Penn's Cave

Centre Hall, PA

Teacher's Guide

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Introduction

Penn's Cave welcomes the teachers and students who visit us throughout the year. Penn's Cave has developed this teacher's guide full of information and activities designed to integrate classroom learning with the field trip experience.

When you prepare for your field trip, please remind students to dress appropriately for the weather. Acceptable items to bring include cameras, small flashlights, notebooks, and snacks for the bus ride. Distracting items, such as laser pointers, are not permitted. Eating on the boat gets messy, so we ask that food or drinks be left behind.

Each boat holds 22 students, and one chaperone / teacher. Groups recienve one complimentary chaperone ticket for every 22 student tickets purchased. Additional chaperones are welcome, and tickets may be purchased at the a discounted price. Group rates include use of picnic facilities and parking. There is a snack bar inside by the gift shop, so please inform the parents and plan enough time for shopping, if so desired.

Panning for real, semi-precious gemstones is also availble. Bags of mining till are placed in screens in our wooden sluice, and students search for the hidden treasures inside. Every bag is guaranteed to contain gemstones. Please call or check the website for pricing and further details.

Wildlife tours are available for school groups, as well. Journey by bus into the Wildlife Park and get a close-up look at native North American animals like Texas Longhorn cattle, bison, wolves, bears, a mountain lion, elk, and deer. Group rates available for the wildlife tour, and combination cave / wildlife packages are also available.

Questions can be addressed to :

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We look forward to seeing you soon!

Portions of this teacher's guide integrate Pennsylvania State Acedemic Standards 3.5, 4.1, and 4.2.

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HISTORY OF PENN'S CAVE

The first white man to Penn's Cave was a distant relative of the famous America poet, Edgar Allen Poe. This frontiersman, James Poe, and his relatives fought the Indians in the mountains of Maryland and Pennsylvania and took up many tracts of land in the Pennsylvania mountains. The original name was spelled Poh, but became altered like so many other old-time names, into its present form, Poe. The Penn's Cave farm, or tract of land, as it was known it the early days, was surveyed in pursuance of two warrants granted to James Poh and dated January 5 and November 3, 1773. A patent for these lands was issued by the Commonwealth of Pennsylvania to James Poe, dated April 9, 1789. James Poe lived on the Penn's Cave farm only a short time, because he spent most of his days at his homestead in the valley bearing his name in the southern part of Centre County (Poe Valley State Park). However, he built a substantial log house, which was the first building in that part of the valley, near the large spring where the Karoondinha, or Penn's Creek, emerges from the cavern. Penn's Cave was named for John Penn, a nephew of William Penn who founded Pennsylvania. John Penn originally owned the land in Selinsgrove, Pennsylvania where his creek joined the Susquehanna River.

James Poe, upon his death, bequeathed the Penn's Cave farm to his daughter, Susanna M. Poe. She later became the wife of Samuel Vantries, and the Penn's Cave farm became known as the "Vantries Place", although the Vantries lived in nearby Linden Hall and rented the farm to Jacob Harshbarger in 1855. Mr. Harshbarger said the first white man to enter the cavern was Rev. James Martin, pastor of the earliest Presbyterian congregation in Penn's Valley. Prior to Rev. Martin's adventure, Indians of various tribes had frequented the cavern, because numerous arrowheads, pottery, and beads had been found in the cave.

Between 1845 and 1860, people frequently entered the cavern through the dry cave entrance in the old orchard. In 1860, a young Quaker, named Isaac Paxton, who had resided in Chester County, became a teacher in Spring Mills. He was a nature lover and took long walks through the hills and valleys to study the birds, flowers, trees, and geological formations. Accompanied by his chum, Albert Woods, a successful agriculturalist from Spring Mills, he walked to Penn's Cave and entered the dry cave. The young men became convinced that they saw a light out in the direction of the watercourse entrance, so they built a raft from lumber they purchased at a nearby sawmill and traversed the entire water course of Penn's Cave for the first time. They discovered that the water way led into the dry cave, where they unearthed the skeletons of two huge panthers, and they also viewed, by the light of a pine torch, the various other rooms of the cavern. News of their discovery spread rapidly, and for years, many local picnics were held near the cavern entrance. Interest in the cavern waned for many years, however, because of the excitement of the Civil War throughout the country. In 1868, Samuel Vantries sold the farm to George Long, who lived in the old log house and used the water from the large spring, which in reality was overflow from the cavern. Mr. Long was a man of serious nature and objected strongly to pleasure-seekers entering the cave, so during his ownership, few people visited the cave. Furthermore, he did not want people to contaminate his water supply. The late Colonel Henry W. Shoemaker, Chairman of the Pennsylvania Historical Commission, in his historical writings of Penn's Cave in the early 1900's, tells of the visit of three Russian dignitaries to the former Governor Curtin of Bellefonte, who had been a United States Minister of Russia. In 1876, the Russians were visiting the Philadelphia Centennial and remembering Governor Curtin, they decided to visit him in Bellefonte. Governor Curtin entertained these men and brought them to Penn's Cave by horse and carriage. They were much impressed with the wonders of the cave and later were served a dinner by Mrs. George Long. Shoemaker writes, "It is stated that nine kinds of pie were on the table at one time, and each Russian sampled them all."

In 1884, after George Long's death, the Penn's Cave Farm passed to his two sons, Jesse and Samuel, who had traveled extensively and realized the financial profit-making potential of the cavern. So hopeful were they of financial success that they constructed a large boat and charged admission to the cavern, and in 1885, constructed the 30-room Penn's Cave Hotel, which is presently the Penn's Cave House. Although the cave remained popular, when hundreds of people visited the resort annually, financial problems eventually caused the enterprise to fail, and in 1905, the land was sold at sheriff's sale to John A. Herman of Pleasant Gap.

In 1908, the cave was once again for sale at sheriff's sale, and two young local brothers, Henry Clay Campbell and Robert Pearly Campbell of Pennsylvania Furnace, purchased the cavern for $12,000. There were four Campbell brothers, and the two oldest brothers had already purchased their own farms, so this purchase was a winning challenge for the youngest two brothers to be like the oldest ones. Henry Clay, who resided in Philadelphia where he taught at the University of Pennsylvania, never lived at the cavern; however, Robert Pearly and his wife, Edith and their children, lived in the hotel, where they hosted overnight guests until 1919. From 1920 to 1929, only meals were served to cavern guests. During the Campbell brothers' ownership in 1927, the cave tunnel at the rear of the cave was opened. Robert, who was also a civil engineer, designed and engineered the project. In 1963, Robert's son, William, purchased the cavern, and today, his descendants own and operate the cavern, farm, wildlife sanctuary, and airpark. In 1976, Penn's Cave and the Penn's Cave Hotel were placed on The National Register of Historic Places by the United States Department of the Interior.

THE LEGEND OF PENN'S CAVE

In the early eighteenth century, long before settlements reached beyond Sunbury, Pennsylvania, a young Frenchman from Lancaster County, Malachi Boyer, set out to explore the wilderness. He roamed into the forests peopled by redskins, with whom he was friendly.

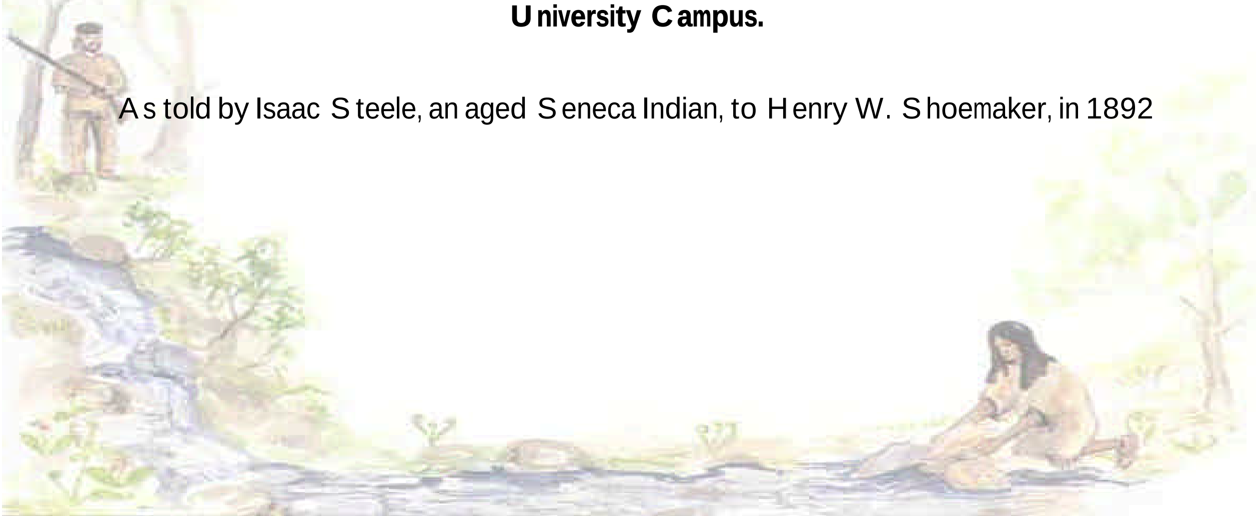
One beautiful April, Malachi camped at Mammoth Springs, near the Indian Camp of Chief O-Ko-Cho, on the shores of Spring Creek near Bellefonte. He made friends with the old chief and sent him small gifts as tokens of friendship.

O-Ko-Cho had seven sons and one beautiful daughter, Nita-nee, whom the sons guarded carefully all the time. One day Malachi caught sight of Nita-nee washing a deer skin in the stream and immediately fell in love with her. Since the Indians would not permit their marriage, they decided to run away, and late one night, they departed for the eastern settlements. They were later captured by the seven brothers and were returned to Chief O-Ko-Cho.

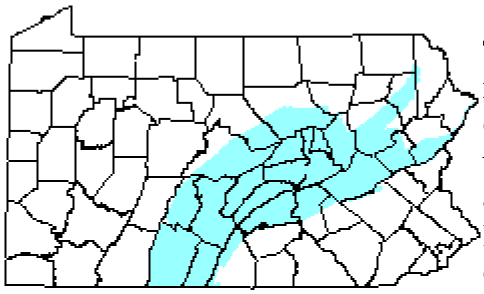
O-Ko-Cho commanded his sons to take Malachi into a yawning cavern filled with water and thrust him in. Every day for a week he swam back and forth searching vainly for an entrance other than the large one guarded by the merciless Indians. Then, exhausted, from his efforts and vowing that the Indians should not see him die, he crawled into one of the furthermost recesses of the cavern and breathed his last. The brothers did not touch the body except to weight it with stones and drop it in the deepest water in the cavern. After these many years, those who have heard the legend declare that on still summer nights an unaccountable echo rings through the cavern, which sounds like "Nita-nee - Nita-nee".

Today in Central Pennsylvania, we honor the beautiful Indian maiden Nita-nee by bestowing her name on Nittany Mountain and Nittany Valley, as well as our world famous Nittany Lion, located on the Pennsylvania State University Campus.

As told by Isaac Steele, an aged Seneca Indian, to Henry W. Shoemaker, in 1892



GEOLOGY OF PENN'S CAVE



The Appalachian Mountain Section consists of numerous, long, narrow mountain ridges separated by narrow to wide valleys (lowlands). The tops of the ridges are always several hundred feet higher than the adjacent valley, and some ridges are more than a thousand feet higher than the adjacent valley. Very tough sandstones occur at the crests of the ridges. Relatively soft shales and siltstones occur in most of the lowlands. Some of the lowlands are underlain by limestone and dolomite. At one time many millions of years ago the rocks in this Section were flat lying. Then they were compressed toward the northwest by immense pressure coming from the southeast. This pressure buckled the rocks into long, linear folds called anticlines (upward-buckled rocks) and synclines (downward-buckled rocks). Erosion of the rocks in these adjacent anticlines and synclines created the ridges and valleys of the Appalachian Mountain Section. The shales and siltstones are eroded more easily than the sandstones. Thus, as erosion proceeds, the slowly eroded sandstones form ridges while the shales and siltstones are eroded more rapidly to form the lowlands.

What is a cave? The National Speleological Society defines a cave as a natural cavity, recess, chamber, or series of chambers or galleries occurring beneath the surface of the earth, and usually extending to total darkness and large enough to permit human entrance. Penn's Cave is located in the topographic region of Pennsylvania known as the RIDGE AND VALLEY section of the Appalachian Highlands, and within this section, the cavern is located in the physiographic division, known as the Valley and Ridge province. Penn's Cave is east of the Allegheny escarpment, a major topographic feature that runs from Alabama to Pennsylvania. The older sedimentary rocks of the Valley and Ridge province have been folded into tight anticlines and synclines with much thrust faulting. The long parallel folds result in a topography of long parallel ridges capped with resistant sandstone, such as Nittany Mountain and Brush Mountain, and intermediate valleys, frequently floored with shale and limestone, such as Brush valley and Penn's Valley, where Penn's Cave is located. This limestone originally was ocean bottom mud that was compressed into rock and squeezed into the folds, described above, by great thicknesses of overlying strata that subsequently have been worn away.

The topography of the Penn's Cave area is controlled completely by the geologic structure. In general, the mountains are synclines, and the valleys are anticlines. In the cavern area, a major fold became crumpled into many smaller folds, the structure axes plunge, and the topography is broken into intermediate valleys. One of these ridges is Nittany Mountain whose southwestern nose is a dominant feature of the State College skyline. East of the Nittany Mountain, is Penn's Valley, which in turn contains at least three smaller anticlines, and Brush Valley which is underlain by a single fold. Penn's Cave is located between these two valleys at the west end of Brush Mountain. The main groups of cavernous limestone in the Penn's Cave area are found in the Cambro-Ordovician carbonate rocks. These carbonate rocks include the warrior limestone, the Gatesburg dolomite, the Stonehenge limestone, Beekmantown dolomite, and at the top of the stratigraphic section, the Champlainian limestone, often referred to as "Trenton" in older writings of Pennsylvania caves. Penn's Cave is located in the Champlainian limestone. Within this stratigraphic section, the cavern is formed in the Nealmont and Linden Hall formations. This limestone was formed in the middle Ordovician Period, 500 million years ago, and the formations dip 33 degrees southeast and strike north 69 degrees east. The stratigraphically highest portions of the cave extend about 10 feet into the Rodman limestone member. The cave spans 31 feet of the Centre Hall member of the Nealmont limestone and 74 feet of the Oak hall member of the Linden Hall formation. According to studies done in the 1970's, Penn's Cave contains 600,000 feet of volume, 25 percent of which is in the Centre Hall limestone and 60 percent of which is in the Oak hall limestone.

Penn’s Cave lies in the headwaters region of the Penn's Creek drainage basin. Both Brush Valley and Penn's Valley drain through Penn's Creek, which flows eastward to join the Susquehanna River above Selinsgrove. The limestone valleys of this region are rolling upland at an elevation of about 1200 feet. Much of the drainage in this Central Pennsylvania region is underground. Drainage from the mountain flanks aggregate into small streams, which flow from the mountains through small gaps. Many of these streams sink at the limestone contact on the valley floor, often into open cave entrances. The subsurface drainage routes are partly through open conduits connecting the sinking streams to large limestone springs. The situation in the Penn’s Cave intermediate area, however, is more complicated. There is no surface drainage in the western end of Brush Valley, and the drainage from the flanks of Nittany Mountain on the west side of the valley must by some route make its way to the Penn’s Cave rising. In addition to the strike route parallel to the mountain, there must also be drainage paths that cross the anticlinal structure, which requires the water circulating into the lower, generally non-cavernous, dolomitic beds, in order to get to Penn’s Cave.

This Penn’s Cave rising is a major regional resurgence. The flow varies (White and Stellmack, 1965) from 1-2 cfs (cubic feet/second) at base flow to 230 cfs at peak flow. The annual hydrograph is a smooth seasonal curve peaking in the spring when there is high precipitation and snows are melting out of the mountains. Base flow conditions occur in September and October when ground water levels are low, and there is little recharge. The exact catchment area for the cave is not known. Various attempts at dye tracing from the sinking streams along Nittany Mountain to the cave (e.g. Mcduffee, 1956) have met with little success. However, the cave is the only resurgence in the area. It appears that the drainage basin extends westward beyond Centre Hall where there is a divide between the Penn's Creek and Spring Creek basins, and eastward to the divide with the drainage as to Spring Bank. The topographic divide is about half way between the two springs, three miles east of Penn’s Cave, but there is no certainty that the underground divide is coincident with the topographic divide. Typical specific discharge for karst spring base flow is .1 to .2 cfs/mi which would imply a catchment for Penn’s Cave of about 10 sq. miles, smaller by a factor of 2 or so from the area encompassed by the surface divides. However, there seems little doubt that the group of sinking streams flowing from Nittany Mountain for the first five or so miles east of Centre Hall, including the large stream at Ellenberger Gap (one half mile west of the cavern) must eventually reappear at the Penn’s Cave rising. How these waters cross the anticlinal fold of Brush Valley transverse to the structure remains a mystery.

The chemistry of the waters emerging from Penn’s Cave has been the subject of several studies. These studies show that water hardness and water temperature undergo considerable variation with seasons of the year and with local storms, thus indicating that the Penn’s Cave discharge is from a system of conduits rather than the outlet from a diffuse body of groundwater. It seems almost certain from chemical, hydrological, and geological evidence that there is much cave still undiscovered upstream from the group of sinkholes that terminate the upstream end of the Penn’s Cave trunk.

The caves in the Penn’s Cave area are of four principal patterns: linear, angulate, branch work, and network mazes (White, 1960). Linear caves have a single straight passage usually parallel to the strike. Angulate caves follow a zig-zag pattern with some sections, usually the longer ones, parallel to strike and the other segments crossing the structural train. Small branch work caves have a tributary pattern. Network mazes have closed loops usually rectangular in ground plan where solution has taken place along two crossing sets of joints. As a general rule, linear and angulate caves occur where the dip is lower. Penn’s Cave is a classic example of linear cavern development along strike joints. Both main segments of the lower level are developed along the strike of the limestone. The single short segment that crosses the bedding near the Straits of Gibraltar has a much smaller cross-section. Passage walls where breakdown has peeled away, or smoothly sculptured surfaces. The north walls of the lower level are usually smoothly sculptured with bedding plane grooves as prominent features. The south wall in the high reach of the passage between the First Room and the Dry Room is also sculptured. Most of the remainder of the south wall is a smooth bedding plane surface.

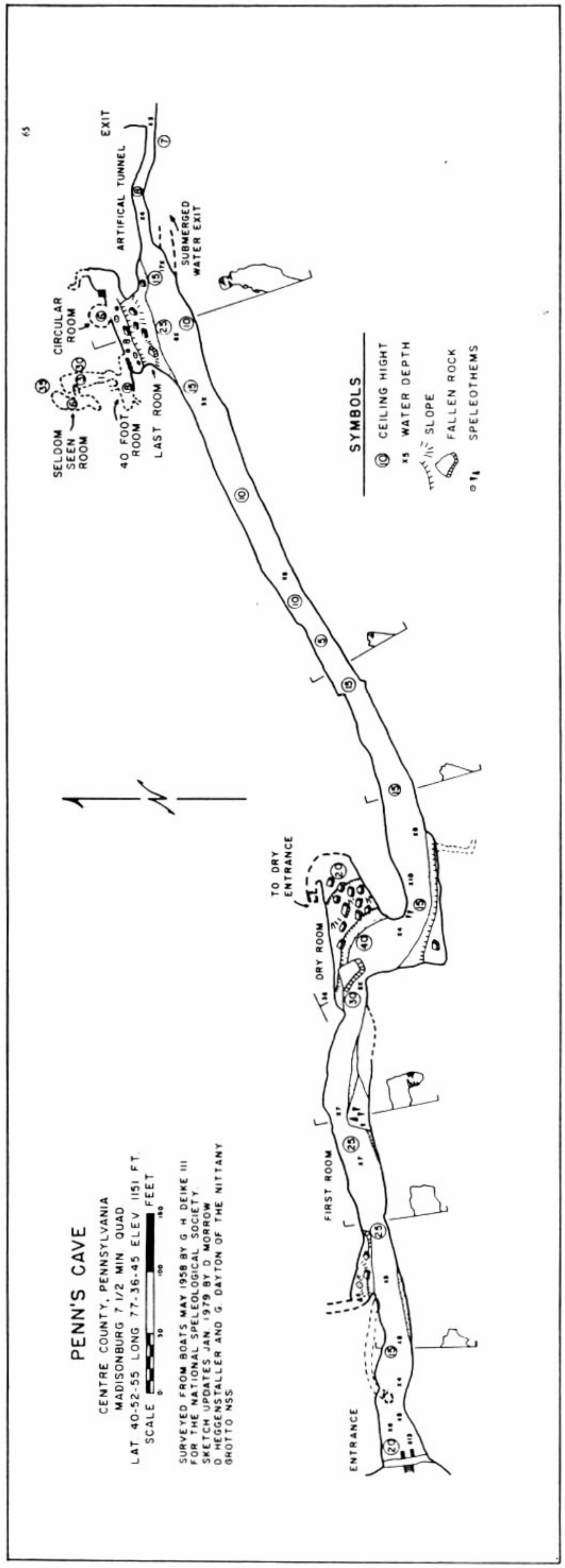
Penn’s Cave, as well as other limestone caverns, was formed in two cycles: first, the dissolving of the limestone rock by slightly acidic ground water deep below the surface, and second, the lowering of the water table and draining of the cavities. For caves to form in the limestone, which is essentially impermeable to groundwater unless it is fractured, the primary paths for groundwater to flow are the joints, fractures, and bedding plane partings that have resulted from earth movements. Water continues to dissolve the limestone, and the initial path along a joint or fracture becomes enlarged to a cave passage. An intensive study by Deike in 1969 of Brush Valley and Penn's Valley caves, where Penn’s Cave is located, shows that most of the cave development was along strike joints with lesser development along dip joints.

Penn’s Cave has two natural entrances. The water entrance opens from the bottom of a sinkhole several hundred feet in diameter and 75 feet deep. This entrance is at the water level defined by the underground stream, and here there is a boat dock from which visitors are taken through the cave. The second, or Dry Cave entrance, is at the bottom of a small sink in the front yard of the former Penn’s Cave Hotel, now known as the Penn’s Cave House. A third entrance was opened in 1929 by blasting a 75-foot tunnel through rock at the downstream end of the cave to permit boats to emerge onto Lake Nitannee, which was created by constructing a small dam on Penn's Creek.

Penn’s Cave is the downstream section of a master trunk drain for the groundwater in the western portion of Brush Valley. The cave consists of two superimposed passages. The lower component of the trunk is the stream passage. The upper component is discontinuous, in part overlapping and continuous with the lower trunk, in other places forming the upper level rooms of the dry portion of the cave. The upstream termination of the cave is the entrance sink, but Penn’s Cave Shelter (a small cave southwest of the entrance sink whose entrance is 35 feet wide and 40 feet deep) is probably a fragment of the upstream portion. West of the entrance sink are several other steep deep sinkholes, which likely mark the line of the partially collapsed trunk. No access to the upstream reaches of the truck drain system beyond the sinkholes has been found. The downstream end of the Penn’s Cave trunk is the spring from which Penn’s Creek emerges. The upper level terminates in breakdown at both ends.

The entrance at the boat dock is a broad, smoothly-arched tunnel 20 feet wide and10 feet high. Both walls come down to meet at the water. The tunnel opens after 150 feet into a high-arched ceiling room, called the First Room, where the upper level comes in from the north and merges with the lower level to more than double its height. High ledges and balconies on both sides of the passage, remnants of the old floor of the upper level, are well decorated with dripstone. From this First Room, the high ceiling passage continues for 250 feet to the Dry Room. The Dry Room is a large chamber, with the water-filled lower level along the south wall and sandy short and breakdown slope rising upward to the ceiling to the east. By climbing the breakdown slope, one comes to a fragment of the upper level continuing along the same bearing as the main cave passage. The Dry Entrance, where the first explorers of the cavern entered, is located here. The next section of the cavern is where blocks of limestone have moved into the stream and created a narrow passageway, the Straits of Gibraltar, which is just large enough to permit the boats to pass through. Beyond the Straits, the lower level passage jogs to the south, crosses the bedding and then turns northeastward again, following the strike, but offset from the line of the upper level passage. The inner section of the cave is a triangular-shaped passage formed by a bedding plane that makes up the ceiling and an irregular solution-sculptured wall along the north side. Sand bars and mud-flats occur here so that the stream has a shore line. It is more than 500 feet from the jog to the point where the ceiling of the passage plunges below water level and the boatman enters the tunnel from which it emerges into a narrow defile which leads out to the lake. Just upstream from the artificial tunnel, the Last Room, also known as the Colored Lights Room, opens on the north side of the passage. This room appears to be another fragment of the upper level. The floor of the room rises steeply over a slope from the water’s edge to decorated chamber at the top of the slope. The south wall of both the upper and lower levels is a single sloping limestone bed.

In the Last Room, there are a number of small, decorated passages. In the northwest corner, one can climb behind the columns to enter a parallel room (The Forty Foot Room), which is 20 by 40 feet and 8 feet high. Trending north from this room is a 45-foot passage and room that slopes south with a ceiling height of one foot at the southern end and 3 feet at the north end. At the northern end of the low passage, a hole in the floor drops into the Seldom Seen Room, 25 feet by 30 feet and 6 feet high, sloping west. In the northeast corner of the Last Room is an opening to a small circular room that is roughly 6 feet high. In the eastern end of the Last Room, just to the east of the Circular Room, is an artificial electrical and air shaft to the surface. In the extreme eastern end of the Last Room is a small passage approximately 2.5 feet high and wide that snakes itself for some 40 feet to the north.



Explorations by the operating staff have revealed several side passages in the cavern that are not seen on the commercial tour. The first of these is just inside the main entrance, where an opening in the ceiling extends above the lower level passage and re-enters it in the north wall just before the First Room. In the north wall of the First Room is a passage that reportedly is over 200 feet long and trends northwest. Just beyond the Dry Room in the south wall, at the beginning of the Strait tunnel, is a passage roughly 20 feet long that ends in a mud plug.

Penn's Cave is well-decorated with speleothems of calcite dripstone and flowstone. Location of joints bringing in surface water are often mapped on the ceiling by lines of stalactites. The surface water seeping through these joints has a high calcite content. Before the water drips away, some of the water evaporates leaving a substantial amount of minerals in the remaining water. Sometimes this water is over-saturated and therefore leaves this mineral deposit behind. These minerals continue to accumulate on the rock forming stalactites, flowstone, and draperies. This process of forming varies from 300 to 500 years per lineal inch, with an accumulation of 1 cubic inch every 100 years. Stalagmites form when the dripping of the water strikes a ledge or bank of the cave. The water runs off these ledges, leaving the heavier mineral deposit behind. When the stalactites and stalagmites join, they form a pillar or column. The columns in the Last Room may be hundreds of thousands of years old. The large shelves on the north wall close to the Last Room were formed by the mineral depositing in large quantities on top of a silt bank. The water later washed away this silt, leaving the formation behind. This occurrence might indicate a period of flooding, with periods of high, but slow-moving waters.

Geology Activity

Understanding Rock Layers

Age/Grade Appropriate

Grades 3 through 4

Key Concepts

Observation

Time

Group cooperation if done in small groups

Background

Fossils are frequently found by people other than paleontologists. Rock collectors, miners, and construction workers may uncover them while working. Ranchers and hikers may find them exposed in stream beds or on the edges of sod tables.

Before the nineteenth century, little attention was given to fossils. Around 1815, an English engineer realized that certain types of fossils were found on only in certain layers of rock. He also observed that if a layer of rock containing one type of fossil occurred on top of a layer containing a different type of fossil in the same location, then the fossil layers occurred in the same order wherever they were found together. This observation and the understanding that the bottom layers were formed first gave scientists a means of constructing a geologic history of the earth in which events can be placed in proper order of age.

The relative age of an object or event is its age as compared with that of another object or event. Finding the relative age simply places things in order of occurrence. In a group of rock layers, the bottom layer is usually the oldest and the top layer the youngest. Generally, each layer is younger than the one beneath it and older than the one above it, except when the earth has been moved through natural or human caused events. This principle is called superimposition because the younger layers are superimposed on the older layers.

Activity

Purpose:

To simulate how deposited sediments form layers in the bottom of a sea such as the Inland Pierre Seaway that once covered the Badlands.

Materials:

½ cup each of 3 different colors aquarium gravel
3 small bowls
1 ½ cups soil or sand
Spoon
2 quart rectangular glass baking dish
Tap water
Timer

Procedure

1. **Pour one color of gravel into each of the three bowls**
2. **Add ½ cup soil or sand to each bowl of gravel**
3. **Use the spoon to mix the gravel and soil thoroughly**
4. **Fill the baking dish halfway with water.**
5. **Use your hand to slowly sprinkle the gravel-soil mixture from one of the bowls into the water**
6. **Wait 10 minutes and observe the appearance of the layer formed by the mixture**
7. **Sprinkle the gravel-soil mixture from one of the remaining bowls into the water**
8. **Again wait 10 minutes and observe the appearance of the materials into the dish**
9. **Add the last gravel soil mixture**
10. **After 10 minutes observe the contents of the dish**

Results

The three different colored mixtures form separate layers in the dish

Why

The gravel and soil that make up the sediment sank through the water to form layers. Because the mixtures of gravel and soil were added in ten minute intervals, the bottom layer is relatively older and the top layer is relatively younger than the other layers. Layers of rock are believed to form in a similar manner, and like the gravel-soil mixture, each rock layer is laid down on top of the one beneath it. This is how we can tell the relative age of each layer and the relative age of the fossils included within the layers.

Cave Exploration

EXPLORING CAVES

People who explore wild caves are called cavers or spelunkers. Specialized training in safe techniques is required for 'caving'. Although learning about caves will spark a sense of curiosity and adventure in students, it should be impressed upon them that they should NEVER set out to explore a cave on their own and without proper training. Local grottos, or clubs, of the National Speleological Society are located in many areas of the United States. These cavers are often willing to conduct 'beginner' caving trips and to teach safe caving methods. It is recommended that persons interested in becoming involved in caving first experience some show caves, then contact an NSS Grotto for their first wild cave experience. Regardless or how much experience they have had, ALL spelunkers follow these basic rules:

1. Never cave alone. Always have an adult with you, one that is an experienced caver.
2. Always carry at least three sources of light: flashlight, carbide or electric lamp, candle. Also take extra batteries, matches (waterproof).
3. Always wear a hardhat and proper clothing. Never cave in shorts and a t-shirt.
4. Make sure people know where you are going and when you expect to return.
5. Realize that caves are fragile and that much damage can be done, even accidentally.
6. Always get the landowner's permission before visiting the cave.
7. Never go into a wild cave when it is raining or when it might rain. Wild caves can flood in a short time.
8. Take nothing but pictures; leave nothing but footprints; kill nothing but time.

For more suggestions on Safety, Equipment, and Techniques visit the National Speleological Society (NSS) on the web at http://www.caves.org

Cave Exploration Activity

Let's Make A Cave

Age Level

Modify for all ages

Subject

Science, Physical Education

Duration

1-1.5 hours

Location

Indoors

Key Vocabulary

Cave, exploration, speleothem, stalactite, stalagmite

OBJECTIVES

Students will avoid touching artificial speleothems while using gross motor skills to negotiate an obstacle course.

MATERIALS

Large cardboard box (such as a furniture or appliance box), yarn, large nail, plastic drinking straws, "Styrofoam" cones, large plastic cups, wooden dowel (height of the box width) tape

BACKGROUND

Speleothem is the name given to any secondary deposit (decoration) inside of a cave. The main types are stalactites, which hang down from the cave ceiling, and stalagmites, which rise up from the cave floor. Notice the "c" in stalactite for ceiling and "g" in stalagmite for ground. Formation of any speleothem takes an extremely long period of time. As each drop of water leaves a tiny amount of mineral residue on a cave ceiling, floor, wall or other feature, it adds to speleothem growth. When a speleothem is broken, it will not be replaced within our lifetime, if ever! Therefore, cavers must be extremely careful while exploring.

PROCEDURE

The cave obstacle course is made up of drinking straws stalactites, plastic cup "stalagmites", and a large cardboard box. Lay the box down so the two ends are open. Brace the center of the box with the wooden dowel "column". Punch a hole in the top of the "cave" with the nail. Thread yarn through one drinking straw and then through the nail hole and knot to secure it. Hang numerous straws, at various levels, in one area of the cave. Allow enough room for the students to wriggle around without touching them. Make the stalagmites by taping large plastic cups together end to end, or mouth to mouth. Stalagmites can be one to three cups high. Get imaginative in your formation creation! Remember to leave a trail with leading to one open end of the box, through it, and out the other end to represent an area of the cave where the explorer can stand upright. The cavers will need to crawl in the area represented by the box.

Additional passages can be created by turning chairs upside down on the ground and placing them next to each other. Students can then belly-crawl under the chairs like they were squeezing through a tight passage in a cave. Several "rooms" can be connected this way. This could be especially fun if different groups or classes each make a "room" and then connect them so the students can explore each new room!

Help the students imagine that they are spelunkers (cavers) just entering an unexplored, wild cave. It is their responsibility to not damage any speleothems. Briefly talk about stalactites and stalagmites, to familiarize the students with the terms.

When they reach the box, the students will crawl through, not hitting any stalactites or stalagmites. Students should take their time and really explore the cave, without touching anything but the bare floor. When each student has had a chance to negotiate the "cave", lead a short discussion on maneuvering methods that the students invented or used. Have the children try another trip through the cave to see if there has been any improvement from their first trial. Of course, no student should be required to squeeze through anything beyond their comfort level – there are plenty of constructive ways for everyone to enjoy this activity.

Follow Up

Before your Penn's Cave boat tour, remind students of their obstacle course experience and help them imagine what it must be like to explore the rooms and passages beyond the water-filled main passage. Keep an eye out speleothems that have been touched or broken. Look for signs of renewed growth of broken speleothems. Encourage students to protect the cave as they go through it, and to be aware of their effect upon the cave.

Cave Creation and Speleothem

Geology

Solutional caves occur in a variety of rock types; however, those formed in limestone are the most numerous. **Penn's Cave** was formed in the Nealmont and Linden Hall limestone formations of the ORDOVICIAN AGE. These rocks are estimated to be 400-500 million years old.

LIMESTONE is composed of the mineral, CALCITE (CaCO3). It was formed in ancient seas millions of years ago by marine animals and plants that extracted calcium carbonate from the sea water to form their shell homes. Fragments of the animal skeletons and plants fell to the bottom of the sea and were later compacted under pressure and cemented into firm rock. Limestone is a SEDIMENTARY ROCK, a rock formed in layers.

About 300-220 million years ago, tremendous mountain building forces resulting from the collision of continents pushed and folded the layers of older rock in the Valley and Ridge province of Pennsylvania.. This produced the ANTICLINES (folds that arch the rock strata upward) and SYNCLINES (downfold) which are now the Appalachian Mountains. **Penn's Cave** is in Brush Valley which is an ANTICLINE.

Fossils we find in the limestone help to tell us the age of the rock. The age of a cave, however, bears little significance to the age of the rocks that enclose it. Most caves are much younger, less than 10 million years old; **Penn's Cave** is estimated to be 30 million years old.

Dissolution

As melting snow and rainwater works through decaying organic material at the surface, the water picks up carbon dioxide (CO_2) being released and combines to form **carbonic acid** (H_2CO_3). This weakly acidic water works down through cracks and fissures in the rocks into the water table. Along the way, the carbon dioxide dissolves calcite in the limestone and forms a mineral rich solution. This process continues to dissolve away the rock, expanding cracks into passages and rooms filled completely with water.

This cave forming process may continue for millions of year. It can be stopped only by two things: a lowering of the water table, or the formation of air passages in the cave system by surface erosion. In **Penn's Cave**, the stream never fell below the cave passageways, and it continues to flow through the cave at the rate of 11,000,000 gallons per day.

$CO_2 + H_2O \rightarrow H_2CO_2$	Carbon dioxide mixes with water to form carbonic acid
$H_2CO_2 + CaCO_3 \rightarrow Ca_s + 2HCO_3$	Carbonic acid dissolves calcite from the limestone producing a calcium bicarbonate solution.

Speleothem

Once the mineral rich water is exposed to the air, carbon dioxide abandons the water, much like it does when one opens a carbonated beverage. The reduced acidity allows the minerals to deposit inside the cave, and speleothem formation begins.

Features, such as stalactites and stalagmites are commonly called formations. Geologists use the word **speleothem**, derived from the Greek words *spelaion* (cave) and *thema* (deposit) to describe these structures.

Speleothems form at varying rates as calcite crystals build up, one upon the other. Although it takes an average of 120 years for a cubic inch to form, several factors can determine the rate of growth. The temperature outside, which affects the rate of decay of the plants and animals (amount of carbon dioxide in the soil), and the amount or precipitation are two important factors.

The shapes speleothems take is determined by how the acidic water enters the cave (by dripping from the ceiling, seeping from the walls, or splashing upon the ground) and how the water stands or flows after entering the cave. Several types of speleothem are described below. The most common speleothem is a stalactite.

The color of speleothems is determined by their mineral content. As the acidic water flows through the fissures, it can pick up other mineral embedded in the rocks and then deposit these minerals along with the calcite crystals. Pure calcite is almost white, sometimes translucent. Iron deposited on formations will oxidize (rust) and accounts for shades of red and orange. Other, less common minerals present in caves, can cause a wide variety of colors of calcite.

$$Ca^{2+} + 2HCO_3^{1-} \rightarrow CO_2^{\uparrow} + CaCO_3 + H_2O$$

Once inside the cave the carbon dioxide is released from the calcium carbonate, leaving only water and calcite behind.

Summary

1. Water picks up carbon dioxide from the air and soil, forming carbonic acid
2. Carbonic acid slowly dissolves away limestone while seeping through fissures in the rock
3. Cave creation continues until the acidic water is exposed to the outside air, releasing CO_2
4. Speleothem (cave formations) are created as the less acidic water deposits minerals inside the cave

- Cave formation can take millions of years
- Speleothem formation can take hundreds of years to form one new inch of material

TYPES OF SPELEOTHEMS

STALACTITE: grow down from the ceiling, form as layers of calcite, and are deposited by water flowing over the outside of soda straws. They form after the centers of the hollow soda straws become plugged.

STALAGMITE: rise from the 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.

SODA STRAWS: or first-stage stalactites are thin-walled hollow tubs about ¼ inch in diameter. They grow from the ceiling of caves as water runs down inside them and deposits rings of calcite at their tips.

COLUMN: when a stalactite and a stalagmite grow together, or when one of them grows all the way to the floor or ceiling, a column is formed.

HELECTITES: small twisted structures projecting from ceilings, walls, and the floor of caves that seem to defy the laws of gravity. Formed by seeping water, they project at all angles. (Cave Flowers)

FLOWSTONE: resembling frozen waterfalls, form when considerable water flows down walls, over floors and older formations, building up sheets or calcite, like icing on a cake.

DRAPERY: on an inclined ceiling, water may deposit calcite in thin, translucent sheets, producing draperies that hang in delicate folds.

BACON: at times, water forming the draperies contains minerals in addition to calcite, resulting in dark orange or brown bands resembling bacon. This other mineral is usually iron oxide, more commonly known as rust.

CAVE CORAL: also know as 'popcorn'. Small knobby clusters formed by seeping water. The water apparently seeps out from between the crystals.

BOTRYOIDS: get their name from the Greek word meaning 'a bunch of grapes'. These are a form of cave coral that have a more rounded shape and a smoother surface. (Cave Grapes)

CAVE BEADS: small white bead-like formations forming on the walls of caves. Water seeps out between, and flows down over the limestone, depositing the calcite in little ridges in the limestone, which crystallizes there, and formed outward into beads.

CAVE PEARLS: are the rarest types of speleothem. They form in layers, in much the same manner that an oyster pearl forms, and are found free floating in puddles or pools of water in caves. A small piece of dirt or sand floating in the water may pick up minerals from the water. They build in layers, and the rotation of the pearl in the water causes it to form into a smooth sphere, resembling a pearl.

CALCITE: is the crystallized form of calcium carbonate of lime, which is the main mineral, which makes up the speleothems. Calcite is white in color, but most cave formations appear brownish-red in color, because of their impurities (sand, clay, iron-oxide or other minerals).

Speleothem Making Activity

Grow Your Own Stalactites And Stalagmites

Materials

Two glass jars, a piece of thick yarn, a saucer, washing soda (sodium carbonate).

Procedure

1. Fill glass jars with warm water.
2. Dissolve as much washing soda as you can in each jar, a little at a time.
3. Arrange jars side by side, with the saucer in between.
4. Place an end of the yarn into each of the jars, making sure the yarn reaches the bottom of the jar.
5. Allow the yarn to dip in the middle and hang over the saucer.
6. Put one crystal of washing soda on the saucer and leave the jars for several days.

Discussion

The water and washing solution in the jars will drip onto the crystal in the saucer, forming a "column," "stalactite," or "stalagmite."

Variations:

- Try other "minerals" such as sugar, baking soda, salt.
- Allow the dip in the yarn to rest at different heights
- Use different substrates on the saucer (cardboard, paper, cloth…)

Acid Attacks Rocks To Form Caves

Materials

Vinegar, medicine droppers, one piece of each-limestone, calcite, and chalk.

Procedure

1. Put a few drops of vinegar on each rock sample.
2. Look and listen carefully.

Discussion

Vinegar contains weak acetic acid. This mild acid can dissolve rocks that contain calcium carbonate. The vinegar should have bubbled or fizzed. This is the type of weathering or erosion which forms caves.

Variation

For older students or as a teacher demonstration, use weak hydrochloric acid (HCl) and an eyedropper for more dynamic results. Even weak HCl is far stronger than the carbonic acid which acts upon limestone in the wild.

Wear safety glasses and have eyewash station available as a safety precaution.

Pennsylvania Game Commission Wildlife Notes

BATS

By Chuck Fergus

Bats are the only mammals that fly. Their wings are thin membranes of skin stretched from fore to hind legs, and from hind legs to tail. The name of their order, *Chiroptera*, means "hand-winged." Their long, slender finger bones act as wing struts, stretching the skin taut for flying; closed, they fold the wings alongside the body.

Pennsylvania bats range in size from the hoary bat (length, 5.1-5.9 inches; wingspread, 14.6-16.4 inches; weight, 0.88-1.58 ounces) to the pygmy bat, or pipistrelle (length, 2.9-3.5 inches; wingspread, 8.1-10.1 inches; weight, 0.14-0.25 ounces). Nine species of bats occur in Pennsylvania; two others are rare visitors from the South.

All Pennsylvania bats belong to family *Vespertilionidae*, and are also known as evening bats or common bats. They are insect eaters, taking prey on the wing. Often they feed over water, and some species occasionally land and seize prey on the ground. A bat consumes up to 25 percent of its weight at a single feeding.

The eyes of our bats are relatively small, but their ears are large and well developed. Bats can see quite well, but unique adaptations help them fly and catch prey in total darkness. While in flight, a bat utters a series of high-pitched squeaks (so high, in fact, they are almost always inaudible to humans), which echo off nearby objects-bushes, fences, branches, insects-and bounce back to the bat's ears. These sound pulses may only be 2.5 milliseconds in duration. Split-second reflexes help the creature change flight direction to dodge obstructions or intercept prey.

A bat will use its mouth to scoop a small insect out of the air. A larger insect is often disabled with a quick bite, cradled in a basket formed by the wings and tail, and carried to the ground or to a perch for eating. If an insect takes last second evasive action, the bat may flick out a wing, nab its prey, and draw the insect back to its mouth. Bats have sharp teeth to chew their food into tiny, easily digested pieces.

Most bats mate in late summer or early fall, although some breed in winter. The male's sperm is stored in the female's reproductive system until spring, when fertilization occurs. The young, born in summer, are naked, blind, and helpless. They are nursed by their mothers as other mammals, and by six weeks of age, most are self-sufficient and nearly adult size.

The reproductive potential of bats is low. Most bats, including the smaller species, usually bear a single young per year; the larger species may have up to four. There is only one litter per year.

None of Pennsylvania's bats fly during the brighter hours of daylight, preferring to make their feeding flights in late afternoon, evening and early morning. However, it's not unusual to see a bat flying during the day. Roost disturbance and heat stress may cause bats to take wing during daylight hours. During the day, they roost singly, in pairs, in small groups, or in large concentrations, depending on the species. They seek out dark, secluded spots such as caves, hollow trees and rock crevices. They may also congregate in vacant buildings, barns, church steeples and attics; some hide among the leaves of trees. They hang upside down, by their feet.

In fall, winter and early spring, insects are not readily available to bats in Pennsylvania and other northern states. At this time, three species migrate south; six others hibernate underground, usually in caves.

Bats are true hibernators. Throughout winter, they eat nothing, surviving by slowly burning fat accumulated during summer. A hibernating bat's body temperature drops close to the air temperature; respiration and heartbeat slow; and certain changes occur in the blood. Bats can be roused fairly easily from hibernation, and often are able to fly 10-15 minutes after being handled. Most favor cave zones having the lowest stable temperature above freezing. During winter, bats may awaken and move about within a cave to zones of more optimum temperature. In many caves, bats of several species hibernate together.

Perhaps because of their nocturnal nature, secretive habits and unique appearance -- not to mention superstitions, bats have long been misunderstood and sometimes feared. A number of misconceptions exist about them. They include: Bats are prone to rabies; their droppings are a dangerous source of tuberculosis and other diseases; they are aggressive and often attack people; they are dirty and ridden with lice.

Bats are no more apt to contract rabies than other warm-blooded animals. (People should not, however, handle bats, especially those found on the ground or in the open during the day.) There is no evidence to suggest that bats -- or their droppings, called "guano" -- transmit tuberculosis to man. A host of scientific studies indicate that healthy bats do not attack people, and even rabid bats rarely become aggressive. Bats need to keep themselves extremely clean to fly. They host no more parasites than other animals, and parasites that do afflict bats are very specialized and rarely pose problems to humans. Histoplasmosis, caused by a soil fungus that can grow in accumulated bird and bat droppings, does not, as a rule, survive in hot dry attics. However, as a precaution, it's recommended that you wear a respirator when stirring up dust in bat quarters or cleaning out large accumulations of droppings.

The colonial bats may congregate at favorite roosting sites, often in buildings. While these bats do no real harm to human occupants, their droppings, odor and noise may become a nuisance. To exclude bats correctly may take two years. The first summer you should watch the home at dusk to see where the bats are exiting. Try to get a count of the number of bats. If possible, erect a well-placed bat box of good design before August. The box should be large enough to accommodate the bats you plan to evict. When the bats leave in the fall, seal all entrances. Next spring, when they return, they are likely to move into the bat box, rather than search for a new way into your home, or your neighbor's. Do not seal bats out during June or July because you will trap flightless young inside.

Exterminating is a questionable practice. Poisons used on bats can be dangerous to humans, and may cause sickened bats to scatter and fall to the ground, where they are more likely to come into contact with people and pets. Currently no pesticides are approved for use on bats. Reputable pest control operators use bat exclusion techniques.

To counterbalance their low reproductive rates, bats are relatively long-lived. Some have been banded, released and recaptured more than 30 years later. Because they feed in mid-air and are active at dusk and at night, bats are not often caught by predators. Owls and hawks take some, as do housecats, raccoons and foxes. Rat snakes occasionally eat roosting bats. Other causes of mortality include cave floodings and accidents.

The greatest threat to bats comes from humans. In winter, hibernating bats may be aroused by people exploring caves; repeated disturbances force bats to squander precious calories needed for over-wintering. Caves may be flooded by dams, or dynamited shut. Some scientists suspect that widespread use of pesticides also harms bat populations.

Little Brown Bat (Myotis lucifugus) – this species is common to Penn's Cave

Pennsylvania's most common bat, the little brown, is found statewide. Length, including tail, is 3.1-3.7 inches; wingspread, 8.6-10.5 inches; weight ranges from 0.25-0.35 ounces, and is greatest just before hibernation. Females are slightly larger than males. Color: a rich brown approaching bronze, usually with a dark spot on the shoulders. The fur is dense, fine and glossy; the wings are black and bare.

This bat eats a wide variety of flying insects, including nocturnal moths, bugs, beetles, flies and mosquitoes. Insects are regularly caught with the wing or tail membrane, and transferred to the mouth. An individual emerges from its day roost at dusk, and usually seeks a body of water, where it skims the surface for a drink, and then hunts insects. Bats examined within an hour of taking flight often have full stomachs weighing one-fifth of their body weight. The little brown bat makes several feeding flights each night, and are capable of catching 1,200 insects per hour. A nursing female may eat her own weight in insects nightly.

In October and November, bats leave their summer roosts and move to tunnels, mine shafts and caves. Here, clinging to the ceilings and clustered against one another, they hibernate. In spring, they emerge in April and May. They return to the same hibernation and summer roost sites year after year.

Females disperse from the hibernation roosts, and gather in summer nursery colonies of 10 to 1,000 individuals in attics, barns and other dark, hot retreats. Males are solitary, roosting in hollow trees, under loose bark, behind loose siding and shingles and in rock crevices.

A single young is born to each female in June or early July. After four weeks, the young bat is fully grown, and ready to leave the colony. Females mature sexually at about 8 months of age, while males mature in their second summer. Little brown bats may live more than 30 years.

Northern Long-Eared Bat (Myotis septentrionalis)

Similar in size and color to the little brown bat, the northern long-eared bat may be distinguished by its longer tail and narrower and longer ears. It ranges in forested areas throughout the state, but is much less common than the little brown bat; its distribution is considered local and irregular. Length, 3.0-3.7 inches; wingspread, 9.0-10.7 inches; weight, 0.25-0.32 ounces.

Biologists have learned little of the ecology and behavior of the northern long-eared bat, although they suspect feeding habits are similar to those of the little brown. Long-eared bats roost singly or in small colonies in caves, behind window shutters, under loose tree bark, in cliff crevices. Females gather in nursery colonies in attics, barns, and tree cavities. Probably a single young is born in July. Long-eared bats return to caves in fall, often sharing space with little brown bats, big brown bats and pipistrelle bats.

Indiana Bat (Myotis sodalis)

The Indiana bat resembles the little brown bat, but has a pinkish cast to its fur, giving it a light purple-brown coloration. Length, 2.9-3.7 inches; wingspread, 9.4-10.3 inches; weight, 0.18-0.28 ounces. Sexes are equal in size.

Indiana bats probably roost in trees in summer; and they do not commonly roost in buildings. In winter, some 97 percent of the total species population hibernates in certain large caves in Missouri, Kentucky, Indiana, and Illinois. Pennsylvania is on the fringe of the species' range. In our state in recent years, Indiana bats have been found wintering in five sites (limestone caves and abandoned mines). Populations of *Myotis sodalis* are dwindling throughout its range, and it is on the federal endangered species list.

The Indiana bat hibernates in clusters of about 250 bats per square foot on the ceilings and side walls of caves. In this formation, it is vulnerable to disturbance by cave explorers: when a bat on the edge of the cluster is awakened, it moves about, starting a ripple of activity that spreads throughout the group. A winter of repeated disturbances causes bats to burn vital fat stores, and they may run out of energy before spring.

Females of this species are believed to bear a single young in late June. Feeding habits are probably similar to those of the little brown bat.

Small-Footed Bat (Myotis leibii)

Also known as Leib's bat, this species is one of the smallest in North America: length, 2.8-3.3 inches; wingspread, 8.3-9.7 inches; weight, 0.18-0.28 ounces. As the name implies, it has a very small foot when compared with other bats. When viewed from the front, the bat has a distinct black mask that stretches from ear tip to ear tip. In Pennsylvania, it is rare, and the population is thought to be decreasing; it is classified as a threatened species on the state list. Very little is known about this bat's summer habitat and lifestyle.

The small-footed bat resembles the little brown bat, but has a golden tint to its fur. Feeding and breeding habits probably parallel those of the other small, closely related bats. The small-footed bat waits until November to enter caves for hibernating, and emerges in March. It hibernates in narrow cracks in the wall, floor, or roof, singly and in groups of up to 50 or more. It usually stays close to entrances where the temperature is just above freezing.

Silver-Haired Bat (Lasionycteris noctivagans)

A medium-sized bat: length, 3.7-4.5 inches; wingspread, 10.5-12.1 inches; weight, 0.25-0.35 ounces. The fur is soft and long; the sexes are colored alike, blackish-brown tipped with white, for a bright, frosted appearance.

The silver-haired bat inhabits wooded areas bordering lakes and streams. It roosts in dense foliage, behind loose bark, or in a hollow tree -- rarely in a cave. It begins feeding earlier than most bats, often before sunset. Silver-haired bats do not hibernate in Pennsylvania, migrating farther south. In summer, a few may breed in the cooler, mountainous sections of the state, but most go farther north.

Eastern Pipistrelle (Pipistrellus subflavus) – this species is common to Penn's Cave

The pipistrelle is also called the pygmy bat because of its small size: length, 2.9-3.5 inches; wingspread, 8.1-10.1 inches; weight, 0.14-0.25 ounces. Its fur is yellowish brown, darker on the back. The back hairs are tricolored: gray at the base, then a band of yellowish brown, and dark brown at the tip.

Pipistrelles take wing early in the evening and make short, elliptical flights at treetop level. In summer, they inhabit open woods near water, rock or cliff crevices, buildings and caves. They hibernate from September through April or early May, deep inside caves and away from the openings, in zones where the temperature is about 52-55 F. They sleep soundly, often dangling in the same spot for months.

Pipistrelles eat flies, grain moths and other insects. They breed in November, and young, usually two per litter, are born in June or July. Pipistrelles live 10-15 years. They are found throughout Pennsylvania, except in the southeastern corner.

Big Brown Bat (Eptesicus fuscus) – this species is common to Penn's Cave

Second in size to the hoary bat, the big brown is 4.1-4.8 inches long; wingspread, 12.1-12.9 inches; weight, 0.42-0.56 ounces. The fur is dark brown, and the face, ears and flight membranes are blackish. This common bat ranges throughout the state in diverse habitats: attics, belfries, barns, behind doors and shutters, hollow trees, in city and country.

Big brown bats fly at dusk, and generally use the same feeding grounds each night. They fly in a nearly straight course 20-30 feet in the air, often emitting an audible chatter. Major foods include beetles and true bugs (junebugs, stinkbugs and leafhoppers) many of which are major agricultural pests. A colony of 150 big brown bats can eat enough cucumber beetles during the summer to protect farmers from 18 million rootworm larvae.

Among the last bats to enter hibernation, big brown bats seek out caves, buildings, mines and storm sewers in October, November or December. They hang close to the mouths of caves. They emerge in March and April. Females bear young in June, usually two per litter. As young mature and leave the nursery colony, adult males enter and take up residence. Big brown bats have lived up to 19 years in the wild.

Red Bat (Lasiurus borealis)

A bright rusty coat and long, pointed wings distinguish this species. Length is 3.7-4.8 inches; wingspread, 11.3-12.9 inches; and weight, 0.28-0.49 ounces. Individuals roost singly in trees (except for females with young), often on forest edges, in hedgerows, and shrubby borders; they seem to prefer American elms. Rarely do they use caves or buildings.

Red bats start flying early in the evening, preying on moths, flies, bugs, beetles, crickets, and cicadas, which they take from air, foliage and ground. Strong fliers, red bats are considered migratory, although their patterns are little known. The sexes may migrate separately. Red bats start south in September or October, flying at night. They can withstand body temperatures as low as 23 degrees F.

Females bear 1-5 young (usually 2-3) in their treetop roosts. For the first few days, the young remain clinging to their mother when she flies out on hunts. Young are able to fly at 3-4 weeks, and are weaned when 5-6 weeks old. Longevity is about 12 years. The red bat ranges across Pennsylvania.

Hoary Bat (Lasiurus cinereus)

The largest bat of the Eastern forests, the hoary is 5.1-5.9 inches long; has a 14.6-16.4-inch wingspread; and weighs 0.88-1.58 ounces. The fur is dark brown, heavily tinged and white. The species ranges across the state, but is uncommon.

Hoary bats roost in trees, they prefer conifers, but also use deciduous trees, in woods, forest edges and farmland. They choose protected sites 12-40 feet above the ground. Strong, swift fliers, they take to the air later than most other bats. They prey mostly on moths, but also take beetles and mosquitoes.

Hoary bats migrate to warmer climates in winter. In spring, they return and raise young. The young are born from mid-May to early July, usually two to a litter. Females have two pairs of breasts and sometimes have three of four pups in a litter. The female gives birth while hanging in a tree. Young grow rapidly and are able to shift for themselves in about a month.

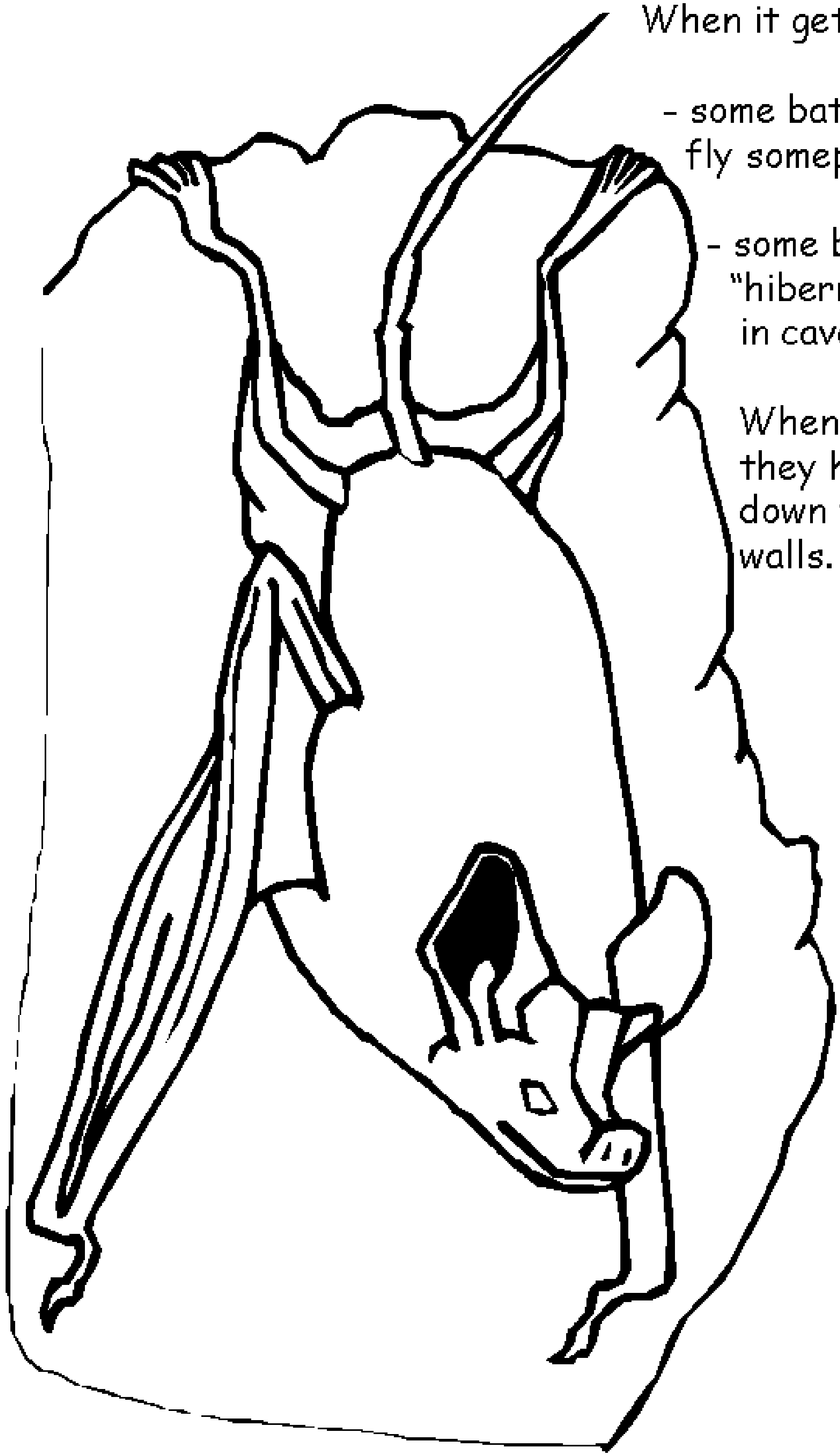
Note: The Seminole Bat *(Lasiurus seminolus)* and Evening Bat *(Nycticeius humeralis)* have been found a few times in Pennsylvania, but are not considered regular residents.

Homeowners having problems with bats may wish to request the booklet, *A Homeowner's Guide to Northeastern Bats and Bat Problems*, by Lisa M. Williams-Witmer and Margaret C. Brittingham, Publication Distribution Center, Pennsylvania State University, 112 Agricultural Administration Building, University Park, PA 16802. A video, *The Season of the Bat*, is also from: Wild Resource Conservation Fund, P.O. Box 8764, Harrisburg, PA 17105-8764 (Phone -- 717-783-1639)

Bat Coloring Pages

The following pages contain pictures which may be printed out and colored by the students. These images were taken from the Contra Costa County Office of Education Bat Thematic Resource website, listed in the **Additional Resources** section.

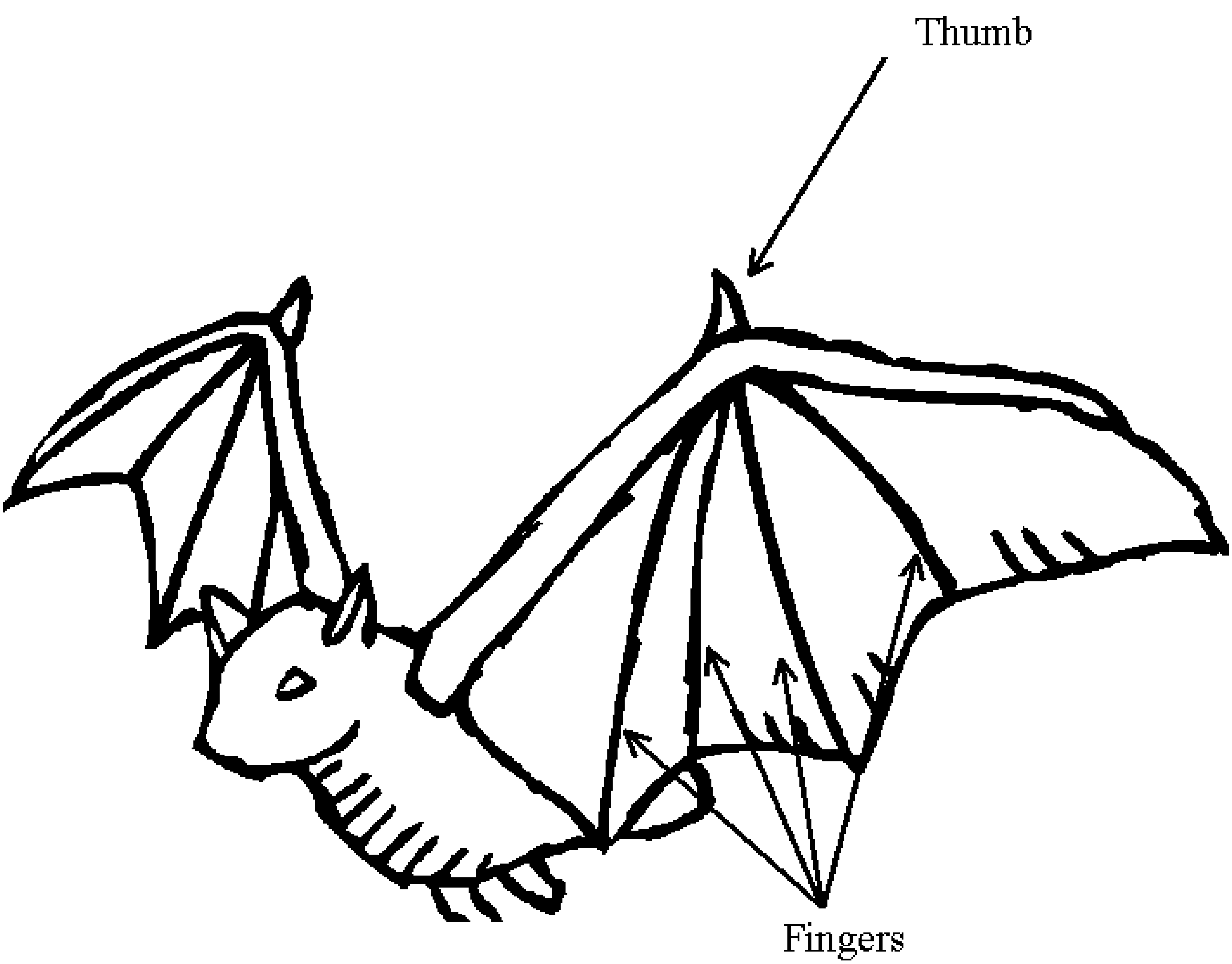
The Internet is full of other resources and lesson plans for learning about bats in your classroom. Several helpful websites have been listed in the **Additional Resources** section.



When it gets cold:

- some bats "migrate" or fly someplace warmer.
- some bats "hibernate" or sleep in caves.

When bats sleep, they hang upside down from the cave walls.



Bats are the only mammals that can fly.

Bat wings are made of two thin layers of skin which are stretched over their arms and fingers.

Bat fingers are very long. If we were like bats, our fingers would be longer than our legs!

Conservation

Surface/Subsurface Relationships Or…

What goes down…must come up.

Caves and the land in which they are located are closely tied together. What happens on the surface can affect the subsurface including GROUNDWATER and caves. For many years, it was generally believed that soil protected groundwater from contamination by human activities on the surface, by filtering out the contaminates. However, this may not always be true. Activities on the land surface, including sewage pollution, runoff from agricultural chemicals, and the elusive "non-point source" pollution, can adversely affect the quality of groundwater, which is the drinking water for about 50% of the U.S. population and 37% of Pennsylvania's residents.

Due to its complex geological history, Pennsylvania has four types of aquifers. Those in carbonate rock are located in the valleys of Central and Southeastern Pennsylvania. In the caves, solution channels, and sinkholes (karst terrain) of these aquifers, large amounts of groundwater can be stored. Contaminants from the surface can move rather quickly and reappear in water supplies miles from their source.

Touring a cave gives us a good 'picture' of the make-up of karst. Imagine you are actually inside the groundwater system, touring a portion of an aquifer, where all the cracks and crevices were once completely filled with water. As the limestone beneath the soil was dissolved to form the cave, the overlying soil settled or collapsed to form sinkholes.

Water entering the ground through sinkholes can carry with it soil, organic debris, and pollutants. This surface water becomes part of the groundwater flow system. Contaminated water draining through a sinkhole in turn pollutes groundwater that wells and springs draw from. Sinkholes are environmentally sensitive areas and should NEVER be used as dump sites. Sinkholes that have been used as dumps should be cleaned out to prevent any further contamination of the groundwater. Treat sinkholes with care—remember; WHAT YOU SEE (in a sinkhole) IS WHAT YOU GET (in your faucet)!!!

Detecting groundwater contamination can be difficult, much more difficult than detection of surface water contamination. Since we can't see groundwater, the first we notice any contamination is usually when it appears in water from springs or wells. "Cleaning up" groundwater can be costly and difficult.

WHAT CAN YOU DO?

- RECYCLE! The only way to reduce the amount of trash going to landfills is for all Americans to actively recycle.
- Dispose of potentially hazardous wastes (chemicals, batteries, oils) in an approved manner/
- Share the message of cave conversation with your family and friends.
- Visit caves carefully! Remember the NSS motto: Take nothing but pictures; Leave nothing but footprints; Kill nothing but time.

Benefits of Caves

Great care must be taken to protect and preserve both the underground life and the cave around it. Caves are non-renewable natural resources, which benefit and enrich our lives in many ways, a few of which are:

Insect Control: Caves provide shelter for many North American bats. Most bats feed on insects, consuming nightly more than half their own weight in insects.

Scientific Knowledge: Caves provide homes for many threatened and endangered species, many of which are specially adapted to the darkness, providing biologists insight into these special adaptations.

Water Supply: Many communities depend on groundwater stored in carbonate rock aquifer for their water supply.

Education/Recreation: The near 200 show caves in the United States, 9 of which are in Pennsylvania, provide recreational and educational opportunities for millions of students and vacationers each year. Undeveloped, or 'wild' caves, of which there are over 1,000 in Pennsylvania, attract cavers (spelunkers) to their unspoiled wilderness for adventure and exploration.

Dangers to Caves

Caves may seem eternal, having been around for hundreds of thousands of years. But every cave is sensitive, whether the cave is open to the public as a show cave or it is an undeveloped wild cave. The biggest threat to these fragile environments is MAN. This threat includes, but is not limited to:

Vandalism: Occurring most often where access to a cave is free and easy, vandalism can and still does occur in show caves. Vandalism ranges from graffiti on cave walls to the breaking and removing of speleothems or simply the casual visitor leaving trash behind. All are detrimental to the preservation of the cave's fragile environment.

Pennsylvania Cave Protection Act: It was signed into law in November of 1990 after much lobbying effort by the Pennsylvania Grottos (Club) of the National Speleological Society. It is now ILLEGAL to harm the cave environment in any way. Although the law is a help, many caves are in remote areas, and it is extremely difficult to catch vandals.

Quarrying: Limestone quarrying can utterly destroy caves. Even when preservation is considered, removal of nearby stone can still cause the collapse of the cave. A limestone quarry operation in Centre County is presently a threat to Hosterman's Pit, a significant wild cave. A campaign to save Hosterman's Pit has been initiated by the Nittany Grotto of the NSS.

Dam Construction: When caves are flooded by dam building, the geological process is immediately halted and cave animals are killed. Rarely are caves assessed for value before they are destroyed.

Water Pollution: One of the most damaging environmental problems facing society and caves today is water pollution. Water is vital to all life.

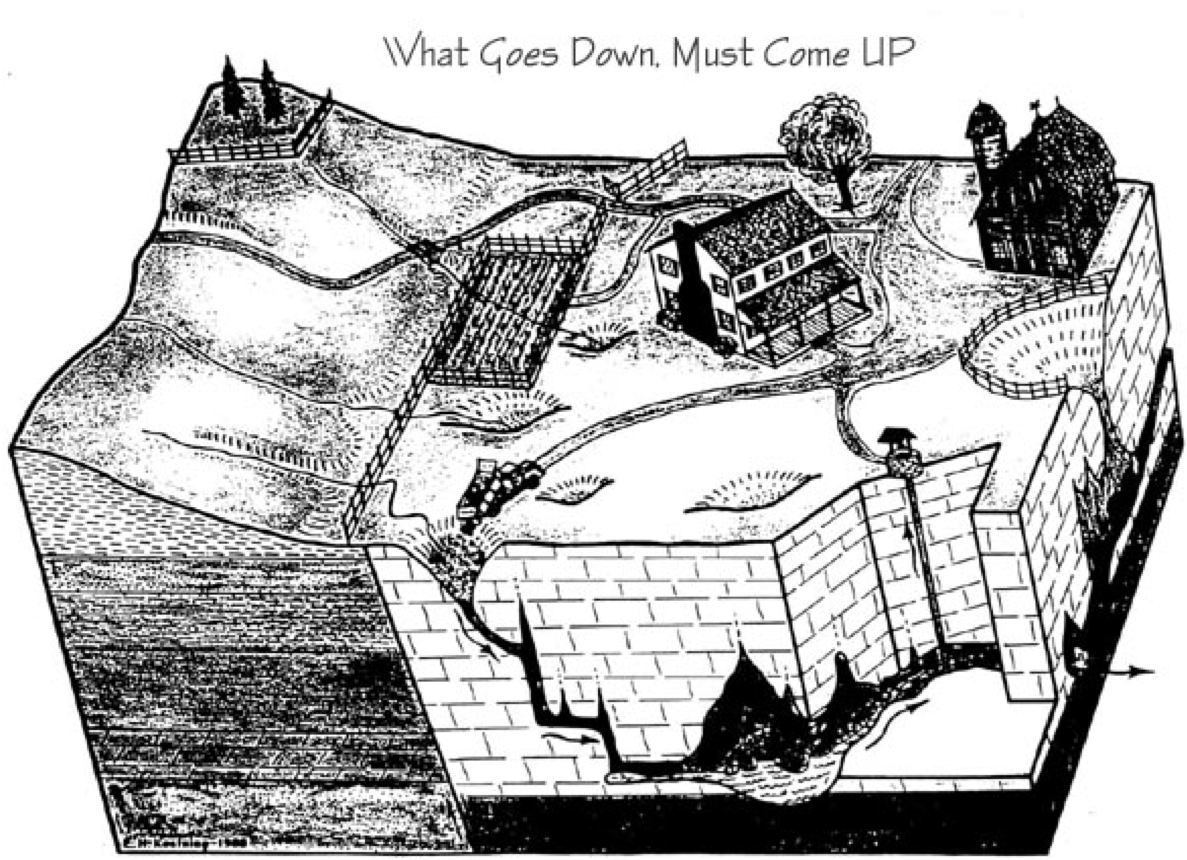
Sewage Pollution: Household septic systems often do not work properly in karst, due to limited filtration. Inadequate waste treatment facilities may also provide a source of organic pollutants. Even city sewage systems can leak when cracks occur in bedrock or sewer pipes.

Solid Waste Pollution: Most soils in Karst areas are too thin to protect underlying groundwater from dumpsite runoff. Substantial volumes of water move through trash, creating a liquid called "leachate". When leachates mix with groundwater, they can kill aquatic life and cause terrible odors.

Oil And Gas Pollution: Gas and oil are very serious water pollutants. When accidental spills from highway accidents and leaks from pipelines and underground storage tanks occur, oil and gasoline can readily follow the same paths as water. Not only do petrochemicals carry a biological burden with them, but they may interfere with the deposition of minerals inside caves.

Agricultural Chemical Runoff: Rapid movement of the groundwater in karst areas causes chemicals within the soils to be leached out quickly. Therefore, extra amounts of pesticides and fertilizers are often applied.

Non-Point Source Pollution: Runoff from a variety of sources, including paved surfaces and residential lawns and gardens, carries many pollutants into the water ways and possibly into karst terrain. These chemicals have a detrimental effect on sensitive environments.



How Does Pollution Get in a Cave?

Materials

- Large plastic jug – preferably clear
- Funnel
- Water and catch-basin
- Experimental materials such as food coloring, dirt, sand, classroom objects, etc.

Procedure

1. Punch a few holes of different sizes in and around the jug, near the bottom.
2. Place or tape funnel in mouth of jug.
3. Over a sink or basin, fill the jug with water, and observe results.
4. Add materials, one at a time, to the "sinkhole" and watch what happens when more water is added.
5. Repeat with other materials on hand.

Discussion

Let the funnel represent the sinkhole, and the materials are objects that have found there way in over time. Let the students explore (smell, touch, look) the water after each experiment. Have the students describe what happens to the inside of the cave (jug) as well as the water passing back into the environment.

Which objects had the greatest effect? Which ones might be found in a real sinkhole. What can students do to prevent pollution from damaging the caves and water sources? What might like to live in or drink the water that has come out of the polluted cave?

Variations:

Try adding several materials to the sinkhole at once. This activity can be modified to fit your grade by adding appropriate steps from the "Scientific Method" to the activity. Students can also chart/record results or work in small groups.

Additional Activities

Business Letter Composition

Have each student choose a cave from the National Caves Association website (http://www.cavern.com) and write to that cave for brochures/additional information. Be sure to include caves representative of some of the Types of Caves listed above.

Letter Writing Campaign

Find out if there is a groundwater pollution problem, sinkhole dumping, and/or a cave in danger of being destroyed in your area. Write letters to the editor of your paper AND to your senators and congressmen expressing your feelings about the issue. Information sources may include: local government officials, PA Department of Environmental Resources, the Chesapeake Bay Education Office, and/or the NSS.

Check Your Waterways for Pollution

Some laundry soaps and detergents contain fluorescent dyes called optical brighteners. These dyes are used to 'whiten' clothes. Since laundry waters are a component of sewage, their presence is evidence of sewage contamination in the stream or spring.

Sampling for optical brighteners uses pads of cotton, which have not been optically brightened. Most of the Johnson & Johnson cotton balls have not been optically brightened (check them before use). A packet of about ¼ ounce of cotton is made by sewing or stapling the cotton into a packet of screen wire. Fiberglass screen wire is best; it does not rust or stick in your fingers. The packets are then wired to rocks in the water at the location that you wish to test. Position them to get the largest stream flow as safely as possible. After a few days (not more than a week), collect the packet and place it in a clean plastic bags for transport. Refrigerate the sample after collection.

The packets must be cleaned by vigorously spraying them with water. A garden hose with a pistol-grip nozzle works well. (Sprayer on kitchen sink does not produce enough pressure.) After washing, the cotton is removed from the packet and placed in a clean plastic bag. Working in a darkened room, the sample is examined with an ultra-violet light (the type used for mineral samples is fine). If optical brighteners are present in the water, they will have dyed some of the cotton a fluorescent white. Control samples, some place in distilled water and others in wash water containing detergents with optical brighteners, are compared under the ultra-violet light with the stream samples. Be certain to label stream and control samples properly, and all samples can be saved for future use by drying or freezing.

CAVE BULLETIN BOARD or DIARAMAS:

Help spread the message of the importance of caves and what we can do to protect them AND groundwater by doing a bulletin board in your school or public library. You may choose to design posters to put up in your school or community.

With construction paper, cut out speleothem shapes for a Cave Bulletin Board.

Using a shoebox (or school display case) and shape construction paper for speleothems.

You may want to use:

narrow tubes for soda straws
cones for stalactites and stalagmites
crumple paper to build flowstone
pile ‘balls’ of paper for cave coral

1. Glue to tape your creations in your display.
2. Be sure to add color.
   White: pure calcite
   Red/Orange: cave bacon
   Brown: remaining formations
3. Add to your display. As you continue with the section on CAVE LIFE you can add cave animals to your bulletin board or dioramas(s).

SUGGESTED FIELD TRIP FOLLOW-UP ACTIVITIES

Penn’s Cave Map---Using the map of Penn’s Cave, see if you can retrace your tour route. Use the key provided to recognize specific features of the tour.

Cave Pictures---Draw, color, or paint pictures of your visit. Display them in your school, OR send them to Penn’s Cave. We will display student’s artwork throughout the season as space permits.

Additional Reading---Check your school or local library for children’s books on caves, bats, and/or rocks and minerals. Read one or more of these books in the classroom, or assign as extra credit.

GLOSSARY

Anticline: folds that arch rock strata upward.

Aquifer: rock or soil layers beneath the water table that store and transmit usable amounts of water.

Calcite: the mineral which limestone (and speleothems) is composed of.

Carbonic Acid: produced when carbon dioxide combines with water. It attacks calcite to form caves.

Echolocation: use of reflected sound by bats (and other animals such as dolphins) to locate objects.

Endangered Species: in danger of becoming extinct, these species are protected by law.

Groundwater: water stored beneath the water table in the zone of saturation where spaces are filled with water.

Hibernation: state of greatly reduced activity and metabolism, occurring in winter.

Karst: terrain in which solution, or dissolving of limestone, plays a major role in land erosion.

Sedimentary Rock: one formed in layers.

Show Cave: prepared for visitors and open for tours by the public.

Sinkhole: depressions caused by the dissolving of carbonate bedrock and the collapsing of the surface.

Solutional Cave: formed when soluble rocks are dissolved by water containing a weak natural acid.

Speleology: the study of all aspects of caves and cave life.

Speleothem: secondary mineral deposits in caves commonly called cave formations.

Spelunker: a person who explores caves, often called 'cavers'.

Syncline: downfolds in the rock strata.

Threatened Species: protected species which are at risk of becoming extinct.

Troglobite: animals that spend their entire lives in the cave's total darkness and uniform environment.

Troglophile: animals living most of their lives in the cave, but with the ability to survive outside.

Water Table: the top of the zone of saturation below which all cracks and crevices are filled with water.

Wild Cave: caves that have not been prepared for visitors and for which specialized equipment is needed.

Additional Resources

FOR MORE INFORMATION ABOUT CAVES AND CAVE LIFE, WRITE:

National Speleological Society
Cave Avenue
Huntsville, Alabama 35810

Bat Conservation International, Inc.
P.O. Box 162603
Austin, Texas 78716-2603

National Caves Association
Route 9, Box 106
McMinnville, Tennessee 37110

American Cave Conservation Association
P.O. Box 409
Horse Cave, Kentucky 42749

OTHER RESOURCES:

Pennsylvania Game Commission (Bats)

Contact your regional office for availability of publications/programs or check online at:
http://www.pgc.state.pa.us/

Pennsylvania Geologic Survey (Various Maps/Publications)

P.O. Box 2357
Harrisburg, Pennsylvania 17105-2357
717-787-2169
Chesapeake Bay Education Office (Groundwater/Sinkholes)
225 Pine Street
Harrisburg, Pennsylvania 17101
717-236-1006

Very useful and attractive maps can be downloaded in Adobe Acrobat format from the DCNR website at:
http://www.dcnr.state.pa.us/topogeo/maps&photos.htm

Online Resources

Cave Websites

USGS Learning Web

http://www.usgs.gov/education/index.html

National Park Service: Guide to Caves, Karst, and Groundwater

http://www.nps.gov/ozar/skindeep.htm

National Caves Association

http://www.cavern.com

National Speleological Society

http://www.caves.org

American Cave Conservation Association

http://www.cavern.org/ACCA

Bat Websites

Bat Conservation International

http://www.batcon.org

Contra Costa County Office of Education: Bat Thematic Unit

http://www.cccoe.k12.ca.us/bats/welcome.html

Teachers Resources from Other Caves

Marengo Caves

http://marengocave.com/teachers/

Mammoth Cave National Park Learning Place

http://www.nps.gov/maca/learnhome/learnhome.htm

Carlsbad Caverns About Bats, Caves, Deserts

http://www.nps.gov/cave/teacherguide/abcd.htm

Ohio Caverns School Project Ideas

http://www.cavern.com/ohiocaverns/school.htm

Acknowledgements

Materials and information for the content of this teacher's guide were gathered from many sources, including the organizations and resources listed. We sincerely appreciate all their help.

We would also like to thank a special group of friends - members of the National Caves Association. The show cave community continues to unselfishly share their ideas and creativity in the continued effort to spread the message of cave conservation and appreciation of the underground environment with the American public. The following NCA member caves have generously shared their educational publications with us.

Without their assistance, this booklet would not have been possible:

Lincoln Caverns, Pennsylvania

Crystal Cave, Wisconsin

Fantastic Caverns, Missouri

Mammoth Cave, Kentucky

Beautiful Rushmore Cave, South Dakota

Marengo Cave, Indiana

Thanks also go to the many employees of Penn's Cave who contributed to the creation of this document.