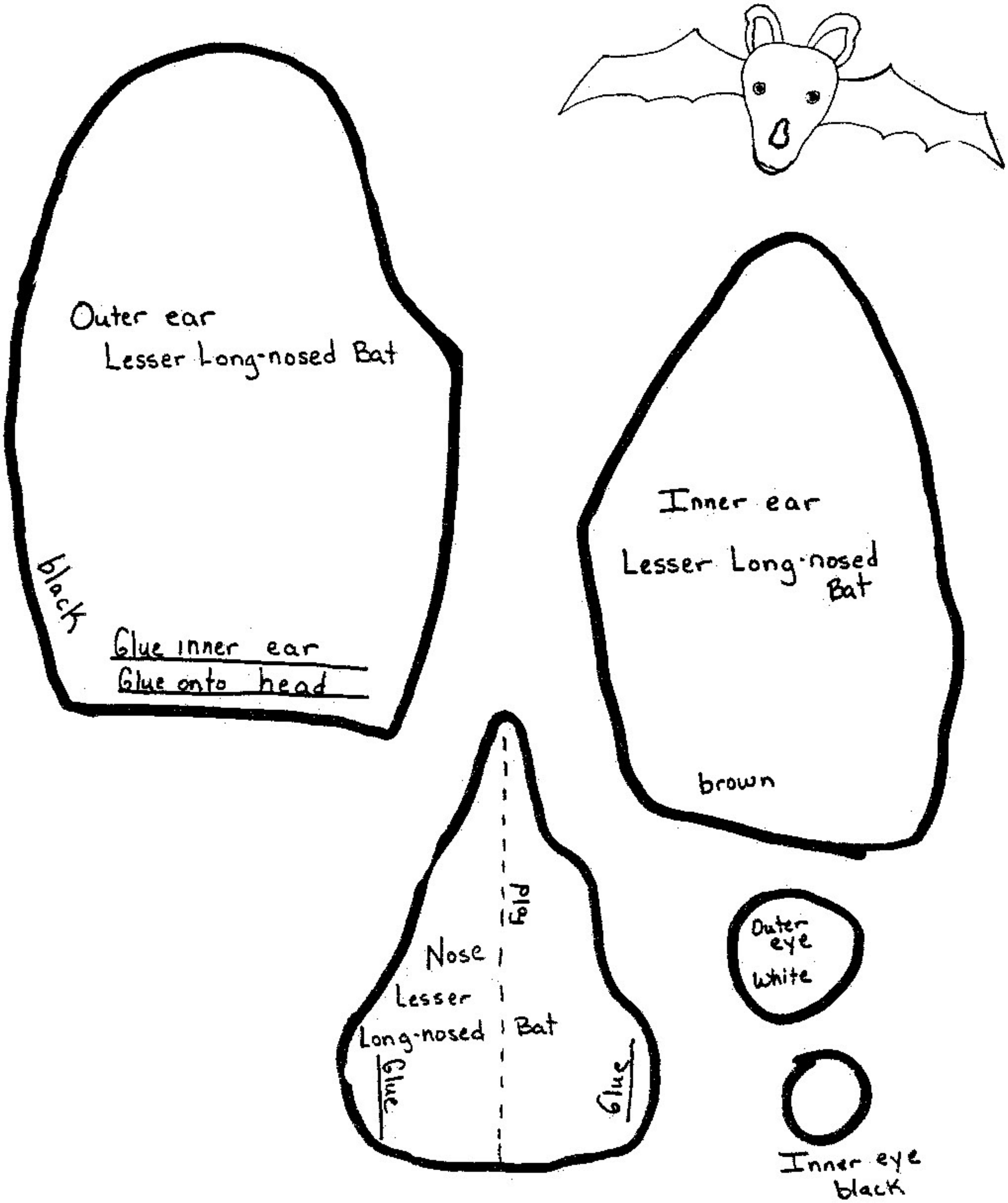

Head for
Cave Bat
Townsend's Big eared Bat
Southern Yellow Bat

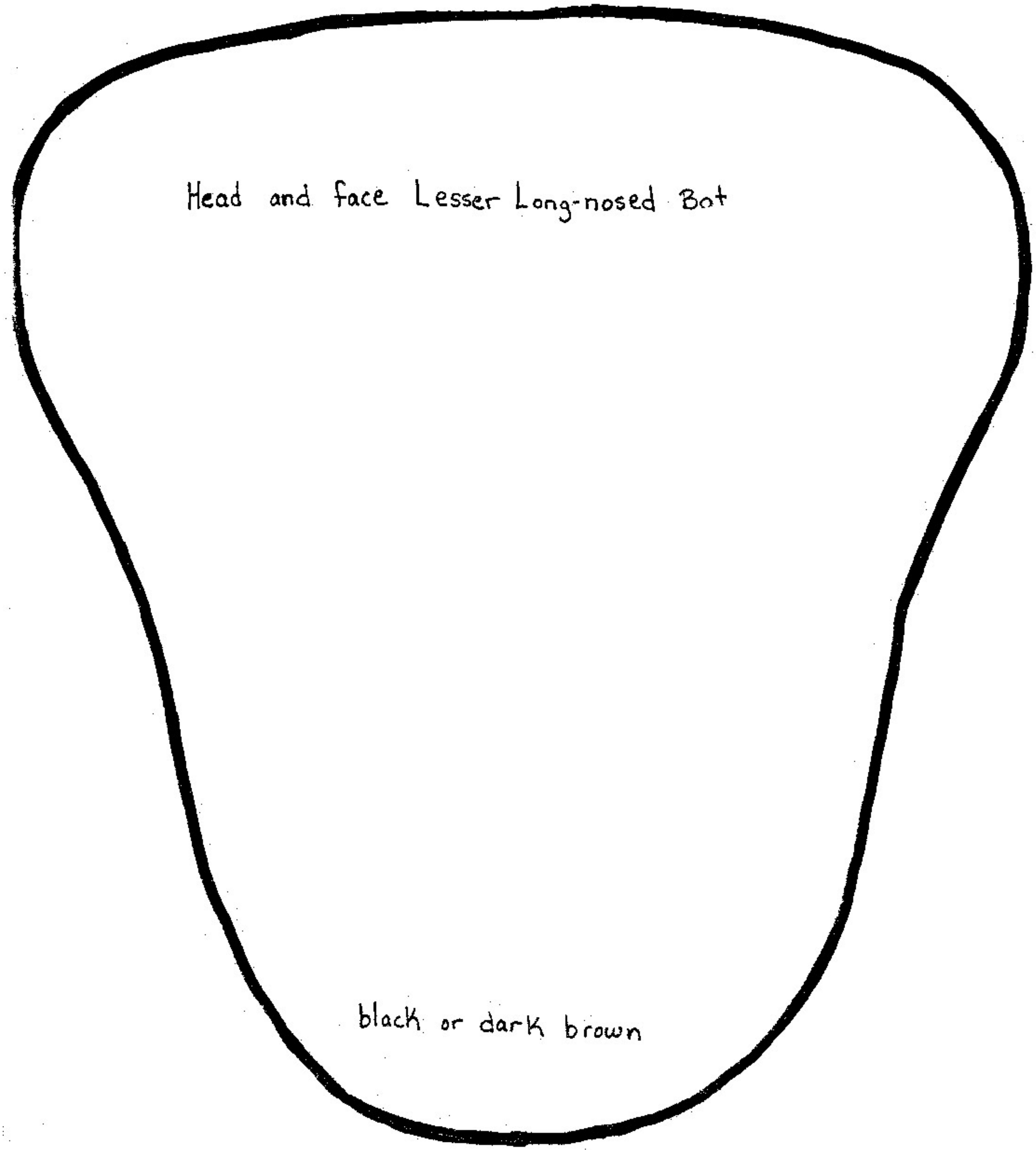
Ghost-faced Bat

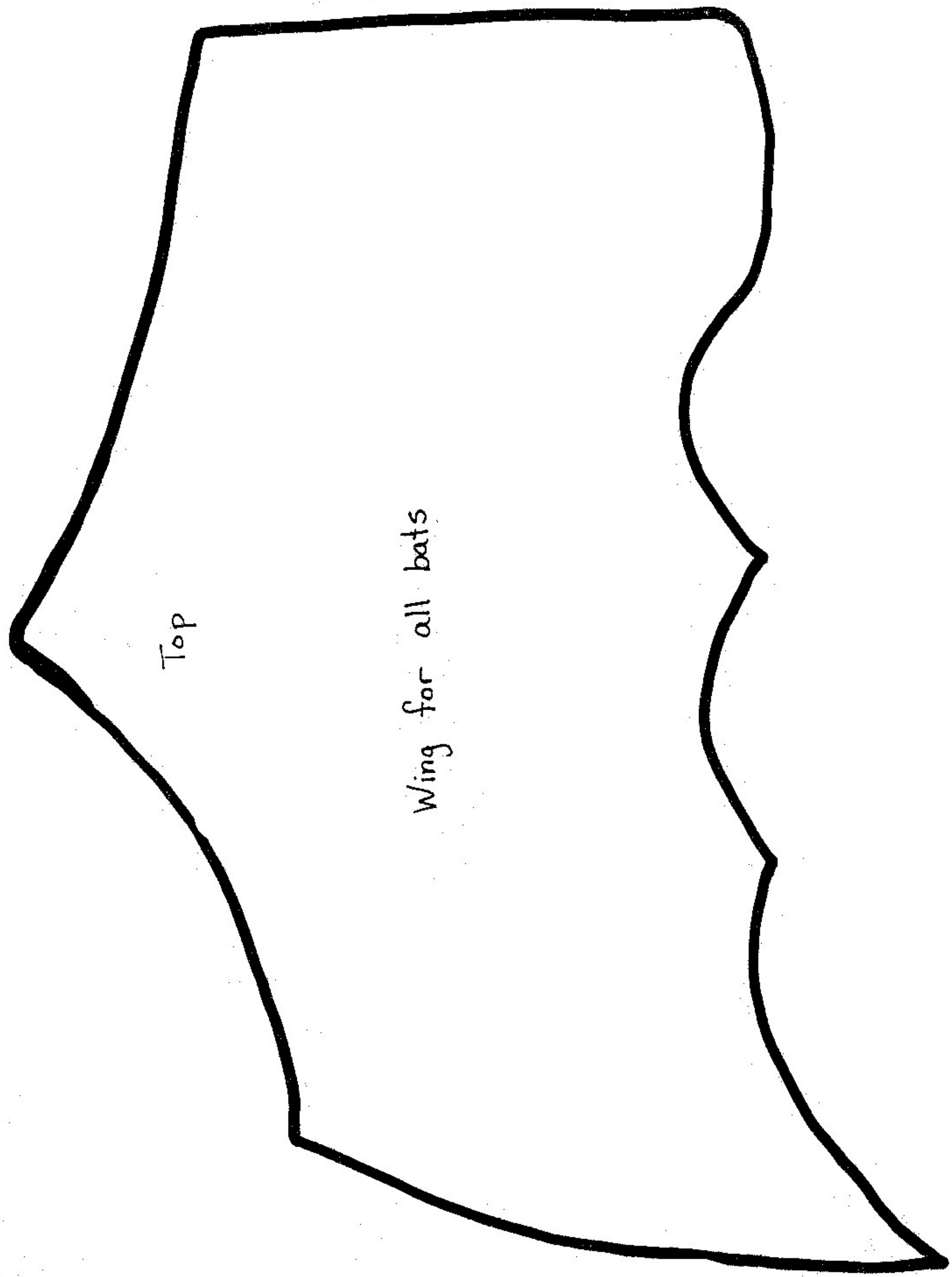



Head
Ghost-faced Bat
light brown or Cream

Lesser Long-nosed Bat




Head and face Lesser Long-nosed Bat
black or dark brown


Top
Wing for all bats

Ghost-faced bat

Mormoops megalophylla

MERLIN D. TUTTLE

Ghost-faced bats are very uncommon in Arizona. Since 1954 only two females have been collected, both in the Santa Rita Mountains on the Coronado National Forest. They were caught at 4,450 feet elevation in a mist net over a waterhole in a woodland riparian area consisting of mature cottonwood, sycamore, and willows. The nearest known colony is about 250 miles south of this Arizona netting location in Mexico. No specimens have been reported since, and nothing more is known about, its distribution in Arizona.

The species' total range extends from southern Arizona and southern Texas through Mexico, parts of Central America, and northern South America. The genus *Mormoops* prefers humid to arid and semi-arid regions, usually below 9,800 feet. Of the two species in the genus, the ghost-faced bat is the only one found in North America. The other species, the Antillean ghost-faced bat (*M. blainvillii*), is found only on some of the Caribbean Islands.

The ghost-faced bat is medium-sized (0.5 ounces), with long, loose fur that is brownish to reddish brown. It can be identified by the leaf-like folds of skin that extend from ear to ear across the chin and in front of the lower lip. In addition, the ears are connected across the forehead, forming a pocket below the eye. The end of the tail points upward from near the middle of the tail membrane. The average wingspread of this bat is 14.5 inches and the average body length is 2.5 to 3 inches. There is no other bat in the United States with these characteristics.

This bat is colonial and roosts during the day in caves and mines. Occasionally they roost in buildings and railroad tunnels. Buildings may also be used for night roosts. This species apparently does not migrate nor hibernate. They have been found in warm roosts during the winter in Texas and Mexico, indicating they remain active year-round.

Ghost-faced bats eat mainly insects that are captured in flight. They look for food high above the ground, and as a result, are rarely caught in mist nets. They are strong, fast fliers and apparently are unable to detect mist nets. Thus, when they are caught, they hit the net with great force.

The breeding period ranges from late winter to early spring. Each reproducing female gives birth to only one offspring in June. No ghost-faced bat nursery colonies have been discovered in the United States.

The ghost-faced bat is not federally listed under the Endangered Species Act, nor is it included on the Department's list of *Threatened Native Wildlife in Arizona*. Little is known about its historical or current range, if any, in Arizona. To manage this species effectively, studies of the distribution, habitat requirements, population dynamics, and life history are needed.

MERLIN D. TUTTLE

Family — ***Phyllostomidae***

Lesser long-nosed bat

Leptonycteris curasoae

Found well into Central America, the lesser long-nosed bat occurs in Arizona from the Picacho Mountains south and west to the Agua Dulces, and south and east to the Chiricahuas, and into Mexico. It also occurs in southwestern New Mexico and Baja California. Those that summer in the United States winter in Mexico, but they do not hibernate.

The long-nosed is one of Arizona's three leaf-nosed bats. It has large eyes, the family's distinctive leaf-like flap of skin at the base of a relatively long nose, small ears, no visible tail, and a greatly reduced interfemoral membrane. It is grayish to reddish-brown above, and brown below. Wingspan averages about 14 inches. Adults average 0.7 ounces. The average body length of this bat is 2.5 to 3 inches.

They usually arrive in Arizona in mid-April. Females are already pregnant, having mated while wintering in Mexico. They soon congregate into maternity colonies, some of which once numbered in the tens of thousands. Today, the known colonies are smaller, typically a few hundred individuals at most, or fewer. The young are born in May, and can fly by the end of June. Maternity colonies break up in mid-summer. Males form smaller, separate roosting colonies.

Like the Mexican long-tongued, the lesser long-nosed feeds primarily on flower nectar and pollen. In early summer, columnar cacti such as saguaros and organpipes are favorite foraging sites. Later, agaves are sought out. In either case, pollen that collects on the hovering bat's head and shoulders as it probes one flower is soon transferred to another. At flight speeds of up to 14 mph, a long-nosed can touch a lot of flowers each night. What pollen is not transferred to flowers is ingested when the bat grooms after feeding. Pollen streaks on a roost wall or floor indicate this species' presence.

In Arizona, from April through July, females are found mostly in areas with flowering saguaros and organpipe cactus at elevations below about 3500 feet. During July their range expands as some females and young, plus some late-arriving males, move up to about 5500 feet in areas of semidesert grassland and lower oak woodland where they forage on agave blossoms. They have all left for more southerly wintering grounds by late September or early October.

In 1988, the lesser long-nosed bat was federally listed under the Endangered Species Act. It is also on the Department's list of *Threatened Native Wildlife in Arizona*, as an endangered species. The U.S. Forest Service considers it a sensitive species. More recent information suggests population declines and threats may not be as great as was believed to be the case when federal listing occurred. Roost disturbance and possible effects of habitat loss such as over-harvest of agaves in Mexico contribute to continued concern for this bat.

Southern yellow bat

Lasiurus ega

MERLIN D. TUTTLE

The southern yellow bat occurs from Uruguay and Argentina in South America, north through Central America and Mexico, into the southwestern United States. In Arizona, it is primarily known from Phoenix and Tucson, but it is thought to occur year-round throughout southern Arizona. The average wingspread of this bat is 13 to 14 inches and the average body length is 2.5 to 3 inches.

Not much is known of the habitat needs of southern yellow bats, but they are usually found near thick vegetation, which they use for roosting. When found in urban areas, they are usually associated with palm trees. Ground crews trimming dead fronds from palm trees have been a major source of southern yellow bat specimens. In more natural settings, southern yellow bats are found in low- to mid-elevations in riparian areas which have thick, leafy vegetation.

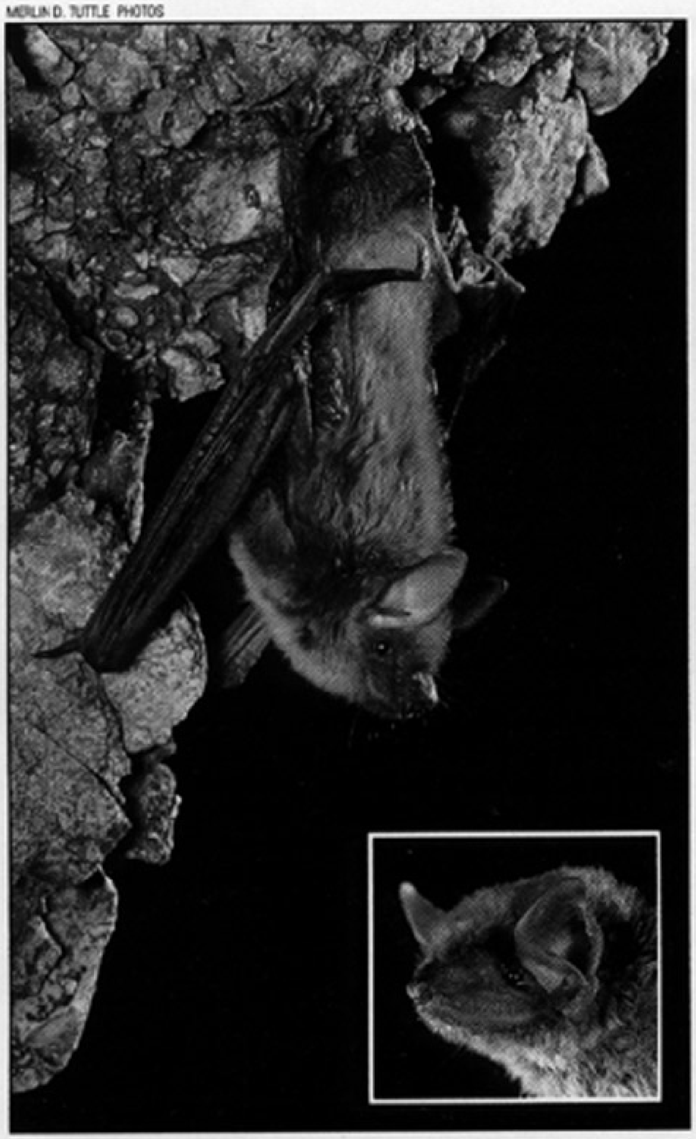
Very little is known about the feeding habits of southern yellow bats beyond the fact that they eat night-flying insects. They have been observed flying in straight lines with slow wing beats about 75 feet above the ground. They have been netted above water holes and swimming pools, but it is unclear whether they were foraging or drinking at the time.

Southern yellow bats give birth to one or two young in June. Like their relatives, the hoary and the red bat, yellow bats have two pairs of mammae instead of the single pair found in most bats. So far, there have been no pregnant or lactating female southern yellow bats captured in Arizona, although pregnant bats have been captured just over the New Mexico border, in Guadalupe Canyon.

The yellow bat has no status under the Endangered Species Act, but is included on the Department's list of *Threatened Native Wildlife in Arizona* as a candidate species. This means that threats to the species are known or suspected but substantial population declines have not been documented. Threats to the species in Arizona include the presumed low numbers occurring in the state.

As of 1992, only 18 yellow bats had been collected here. Other possible threats are difficult to assess, since little is known of the yellow bat's biology, but may include destruction of riparian forest and woodland habitat, trimming of urban palm trees, and vandalism (burning of native palm trees). However, some biologists suggest that since there are no records for the southern yellow bat prior to 1960, the bat is actually expanding its range into the United States from Mexico, aided by the wide use of ornamental palm trees in urban landscaping. Unfortunately, until more research is conducted on the distribution and biology of this species, there will be more questions than answers.

MERLIN D. TUTTLE PHOTOS



Family — *Vespertilionidae*

Southwestern cave myotis

Myotis velifer brevis

The southwestern cave myotis is one of nine Arizona bats that look very much alike. It is small and brown, with fairly small ears and no distinguishing characteristics except a sparsely furred spot between the shoulder blades. The average wingspread of this bat is 11 to 12 inches and the average body length is 2 to 2.5 inches. Its range includes the southwestern half of Arizona (except the extreme southwestern corner), and adjacent areas of California, Nevada, New Mexico, and Sonora, Mexico. During the winter, small numbers are found in southeastern Arizona.

This species roosts near water in caves, mines, barns, buildings, under bridges, and sometimes in abandoned swallow nests. They are usually located in desertscrub habitats which include creosote, brittlebush, paloverde, and cacti. Occasionally, roosts are found in pine-oak vegetation. The species is very colonial, apparently returning to the same roost every year.

Every evening, the bats fly a short distance from the roost and then return. As darkness increases, they fly a bit farther from the roost each time before returning. About 40 minutes after sunset, they finally leave the roost for the night and fly to water to drink. Afterwards, they forage just above the vegetation on such delicacies as moths, weevils, antlions, small beetles, and flying ants.

Mating occurs during the fall, but the young are not born until summer because of delayed fertilization. Males migrate north as early as March to form bachelor colonies of up to 100 individuals. The pregnant females arrive in May to form maternity colonies of 50 to 15,000 bats. A single young is born in late June to early July, after a 45- to 55-day gestation period. Although the babies remain in the roost while the females feed, they will carry their young to safety if disturbed. The young are able to fly and forage on their own in six to eight weeks. Studies indicate that adults may live up to six years, possibly up to 10 or 12 years.

During the summer and into the fall, southwestern cave myotis store fat to prepare for migration and hibernation. During hibernation, they lose 16 to 25 percent of their body weight. The hibernating roost must be cold and humid, preferably 46 to 52 degrees and above 55 percent relative humidity. The cold temperature lowers the bat's metabolism, thus requiring minimal energy for nourishment through the winter.

The southwestern cave myotis is listed by the U.S. Fish and Wildlife Service as a Notice of Review Category 2 species, which affords it special recognition, but no special protection. It is not included on the Department's list of *Threatened Native Wildlife in Arizona*.

Because it congregates in large groups, it is susceptible to human disturbance and encroachment. Further discovery of summer and hibernating colonies is essential, and careful management can likely prevent the need for listing this species as threatened or endangered.

Townsend's big-eared bat

Plecotus townsendii

MERLIN D. TUTTLE

Townsend's big-eared bat is a medium-sized bat with very large ears—as much as an inch long. It also has two large lumps on the surface of the nose. It is brown in color, varying from dark brown to nearly black in more humid areas, to pale brown in the more dry, desert areas of its range. The average wingspread of this bat is 11.5 to 12.5 inches and the average body length is 2 to 2.5 inches.

This species has a very broad distribution. It is found in western North America from Washington and Wyoming east to the Black Hills of South Dakota, southward to Texas, California, Arizona, and through the Mexican uplands in southern Mexico. Isolated populations also exist in the Ozark Mountains of Oklahoma, Missouri, Arkansas, Kentucky, Virginia, and West Virginia. It occupies a variety of habitats including deserts, woodland, and pine forests. In Arizona it is widespread, although not common anywhere. It is most uncommon in the northeastern grasslands and southwestern desert areas of Arizona.

Townsend's big-eared bats hang from open ceilings of mines and caves during the day. They do not use cracks or crevices, and may use open abandoned buildings as a night roost. In Arizona, they hibernate during the winter in cold caves, lava tubes, and mines mostly in uplands and mountains from the vicinity of the Grand Canyon to the southeastern part of the state, south of the Mogollon Rim.

These bats feed primarily on small moths. They have also been reported to take prey from vegetation while in flight. They forage in darkness, and are rarely seen at dusk. Following a late night peak of foraging activity, they usually rest in a night roost. They may also feed again shortly before dawn.

Mating occurs in October but delayed fertilization postpones the birth of one young until June. The females congregate in maternity colonies of 12 to several hundred individuals in the spring and summer, whereas the males tend to be more solitary. The young can fly at one month of age, but are not weaned until they are two months old.

Townsend's big-eared bat is not federally listed under the Endangered Species Act, nor is it on the Department's list of *Threatened Native Wildlife in Arizona*. However, populations in many states are known to be declining, most notably in Oregon, Washington, and some of the eastern isolated populations in Virginia and West Virginia. This bat is highly susceptible to disturbance. Cave exploring and other recreational activities by humans have caused nursing colonies of females to abandon the roost, leaving the young to starve. Surveys designed to locate and monitor maternity colonies in Arizona are needed.

HUMIDITY AND HYGROMETERS

Backgound Information:
Humidity is the amount of water vapor (moisture) in the air. Humidity is recorded inside Kartchner Caverns at 22 monitoring stations throughout the cave. Relative humidity is the moisture in the air relative to the amount of moisture that the air can hold. Relative humidity will change according to the temperature of the air. The moisture content of the air within Kartchner Caverns is a critical management issue. The rate at which water evaporates within the cave is very low. The rate of evaporation is largely determined by the relative humidity of the air. If the relative humidity changes from 99.5% to 99.0%, the evaporation rate will double! This means that very small changes in the relative humidity will have major impacts on the moist conditions in the cave. The relative humidity inside the cave presently ranges from 96.32% to 100% and averages 99.42%. Calculations indicate that the cave would dry out if the relative humidity is allowed to fall below 98.5%.

Summary:
The students make a hygrometer out of milk cartons. They look at the wet and dry bulb readings from the thermometers and determine the relative humidity by looking at the table on page 68. This activity may be whole class or a cooperative group activity.

Step by Step:
(note: there is a student handout of the instructions following this activity if you wish to use it.)

1. To ensure reliable temperature readings, check the two thermometers to make sure they give the same readings.
2. Cover the bulb of one the thermometers with a two-inch square scrap of cotton fabric. Tie it with thread or string, and leave a "tail" of the cotton fabric on one end; this will be in the water.
3. Using rubber bands, attach the thermometers to two sides of a milk carton.
4. Cut a small hole in the carton just below the thermometer with the covered bulb. Push the tail of cotton through the hole.
5. Fill the carton with water up to level of the hole so you can keep the cotton wet.
6. Read and record the dry bulb and wet bulb thermometers.
7. Check the readings of the two thermometers and see the humidity table to find the relative percentage of humidity. Example: If the dry bulb temperature is 75 (vertical axis), and the wet bulb temperature is 70, the difference is 5 degrees (horizontal axis),so the relative humidity is 78% (see the place where they intersect).
8. If this activity is conducted with cooperative groups, have the groups set up their hygrometers in different areas of the room or outside, and compare their results.
9. Water evaporating from the thermometer with the moist cloth uses heat. Therefore, the temperature drops. The water in the cloth around the wet-bulb thermometer will keep evaporating as long as the air can hold more water vapor. Dry air can take on more water vapor than air that is already filled with moisture.

The drier the air (lower the humidity), the further apart the two temperature readings will be.

Assessment:
Have the students look at the temperatures of the dry and wet bulb thermometers and tell what they notice. Have the students try to explain why this is happening.
What would happen to the humidity within Kartchner Caverns if a large hole was opened up to the outside air?
What would happen to the humidity within Kartchner Caverns if the temperature drops 10 degrees?
What would happen to the speleothems if there was less humidity?

SUBJECT: Underground Atmosphere

MATERIALS:
each group will need 2 room thermometers, small piece of cotton material, thread, a quart milk carton, rubber bands, scissors, relative humidity table (see next page of activity)

GRADE LEVEL:
4-6

TIME: 1 hour

OBJECTIVE:
Students will determine the relative humidity with a milk carton hygrometer.

CONCEPTS:
Relative humidity, temperature, and airflow create the microclimate of Kartchner Caverns.

CONCEPTS:
Caves provide habitat for permanent and visiting animal populations.

Meets Arizona Department of Education Academic Standards

Science:
1SC-E3, PO1
6SC-E6, PO1 & 2

HUMIDITY AND HYGROMETERS

MAKING HYGROMETERS

MATERIALS:
2 thermometers
2” square of cotton material, thread, quart milk carton, 2 rubber bands, scissors, relative humidity table

DIRECTIONS:

1) Check the two thermometers to make sure they have the same temperature reading.

2) Cover bulb of one thermometer with the cotton fabric. Tie it with thread and leave a fabric “tail.”

3) Use rubber bands to attach the thermometers to 2 different sides of the milk carton.

4) Cut a small hole in the carton just below the thermometer with the covered bulb. Push the fabric “tail” through the hole to the inside.

5) Fill the carton with water up to the level of the hole so the cotton fabric remains wet.

6) Place hygrometers in different locations around the school or classroom.

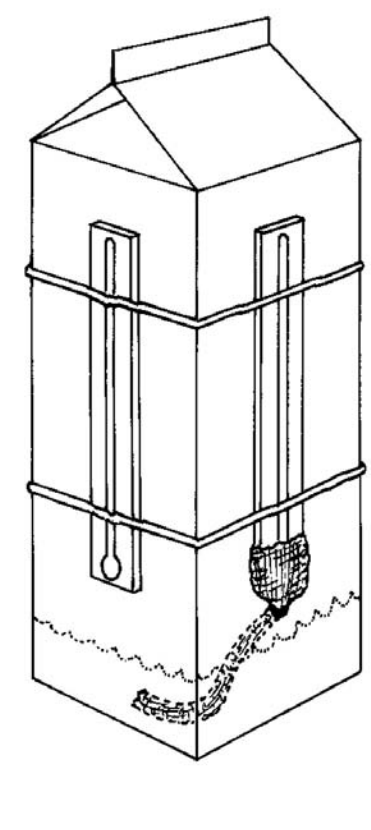
Relative Humidity Table

Difference between Dry-Bulb and Wet-Bulb temperatures

Dry-Bulb Temperatures (˚F)

	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24
10	78	56	34	13														
15	82	64	46	29	11													
20	85	70	55	42	26	12												
25	87	74	62	49	37	25	13											
30	89	78	67	56	46	36	26	16	6									
35	91	81	72	63	54	45	36	27	19	10	2							
40	92	83	75	68	60	52	45	37	29	22	15	7						
45	93	86	78	71	64	57	51	44	38	31	25	18	6					
50	93	87	80	74	67	61	55	49	43	38	32	27	16	5				
55	94	88	82	76	70	65	59	54	49	43	38	33	23	14	5			
60	94	89	83	78	73	68	63	58	53	48	43	39	30	21	13	5		
65	95	90	85	80	75	70	66	61	56	52	48	44	35	27	20	12	5	
70	95	90	86	81	77	72	68	64	59	55	51	48	40	33	25	19	12	6
75	96	91	86	82	78	74	70	66	62	58	54	51	44	37	30	24	18	12
80	96	91	87	83	79	75	72	68	64	61	57	54	47	41	35	29	23	18
90	96	92	89	85	81	78	74	71	66	65	61	58	52	47	41	36	31	26
100	96	93	89	86	83	80	77	73	70	68	65	62	56	51	46	41	37	33

Example: If the dry bulb temperature is 65 (see numbers at left), and the wet bulb temperature is 62, the difference is 3 degrees (seenumbers at the top of the chart), and so the relative humidity is 85% (see the place where they intersect).



MINERALS AND MANNERS

Background Information:
After the water table drops and the passageways are formed within a cave the formations or speleothems begin to form. Water seeps through cracks in the limestone and dissolves a mineral within the rock called calcite. If the water encounters an air-filled, it will leave a thin layer of calcite clinging to the rock. Over thousands of years, the layers of calcite build up. This is the reverse process by which limestone is dissolved to produce caves. Speleothems consist mainly of calcite, the same mineral that makes up limestone.

Summary:
(Cooperative groups) This activity will let the students see how speleothem formation can be simulated. They are to follow directions carefully and write down everything they observe during the next five days. After the five days the students will share their experiment with the class and report their findings.

Step by Step:
1. Put students into groups of three. Have the students organize themselves to have a recorder/timer, materials person, and a spokesperson.
2. Prepare boxes or trays with the ingredients for experiment. Make sure there is room to set aside each of the group's experiments for several days.
3. Explain that speleothems are cave formations. Speleothems differ in shape and colors. The most common speleothems are stalactites, which hang from the ceiling, and the ones that grow from the floor are stalagmites. Speleothems are formed when water carrying tiny bits of dissolved rock enter an air-filled space in a cave. When the water evaporates, the dissolved rock begins to solidify. The speleothems in Kartchner Caverns are beautiful because the cave has remained untouched for thousands of years allowing the formations to grow successfully. The rich colors blended with the speleothems are created by different minerals that have mixed with the calcite solution.
4. Have each group of students place a shoe-box lid, open side up, on the table and to set a cup inside each end of the lid.
5. Instruct them to fill the cups with hot water, adding baking soda a little at a time until there is slightly more than will dissolve in the water.
6. Have them add some food coloring to the water and stir.
7. Soak string in water for a few minutes before attaching to nails. Each group will need to tie each end of the length of string to a nail. Show how to drop one nail into each cup so that the strings are suspended between the cups, hanging at least two inches below the rims of the cups.
8. On their group record sheet, have the recorder write down exactly what the group did to prepare their experiment. Set aside experiments until the next day.
9. Over the next week, have the students observe their experiment and write down any changes they see. Within one or two days the strings will become saturated and water will begin to drip onto the box lid. As the water evaporates, the baking soda will become solid, hanging from the strings like stalactites and building up on the lids like stalagmites. Allow the formations to grow for a full week.

ASSESSMENT:
After a week, have each group show their experiments and tell what they observed. Have the students notice any difference between group experiments. What made the differences?

SUBJECT: Cave Features

MATERIALS: hot water, clear plastic cups, baking soda, food coloring, shoe box lids, stirring spoons, long nails, magnifying glasses, cotton string, copies of record sheet

GRADE LEVELS: 4-6

TIME: 3 to 5 days with 45 minutes the first day and 10 minutes each subsequent day.

OBJECTIVES: Students will be able to explain the growth of stalactites, stalagmites, columns and other speleothems found in Kartchner Caverns.

CONCEPTS: Cave minerals and the manner in which they are deposited determines the speleothem's shape and colors.

CONCEPTS: Caves provide habitat for permanent and visiting animal populations.

Meets Arizona Department of Education Academic Standards

Language Arts: W-E1, PO1-5 Standard 3 Essentials

MINERALS AND MANNERS
Record Sheet

Group Names ____

Observations

Day 1 ____

____

Day 2 ____

____

Day 3 ____

____

Day 4 ____

____

Day 5 ____

____

Summary

____

____

____

____

____

DOES IT DISSOLVE?

Background Information:
Limestone is the most common cave-forming rock, composed of a mineral called calcite. When carbonic acid in water comes in contact with calcite, the calcite begins to dissolve. A similar and faster chemical reaction occurs with a stronger acid, such as hydrochloric acid. Cold, dilute hydrochloric acid will produce a bubbling reaction upon contact when calcite is present in any object.

Summary:
This activity should be done as a teacher demonstration. Have the students observe and write comments on their observation sheet.

Step by Step:
Acid will burn skin and clothing, eyes and nose!

1. Mix a solution of HCl and water in a ratio of 10 to 1 (10 parts water to 1 part HCl). If using lemon juice or vinegar, use as is.
2. Have the students rub rocks together to create a "new" surface, This will increase the possibility of a reaction when the HCl is dropped on the rock. Using the dropper, place one drop of hydrochloric acid on each rock sample.
3. Have the students observe what happens and record observations in proper column (acid reaction or no reaction).
4. Wipe acid drops off samples with paper towels. Be careful not to get acid on your hands.
5. Test a seashell with the acid. Have the students observe and record observations.

Assessment:
Let the students discuss conclusions and complete questions on worksheet.

SUBJECT: Cave Origins

MATERIALS: copy of record sheet for each student, pencil, safety glasses or goggles, hydrochloric acid, jar or beaker, dropper, rock samples of limestone, granite, sandstone, seashells, and paper towels (May use lemon juice or vinegar, as a less harmful acid, with crushed or powered rocks and shells.)

GRADE LEVELS: 4-6

TIME: 30 minutes

OBJECTIVES: Students will observe the trial and error method to test which rock/shell samples react with hydrochloric acid

CONCEPTS: The dissolution of limestone creates tunnels or passages as a cave is formed.

Meets Arizona Department of Education Academic Standards

Science:
1SC-E1, PO3 & 4
5SC-E1, PO1 & 2

DOES IT DISSOLVE?
RECORD SHEET

	ROCK SAMPLES	ACID REACTION	NO REACTION
A.	______________	______________	______________
B.	______________	______________	______________
C.	______________	______________	______________
	seashell	______________	______________

Read the information below and answer the questions.

Limestone is composed of the mineral calcite. Limestone was formed in ancient seas millions of years ago by sea animals and plants that extracted calcium carbonate from the sea water. Pieces of the animal skeletons and plants fell to the bottom of the sea and were later pressed down and cemented into firm rock. Limestone caves are formed when acid attacks this calcite.

1. Which rocks samples had a reaction to the acid:

2. Which rocks samples did not react to the acid:

3. What did the rock samples that reacted to the acid have in common?

4. Kartchner Caverns is a limestone cave. What does that tell us about the history of the land in which the cave is located?

JUST IN TIME

(Adapted with permission of the National Wildlife Federation from the **"Digging into Dinosaurs"** issue of Nature Scope.)

Background Information: Kartchner Caverns was not formed "yesterday"! The area in which Arizona is located was once covered by an ancient sea, not just once but several times. Because these seas had calcium carbonate life forms that died and were pressed together by heat and pressure, limestone was created. The limestone found in Kartchner Caverns has been identified as Mississippian Escabrosa Limestone. This activity will help to show students that the cave took a long time to form and that "a long time" is relative in geological terms; in spite of the age of the cave, it is relatively short-lived in terms of geological time.

Summary: Students will plot specific events on a timeline and/or draw a picture of their particular event. This activity may be conducted as an outdoor or indoor activity. If 240 yards is too large for the area you have available, you might want to change the scale. On the following page the measurements for each event are given for indoor or outdoor use.

Step by Step: The scale for the outdoor timeline is 1/2 inch for every 250,000 years. If this is too large, use the smaller indoor scale shown in the first column of the list or make up your own scale to fit the space that is available.

OUTDOORS:

1. Assign each student an event from the list. Have each student research his/her event and write interesting information about the event to share. (Add more events if needed.)
2. Find a space about 240 yards long (about 2 1/2 football fields). You will probably need to tie together several ropes to equal 240 yards. To make the distance manageable, you can mark off the rope in 10' increments. Alternately, the teacher can premark all the event locations on the string and simply have the students find their place. (If rope is not available sidewalk chalk around the school perimeter may work.)
3. Explain that one yard is about one large walking step.
4. Beginning as a whole group have the student with 'Earth begins' take his/her place at one end of the rope. Have that student mark his/her place on the line, tell the year and give a brief explanation of the event. Move the whole group to the next event and repeat this procedure down the rope until present day.
5. When the timeline has been discussed completely have the students return to their event on the timeline so that they will see the expanse of time that has elapsed.

INDOORS:

This activity can be performed indoors using the length scale in the left column. Make the timeline by plotting the events on a long strip of adding machine paper. Explain that the length of the tape equals the age of the earth. Assign an event to each child and have them draw pictures of their event. Tape the timeline and pictures to the wall.

Assessment: After returning to the classroom, have the students discuss where each event took place in relation to the others. Have the students make a timeline similar to the indoor activity.

SUBJECT: Cave Origins

MATERIALS: Outdoor materials-yardstick, masking tape, rope to equal 240 yards, research materials, events copied and cut to give to individuals. Indoor materials-ruler, adding machine tape, colored pencils or markers, drawing paper, events copied and cut to give to individuals, tape.

GRADE LEVEL: 4-6

TIME: two sessions of 45 minutes

OBJECTIVES: Students will demonstrate the age of the cave and its formations in relation to other events of significance locally and globally.

CONCEPT: Caves are relatively short-lived when compared to other geologic events.

Meets Arizona Department of Education Academic Standards

Language Arts:
R-E2, PO1-5
W-E1, PO1-5
W-E4, PO1-3
W-E5, PO1-3
W-E8, PO1

Science:
6SC-E4, PO, 1 & 2

JUST IN TIME

(Indoor) Length from Present	(Outdoor) Length from Present	Years ago	Event
38 feet	254 yards	4,57 billion	Earth begins
29 feet	194 yards	3.5 billion	Life on earth begins
25 feet	167 yards	3 billion	First fossils form; algae, fungi, and bacteria are abundant
4.5 feet	31 yards	550 million	Jellyfish, sponges, and worms are abundant
3.75 feet	25 yards	450 million	First primitive fish
33 inches	18 yards	340 millions	Crinoids deposited
31 inches	17 yards	310 million	First reptiles
30 inches	17 yards	300 million	Deposit of Escabrosa Limestone
24.5 inches	24 yards	245 million	Age of Dinosaurs begins
7 inches	4 yards	70 million	Birds develop
6 inches	11 feet	65 million	Dinosaurs extinct; Age of Mammals begins
4 inches	7 feet	40 million	First elephants
3.5 inches	6.5 feet	38 million	Saber-toothed tiger evolves
3 inches	6 feet	30 million	Evolution of horse
1 inch	2 foot	10 million	Faulting and lifting of Whetstone and Empire Mountains
.6 inch	1 foot	6 million	Canyon cutting begins in western Grand Canyon
.5 inch	10 inches	5 million	First humans
.15 inch	3 inches	1.5 million	Beginning of Pleistocene and Ice Ages
.07 inch	1.5 inches	200, 000	Cave passages dissolve along the level of the water table within Kartchner Caverns
.01 inch	.24 inch	120,000	Major speleothem growth occurs during interglacial period
.008 inch	.16 inch	80,000	Shasta Ground Sloth dies
.005 inch	.1 inch	50,000	Bat guano deposits
.003 inch	.06 inch	30,000	Speleogrowth slows during the last glacial period to present
.0016 inch	.03 inch	16,000	World's longest soda straw begins forming
.0011inch	.02	11,000	Charcoal from human fire at Lehner Mammoth Kill Site
.001 inch	.02	10,000	End of the most recent Ice Age
.00002 inch	.0004 inch	213	Declaration of Independence signed in 1776
.00001 inch	.0002 inch	110	Earthquake in San Pedro Valley
.000003 inch	.00006 inch	30	Randy Tufts finds sinkhole but does not enter
.0000025 inch	.00005 inch	25	Randy Tufts and Gary Tenen find what is now **Kartchner Caverns!**

CAVE CONSCIOUS

Background Information:
Gary Tenen and Randy Tufts kept Kartchner Caverns a secret for 14 years; from its discovery in 1974 to its designation as an Arizona State Park in 1988. The discovers knew that the cave was both unique and fragile. Like all caves, it was subject to permanent damage through unregulated visitation and intentional vandalism. This had been the unfortunate history of many southwestern caves that were unprotected. In addition, with the opening of nearby Arizona Highway 90, the cave was very accessible. Tenen and Tufts along with the Kartchner family decided that development of the cave as a park would provide the necessary protection. If the cave became public property and was protected by Arizona State Parks, it would be managed in the best possible way to preserve it and avoid vandalism. The process of arranging that status took fourteen years.

Summary:
The students read "Situation Cards" which could have been or could become problems for the life of Kartchner Caverns. They then discuss the situations in detail and develop a skit which portrays the group's solution to the situation.

Step by Step:
1. The teacher should copy and cut out the situation cards.
2. Divide the class into groups of three or four, and give each group a card.
3. The students read through the situation card and decide which solution they would like to support or they may develop their own solution. (15 minute time limit suggested)
4. Students need to explore both the benefits and drawbacks of each solution.
5. Each group will present a short skit to the rest of the class. All of the group members need to be involved.

Assessment:
When a group is finished with their skit have them share the solutions they did not choose and discuss why they did not choose these particular solution.

SUBJECT: Stewardship

MATERIALS: copy of situation cards, one per group of 3 to 4 students

GRADE LEVELS: 5-6

TIME: 45 minutes

OBJECTIVES: Students will be able to identify actions which are harmful to caves, discuss why these actions are so destructive, and recommend alternatives that promote stewardship of Kartchner Caverns.

CONCEPTS: Kartchner Caverns is a non-renewable natural resource that is being protected by Arizona State Parks. Individual and community lifestyle decisions have an impact upon the cave's well being.

Meets Arizona Department of Education Academic Standards

Language Arts:
R-E2, PO1-5

Science:
2SC-E1, PO1 & 2
2SC-E4, PO1
3SC-E3, PO1-3
3SC-E4, PO1 & 2

CAVE CONSCIOUS SITUATION CARDS

1. You and a friend have found a sink hole which leads into a dark crevice. You decide to explore the hole and find yourselves in a big room with beautiful formations. You look around carefully and notice there are no other footprints, no trash, no writing or painting on the walls, no broken stalagmites or stalactites. This cave has probably never been explored by humans.

Would you:

- Tell the authorities about the cave, for examples the local sheriff or Forest Service or the caving club.
- Cover it up and never go back.
- Put a gate on the cave.
- Keep it a secret and hope nobody else finds it.
- Break off some speleothems. Return to the cave often to collect formations.
- Tell your friends about the cave and bring some of them to see it.
- Keep quiet about the cave and explore it with your friend.
- Decide to find a way to protect it permanently even if it means lots and lots of work for a long time
- Come to the cave as often as you can even after you have explored it.

OR?

2. You are a hard working person who owns some good ranching land. You have used your land wisely and are comfortable with your success. You receive a phone call from some strangers who say they want to show you something they found on your land. The strangers come to your house and show you slides of an amazing cave full of beautiful formations. You are excited about this discovery.

Would you:

- Mine the cave for its formations and sell them.
- Decide to help the strangers find a way to protect the cave.
- Agree to sell the cave to the government so it can create a park.
- Tell your friends and bring them to the cave.
- Cover the cave up to wait until you decide what to do about it.
- Close off your property to hunters, including some of your friends.
- Prosecute the strangers for trespassing.

OR?

3. You are the director of an agency that has been given the opportunity to develop a natural resource of a living cave. There are over 2 miles of trails in the cave which could be opened for public viewing. The cave is a living wet cave with beautiful and unique speleothems.

Would you:
- Open all of the rooms to the public. Widen the small entry ways so visitors can crawl easily.
- Open the most easily accessible rooms that have spectacular formations with tunnels leading from room to room. Have air locked doors to prevent loss of moisture. Make handicap accessible trails.
- Have wide tunnels opening up to the outside to let fresh air in and the damp musty air out.
  OR?

4. You are a spelunker and you are in a new cave. You come upon a roosting bat population on the ceiling. You notice some very small bats with no hair. This is a nursery colony.

Would you:
- Leave quickly and quietly the way you came.
- Proceed further into the cave only shining the lights on the bats to see how many bats are in the area.
- Try to capture a few bats to see what species is occupying the cave.
- Make a lot of noise and flap your arms to get all of the bats to leave.
  OR?

5. The demand for cave tours is greater than expected. Right now, each visitor goes with a group that is supervised and led by a ranger. If the visitors go by themselves, lots more people could take the tour, Arizona State Parks would make more money from cave tours and more people would have an opportunity to see the cave.

Would you:
- Keep the policy the same...ranger guided tours only.
- Make each tour group led by a ranger twice as big as planned.
- Have rangers inside to guard the cave, but let visitors walk themselves through the cave.
- Let everybody go through the cave without ranger supervision.
  OR?

6. Parts of the cave are closed during certain times of year so the bats can raise their young undisturbed. People are upset because they have traveled a long way to see the WHOLE cave.

Would You:
- Move the bats out. They are making a mess inside the cave, anyway.
- Allow the visitors to see the bats, but tell them to be quiet as they go past.
- Let some visitors go away disappointed.
- Put up a plexiglass wall between the visitors and the bats.
  OR?

7. People get thirsty and hungry during the tour. It would be convenient for them to have vending machines in the cave or tunnels leading into the cave.

Would you:
- Put a small restaurant inside the cave. It would be a great experience to have lunch in Kartchner Caverns.
- Put vending machines inside the cave but be sure to have lots of trash cans available.
- Put vending machines only in the entrance tunnels so people don't throw litter inside the cave.
- Don't allow food or drinks near the cave. People will just have to wait until they get back to the Discovery Center.
  OR?

GLOSSARY

Adaptation- An often hereditary alteration or adjustment by which a species or individual improves its condition in relation to its environment.

Calcite- The by-product of carbonic acid and limestone. The predominant mineral of which speleothems are formed. Calcite is colorless to white in color. Most cave speleothems appear brown-red because of impurities (sand, clay, iron-oxide or other minerals) within the calcite.

Calcium Carbonate- Mineral formed by a combination of saltwater and fresh water.

Carbonic Acid- A weak acid created when water mixes with carbon dioxide in the soil. This acid may dissolve calcite and redeposit it in the form of a speleothem.

Cave- An underground hollow, usually with an entrance in a hill or cliff.

Cavern- Commonly defined as a large cave, although the terms are interchangeable.

Column- A speleothem that is formed by the joining of stalactite and stalagmite, or when a stalactite connects with the cave floor or a stalagmite connects with the cave ceiling.

Dissolution- A process of breaking up into parts, dissolving.

Echolocation- A navigating system in which bats emit sounds that strike objects and return as echoes. The bats can determine what the object is, where it's located and how fast it's moving.

Environment- The total of all of the surroundings-air, water, vegetation, humans, wildlife—that has influence on an organism, including physical, biological, and all other factors; the surroundings of plant and animals, climate and location.

Evaporation- The process of converting a solid or liquid into a vapor gas.

Fault- A fracture or break in a series of rocks along which there has been vertical or lateral movement or both as a result of excessive strain.

Flowstone- Looks like a rock "waterfall" formed when water flow down walls over floors and older speleothems over a period of time, building up sheets of calcite.

Formations- Common term for cave features such as stalactites and stalagmites formed by minerals being deposited in a cave. Sometimes called 'decorations,' but properly termed as 'speleothem.'

Fossil- Any hardened remains or traces of plant or animal life of some previous time period, preserved in rock formations in the earth's crust.

Fracture- In geology, a clean break in stratum brought about by deformation under strain of compression or tension.

Guano- The waste and excrement of bats or birds.

Habitat- The arrangement of food, water, shelter, and space suitable to animals' needs.

Helictites- Twisted speleothems projecting at all angles from ceilings, walls and the floor of caves that seem to defy the laws of gravity.

Humidity- The amount or degree of moisture in the air relative to the ambient temperature.

Insoluble- Something which cannot be dissolved; not soluble.

Karst- Terrain where topography has been formed chiefly by the dissolving of rock. Karst areas commonly have inward-sloping depressions at the surface, and the drainage is subterranean.

Hygrometer- An instrument used to measure humidity.

Limestone- Rock formed from underwater sediment.

Rimstone Dam- Calcium carbonate deposits located on cave floors that usually impound small pools of water.

Soda Straw- Thin-walled hollow tube speleothems about 1/4" in diameter. They grow from ceilings of caves as water runs down inside them and deposits rings of calcite at their tips.

Solution- Liquid that contains a dissolved substance.

Speleology- The scientific study of both the physical and biological aspects of the cave environment.

Speleothem- The proper term for the secondary deposit features in a cave, such as stalactites and stalagmites, derived from the Greek words "spelaion" meaning cave and "thema" meaning deposit. Sometimes called "formations" or "decorations."

Spelunker- A term for a person who explores caves.

Stalactite- A speleothem that hangs from cave ceilings and forms as layers of calcite are deposited by water flowing over the outside of soda straws. They form after the centers of hollow soda straws become plugged, or partially plugged. They can also form by water depositing minerals on the cave ceiling.

Stalagmite- A speleothem that rises from the cave floor and are many times, but not always, formed by dripping water from stalactites above. They are usually larger in diameter than stalactites and more rounded on top.

Stewardship- Related to the environment, the concept of responsible care taking; based on the premise that we do not own the resource, but are managers of the resource and are responsible to future generations for their condition.

Troglobite- Animals that spend their entire lives in a cave's total darkness and uniform environment. Many have very small or no eyes, and have very reduced pigmentation.

Troglophile- Animals that live mostly in the dark zone of a cave but have the ability to survive outside.

Trogloxene- Animals that live above ground, but often enter caves.

Vandalism- The willful or malicious destruction of damage of any public or private property.

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Arizona Game and Fish Department, Guide to the BATS Resource Trunk

Kartchner Caverns State Park®
Natural History Curriculum
Kindergarten through 6th Grade

Opinion Survey
Date_________

Thank you for helping us improve our service to you by taking a few minutes to complete this survey. Please answer to the best of your ability and save all comments until the end of the survey. When finished, please return it to Arizona State Parks, Research and Marketing, 1300 W. Washington, Phoenix, AZ 85007.

Part I

1. How did you acquire the Kartchner Caverns State Park® Natural History Curriculum? *(Please ✓ one)*

❒ Library
❒ Called Arizona State Parks
❒ Education Outreach Coordinator
❒ At KCSP®
❒ Collegue
❒ Attended workshop ___________________ *(Please specify)*
❒ Event ________________ *(Please specify)*
❒ Other ________________ *(Please specify)*

2. What purpose did (or will) the curriculum serve in your classroom? *(Please ✓ one)*
❒ Prepare for a field trip to KCSP®
❒ Enhance other classroom subjects or projects
❒ Prepare for a field trip to a setting similar to KCSP®
❒ Follow-up activities after visiting KCSP®
❒ Other *(Please explain)*_____________________________________

3. Have you implemented the curriculum or do you plan to implement it? *(Please ✓ one)*

❒ Yes
❒ No (If no, please skip to question 3c.)

↓

a. **If yes**, when do you plan to implement the curriculum in your programs? *(Please ✓ one)*
❒ I have already implemented it
❒ Within the next 6 months
❒ Unsure
❒ Within the next month
❒ Within the next year

b. **If yes**, which activities did you use (or plan to use) in your program? *(Please ✓ one)*
c. **If no**, why did you choose not to use the curriculum in your classroom? *(Please ✓ one)*
❒ It does not correlate with present subjects or topics in class
❒ Not enough time
❒ Did not like it *(Please explain)* ____
❒ Other *(Please explain)* ____

4. Within the section of the curriculum that you used, are there any activities that you don't consider useful? *(Please ✓ one)*
❒ Yes
❒ No

↓

If yes, which activities? ____

Part II

Educational Value of the Kartchner Caverns State Park® Natural History Curriculum

5. Please consider the following statements about the curriculum and rate your agreement with each.

(Please ✓ one for each statement)	Strongly disagree	Disagree	Agree	Strongly agree	Not applicable
Activities are grade-level appropriate	❒	❒	❒	❒	❒
Students have the opportunity to learn and do new things	❒	❒	❒	❒	❒
Students' previous experience and knowledge are challenged	❒	❒	❒	❒	❒
Students' previous experiences and knowledge are utilized	❒	❒	❒	❒	❒
Activities allow students to integrate new knowledge	❒	❒	❒	❒	❒
Activities allow students to effectively apply new information	❒	❒	❒	❒	❒
Multiple learning styles are effectively addressed	❒	❒	❒	❒	❒
The directions are easy to follow	❒	❒	❒	❒	❒
The activities are easily carried out by students	❒	❒	❒	❒	❒
The activities are useful	❒	❒	❒	❒	❒
The activities involve the students	❒	❒	❒	❒	❒
The curriculum format is easy to use and implement	❒	❒	❒	❒	❒
Overall, the instructions were clear	❒	❒	❒	❒	❒
Overall, I am satisfied with the curriculum	❒	❒	❒	❒	❒

6. Please share any additional comments you might have about the curriculum in the space below.

____

____

Demographics

7. Which of the following describes your role in an educational setting? *(Please ✓ one)*

❒ Classroom teacher
❒ Classroom aid
❒ Student teacher
❒ Scout/youth group leader
❒ Home school educator
❒ Librarian
❒ Other *(Please specify)* ________________

8. What grade levels do you teach? *(Please ✓ all that apply)*

❒ Kindergarten
❒ 1st grade
❒ 2rd grade
❒ 3rd grade
❒ 4th grade
❒ 5th grade
❒ 6th grade
❒ None
❒ Other *(Specify)* ______________

9. How many children do you contact in a typical school day? *(Specify)* _____

10. What is your gender? *(Please ✓ one)* ❒ Male ❒ Female

11. School/Organization Name *(Please specify)* ____________________________________

12. School/Organization Zip Code *(Please specify)* _____________________

Thank you for your participation.

This document was prepared under the authority of
the Arizona State Parks Board.

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