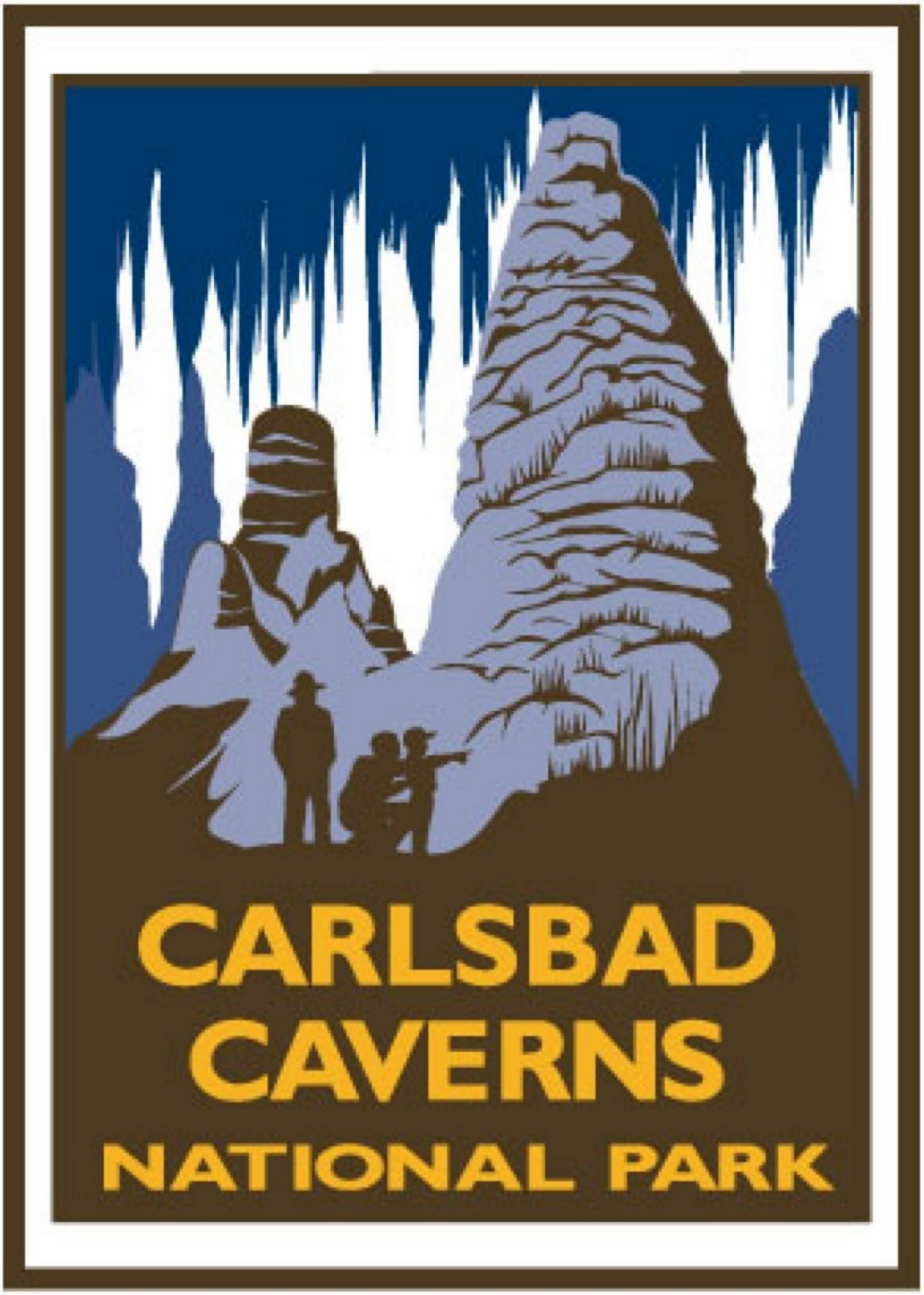
About Bats, Caves, & Deserts

A curriculum and activity guide for Carlsbad Caverns National Park

Elementary School



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Introduction

About Bats, Caves, and Deserts (*ABCD*) is based on the *Carlsbad Caverns Teacher's Activity Guide* published in 1996. Like the guide, *ABCD* is basic, appealing primarily to elementary teachers. However, it differs in a number of ways. *About Bats, Caves, and Deserts:*

- is aligned with New Mexico State of Education's state-wide curriculum framework, Content Standards with Benchmarks for Kindergarten through 12th Grade, published in 1996 and 1997
- explains field trip options
- explains the reasons for park rules
- explains the fee waiver process
- includes a section with basic information on park resources
- includes new activities
- has a comprehensive glossary
- lists content standards and benchmarks for cross-referencing
- includes evaluation forms

Understanding the Codes for Benchmarks

For efficiency, Carlsbad Caverns National Park has assigned codes to each benchmark written by the New Mexico Department of Education for kindergarten through twelfth grade.

Each benchmark code includes the following four elements:

1. **Subject Code:** The subject code is the first two letters.

SC	Science
LA	Language Arts
SS	Social Studies
MA	Mathematics
AE	Arts Education

2. **Content Standard Code:** The content standard code appears immediately after the two letter subject code, and corresponds with the number assigned by New Mexico Department of Education.

3. **Academic Level Code:** The Academic Level Code is the single letter that appears after the dash.

E	Primary/Elementary Grades (K-4)
M	Middle/Intermediate Grades (5-8)
H	High/Secondary Grades (9-12)

4. **Specific Benchmark Code:** The individual benchmark code is the last number in the code at large. All individual benchmarks were numbered consecutively as they appear within their content standard.

Example: SC2-H1=Science, Content Standard 2, Secondary Level, First Benchmark Listed

Section 1 – Field Trip Basics

Field Trip Essentials for Teachers

- If you are applying for a waiver of cave entrance fees, mail your **fee waiver application** at least one month in advance of your group's visit. The park needs 15 working days after receipt of your application to thoroughly review and respond to your application.
- Prepare your students through curriculum-based, **pre-visit activities**.
- Stress **park rules** with your students and chaperons prior to the field trip. Teach your students the reasons for each rule.
- Make sure all adults and students in your group participate in the park's **group orientation**. A park ranger will ask your students to recall park rules and the reasons for them. Students will also be asked to share what they learned in the course of their pre-visit studies.

Important Field Trip Notices

- A fee waiver may be revoked and a bill of collection sent to your school, if your group behaves inappropriately. A bill of collection may also be sent if the group's activities indicated that the primary purpose of the field trip was recreational, rather than educational, in nature.
- A fee waiver applies **only** to the self-guided Natural Entrance Route and the self-guided Big Room Route. Park rangers are not available to conduct tours of the Cavern's self-guided areas.
- An optional audio guide is available for a rental fee of $3.00 per person.
- Tours, times and fees are subject to change, without notice.
- Field trip dates should coincide with classroom studies. Most schools schedule field trips for April and May. Fall and winter field trips are often more conducive to learning, as the cave is less crowded and park rangers have more opportunities to conduct special educational programs.
- Ranger-led educational programs must be scheduled well in advance.

Group Rules and Safety Matters

- Students must **stay with adult sponsors** at all times. We recommend **1** adult for every **6** students; but will allow a 1:10 ratio. Each adult is responsible for a specific group of students and must maintain control. On trails (cave or surface), one sponsor must led the group and another must be at the end. Other adults should scatter among the students.

- Only **50** group members will be permitted into the Cavern at the same time. Larger groups may divide into groups of 50 and enter the cave in 15-minute intervals, or groups may start at the same time through different entrances.
- **Remain on hard-surface cavern trail** because the cavern floor is very delicate and can be hazardous.
- **Talk quietly** to allow yourself and others to enjoy the cave's natural silence.
- Cave pools are not wishing wells. **Do not throw anything in the pools**. Foreign materials introduce new bacteria. The native bacteria may not be able to compete with the foreign bacteria, and thus, may be eliminated.
- **Tobacco use of any kind is not permitted** anywhere in the caves.
- **Gum, food and drinks are not allowed** on the cavern trail system. The odor from gum and food can attract animals not normally found in the cave. Once they are in the cave, they often cannot find their way out. The underground rest area is the only place where food is permitted.
- **Do not touch cave formations, walls or ceilings**. Oils and dirt from hands can permanently damage and stain the caves.
- **Do not collect anything natural to the park**.
- **In case of injury or illness, notify a ranger immediately**. Phones are located along the cavern trail.
- This is a desert! Everyone should **carry a bottle of water** on surface hikes.
- Please let your students know in advance that elevators are used to return visitors to the surface. If a walkout is necessary, notify a ranger.

Fee Waiver Application Process

As a unit of the National Park System, Carlsbad Caverns National Park complies with the Code of Federal Regulations (Title 32, Part 2, Section 71.13) and NPS Guideline #22. Under these regulations and guidelines, your group may qualify for a waiver of cave entrance fees.

Although there is no entrance fee for children 15 and under, the fee waiver provides free access to the cave for the adult sponsors (at a minimum ONE adult is REQUIRED for every TEN students). Only organized tours or outings conducted for educational or scientific objectives are eligible. Please remember that the National Park Service allows a maximum of 300 students per day into the cave. To apply, please send the following:

1. A letter on your school's letterhead stating the purpose of your visit, name and phone number of sponsoring teacher, the number of students, number of adult sponsors, date of visit, and approximate time of arrival.
2. A copy of your lesson plans to verify the relationship between your studied curriculum and the park's resources.
3. Return a signed copy of the Group Visitation Rules to ensure that the rules have been discussed with all group participants prior to the visit.

If the park questions whether or not your group is from a bona fide educational institution, you will be asked to provide documentation of your official recognition as a bona fide educational institution, such as a copy of the school's Educational Tax Exemption Certificate.

Mail your fee waiver request at least three weeks in advance of your group's visit to allow the park sufficient time to thoroughly review and respond to the application.

Send your request to:
Carlsbad Caverns National Park
Attention: Fee Collection Supervisor
3225 National Parks Highway
Carlsbad, NM 88220
FAX 505.785.2302

If you do not receive a response, call 505.785.3137, between 8:30 a.m. and 4:30 p.m. (Mountain Time).

If your application is approved, a copy will be mailed to you. Bring the copy with you when you visit the park and present it to the ranger at the information desk.

A fee waiver may be revoked and a bill for collection sent to your school if your group behaves inappropriately. Go over the cave rules with the students several times before you visit the park.

A bill for collection may also be sent if the group's activities indicated that the primary purpose of the field trip was recreational, rather than educational, in nature.

A fee waiver applies only to the self-guided Natural Entrance Route and the self-guided Big Room Route. Park rangers are not available to conduct tours of the cave's self-guided areas. An optional audio guide is available for $3.00 per person.

Hours of Operation – The park is closed on December 25.

School Year Hours (Mid-September through Mid-May)

8:00 A.M. - 5:00 P.M. Visitor Center

8:30 A.M. Ticket Lines Open

8:30 A.M. - 2:00 P.M. Hours of Entry for Natural Entrance Route

8:30 A.M. - 3:30 P.M. Hours of Elevator Entry for Big Room Route

Hours During Summer Season

The visitor center closes at 7:00 P.M.

The last entry by the Natural Entrance Route is at 3:30 P.M.

The last entry by elevator for the Big Room Route is at 5:00 P.M.

Cave Tours

Self-Guided Tours – Least Restrictive

***Natural Entrance**

- 790-foot descent into the depths of the cavern
- **daily** from **8:30 A.M. until 2:00 P.M.** (longer hours in summer)
- one-mile trail

- **one-hour** walking time
- may continue to the Big Room or may return by elevator
- steep and narrow switchback trail
- not accessible to people using wheelchairs
- not recommended for those with health or walking problems
- appropriate for all academic levels (adult supervision required)
- baby strollers not permitted for safety reasons
- **FEE WAIVER information: 505.785.3137**
- fees without waiver: $6.00 (ages 16 and up). Free for ages 6 through 15

*__Big Room__

- massive 8.2-acre chamber
- **daily** from **8:30 A.M. until 3:30 P.M**. (longer hours in summer)
- one-mile trail
- **1½-hours** walking time
- may enter by elevator or the natural entrance route
- well-graded and mostly level trails
- partially accessible to people using wheelchairs with assistance
- appropriate for all grade levels (adult supervision required)
- baby strollers not permitted for safety reasons
- **FEE WAIVER information: 505.785.3137**
- Without waiver: $6.00 (ages 16 and up). Free for ages 6 through 15

*One general admission ticket or fee waiver covers both self-guided tours. A general admission ticket is good for three days. A fee waiver is good for only the date(s) stated in the letter.

Guided Tours – Restrictive

****King's Palace**

- highly decorated chamber 830 feet below the surface
- **daily** at various times. (additional tours during summer)
- **$ 8.00** (ages 16 and up), **$ 4.00** (ages 4 though 15)
- 1½-hour tour
- meets at underground rest area
- **75-person limit** (These spaces are also available to the general public.)
- not accessible to persons using wheelchairs
- no children under the age of 4
- reservations: call **1.800.967.CAVE (2283)**

Slaughter Canyon Cave

- **undeveloped** backcountry cave (no electricity, no paved trail)

- 30 to 45-minute hike uphill from the Slaughter Canyon Cave parking area to the cave entrance
- **Saturday and Sunday year-round AND daily during season** (Memorial Day through Labor Day) tours are available to the **general public**. For reservations, call **1-800-967-CAVE**. Fees are **$15** for ages 16 and up and **$7.50** for ages 6-15.
- Times vary, tours begin at cave entrance
- **2½-hour tour** plus hiking time to and from cave entrance
- **25-person** limit
- no children under the age of 6
- flashlight with two, or more, fresh D-cell batteries and drinking water for each participant.
- Hwy 62/180 to County Road 418 (5 miles south of White City) and follow signs (45-minute drive from Carlsbad, 35-minute drive from the visitor center).

Guided Tours – Highly Restrictive

****Left Hand-Tunnel**

- easy, one-half mile lantern tour (lanterns provided)
- highlights cavern history, formation, cave pools and Permian Age fossils
- offered **daily** at **9:00 A.M.**
- 2-hour tour
- **15-person limit** (adults and students) – no exceptions
- **no one under the age of 6**
- **$7** (ages 16 and up), **$3.50** (ages 6 through 15)

****Lower Cave**

- evidence of early exploration, cave pools and beautiful formations
- moderately-strenuous, 50-foot descent on ladder
- gloves are four AA batteries needed for participant (helmets supplied)
- **Monday – Friday** at **1:00 P.M**.
- 3-hour tour
- **12-person limit** (adults and students) – no exceptions
- **no one under the age of 12**
- **$20** (ages 16 and up), **$10** (ages 12 through 15)

****Hall of the White Giant**

- challenging tour to a remote chamber in Carlsbad Cavern
- strenuous, must crawl long distances, squeeze through tight crevices and climb slippery formations
- gloves, knee pads and 4 new AA batteries for each participant, helmets supplied by park
- **Saturdays** only at **1:00 P.M.**

- 4-hour tour
- **8-person limit** (adults and students) – no exceptions
- **no one under the age of 12**
- **$20** (ages 16 and up), **$10** (ages 12 through 15)

Spider Cave

- cave located off Walnut Canyon Desert Drive, has many bizarre formations
- strenuous caving tour, tight crawl ways and canyon-like passages
- departs from the visitor center and includes a ½-mile hike to cave entrance
- gloves, knee pads, 4 new AA batteries and drinking water for each participant
- helmets supplied by park
- **Sundays** only at **1:00 P.M.**
- 4-hour tour
- **8-person limit** (adults and students) – no exceptions
- **no one under the age of 12**
- **$20** (ages 16 and up), **$10** (ages 12 through 15)

**Also requires general admission ticket or fee waiver for the self-guided tours.

Who to Contact

Call the Park Operators at 505.785.3137, if you wish to:

- ask questions of a general nature.
- bring your school group for self-guided tours only.
- check the status on your request for a fee waiver.

Call the reservation number at 1.800.967.CAVE (2283), if you wish to:

- schedule tours for which students must pay a fee such as Left Hand Tunnel, Lower Cave, Hall of the White Giant, Spider Cave and King's Palace.

Call the Education Office, at 505.785.3127, if you wish to:

- schedule a ranger-led program in the classroom.
- make reservations for the Chihuahuan Desert Lab (high school students).
- share comments, suggestions or complaints about an educational program.

Section 2 – Just the Facts

The Significance of Carlsbad Caverns National Park

These statements explain why the park is important to our natural and cultural heritage:

- Carlsbad Caverns National Park, a world heritage site, contains large caves of world-class importance that have beautiful and diverse speleothems (cave formations); the Big Room in Carlsbad Cavern is the largest, most easily accessible chamber in North America.
- Lechuguilla Cave is the deepest limestone cave in the United States; it contains speleothems and microbes found nowhere else in the world.
- Carlsbad Caverns National Park preserves a portion of the Capitan Reef—one of the best preserved, exposed Permian-age fossil reefs in the world. The park's caves and canyons provide visitors with unique opportunities to view this reef from the inside.
- Capitan Reef has exceptional potential for additional cave discovery, exploration and research.
- The park contains one of the few protected portions of the northern Chihuahuan Desert ecosystem.
- Carlsbad Cavern has a world-famous colony of migratory Mexican free-tailed bats.
- Many species of plants and animals in the park are at the limits of their geographic distribution, including the northernmost and one of the largest colonies of migratory cave swallows in the United States.
- The park's cultural resources represent a long and varied continuums of human use starting in prehistoric times and illustrating many adaptations to the desert environment.
- Capitan Reef provides extraordinary scenic vistas, both from the top of the escarpment and from the rugged canyons below; the quality of these vistas depends on excellent air quality.

A Good Scientific Investigation

A good scientific investigation is not just one experiment. It is a long-term series of related experiments. A good investigation will be characterized by the following:

- It is as specific as possible.
- All factors are held constant except for the one factor being tested.
- It has a control. The control proves that the factor being tested actually caused the result being observed. It is a basis for comparison.
- It is extensive, continuing for a period of time and testing a large population.
- The student doing the investigation records each phase of work in a journal. The journal includes the thought processes the student followed, the work that led up to his/her experiment, the investigative techniques that were used, the results of each test, the problems that were encountered, and the solutions to the problems. Charts are also included in the journal to help organize the data collected.
- Its results are measurable or countable.
- Its experiments are repeated several times and the results are averaged.
- Its results are compared to known data.
- Its results are presented in charts and graphs. A good graph is neatly drawn, is large enough to be clearly seen, uses color or texture to clearly show a difference among items being graphed together, has limited items to prevent confusion, includes a key to explain colors or symbols, has a title and tells a purpose, and has labels for each axis to indicate what they represent and what measuring units are used.

Any *science fair exhibit* should contain the following:

- problem
- purpose
- hypothesis
- data
- results
- conclusions
- materials
- variable
- procedures

The six steps to the *scientific method*:

- State the problem.

- Gather information.
- Formulate a hypothesis.
- Test the hypothesis, limiting the number of variables to one.
- Record and analyze any changes.
- State the conclusion.

When all is said and done, *scientists sometime disagree*. Even when utilizing the data collected from the same study, scientists may draw different conclusions. Yet, as non-scientists, we often feel we must accept whatever the experts write or say. But when they disagree, whom do we believe? How do we draw our own conclusions from the research? How do we know what is fact and what is really theory?

Below are a few questions that a non-scientist may attempt to answer to decide for himself/herself if something is *fact* or *theory*:

- Was the *idea* or *fact* tested through observation and experimentation?
- Is the *idea* or *fact* based on an assumption?
- Is the *idea* or *fact* consistent with other scientific laws; such as, the law of biogenesis, the law of heredity, the laws of logic, the laws of probability, the 1st law of thermodynamics; the 2nd law of thermodynamics?
- Was the *idea* or *fact* tested in such a manner that all things were considered - the actual structure of what was being tested and its chemical nature, etc.?
- Does circular reasoning or *scientific reasoning* support the *idea* or *fact*?
- Does the *idea* or *fact* sound sensible or does it conflict with what you are able to observe in nature?

If you read or hear something that just does not make sense to you, ***investigate***. It may be nonsense!

Fires at Carlsbad Caverns National Park: Foe or Friend?

A Healthy Force of Nature. The underground world is only half the story of Carlsbad Caverns. The park is located in the Chihuahuan Desert, a rich land where a wide diversity of plant and animal communities lives. Natural forces and processes constantly touch its landscape. Long droughts, torrential downpours, strong winds, lightning and wildfires all help shape the desert ecosystem.

Of all natural processes, fire is the least understood and accepted. Yet, it receives lots of attention because of its unmistakable signature—**smoke**!

Researchers believe large fires have occurred in the park about every 25 years. Fire is the most influential ecological disturbance of the park's plant and animal community. Fire has played a major role in shaping the grasslands, which once dominated the park landscape. Because fire releases nutrients into the soil, the fire cycle is needed to maintain nature's balance within the Chihuahuan Desert ecosystem. Without it, the soil would not be able to support its large number and variety of plant and animal communities.

During the first part of the 20th Century, many land managers thought fire was bad. A massive and very successful effort was made to teach fire prevention and to suppress wildland fire. Fires were extinguished as soon as they were spotted. The United States did a good job, in fact, too good of a job, extinguishing all fires. Although unplanned fires are often deadly, not all fires deserve a bad reputation.

Types of Fire. Today, all land management agencies make a clear distinction between types of fire. Wildfires are unwanted fires and are suppressed. Wildland fires, caused by nature's lightning, are closely monitored and allowed to burn within limits. Sometimes fire fighters plan, start and monitor fires for a healthy ecosystem. Today, these planned fires are called management- ignited fires and are allowed to burn within the limits spelled out in the fire plan for the area. Sometimes fires started by lightning or by management get out of control and become wildfires.

When fire managers plan a fire, they do their best to make sure the conditions are right to meet the goals of the plan. Managers consider the following:

- relative humidity
- temperature
- wind speed
- wind direction
- fuel moisture of the vegetation

Why Fire is Beneficial. Prescribed fire is an essential tool in our attempt to restore the park's out-of-balance ecosystem. Fires are planned for these reasons:

- **Fire reduces hazardous fuels that accumulate on the ground**. Forests and rangelands produce undesirable vegetation that ignites readily when dry. A destructive wildfire results when of large amounts of vegetation, much of it dead, is ignited.

- **Fire improves wildlife habitat**. Small fires cause woody vegetation to regenerate and re-sprout, resulting in palatable and nutritious food to wildlife. As thickets of dead and down trees are removed, new areas become accessible to wildlife.
- **Fire removes noxious and competitive weeds**. Harmful plants are either killed or injured by fire, depending upon how intense the fire and how long the plants are exposed to heat.
- **Fire is used to enhance landscapes**. Fire increases the number and visibility of flowering annuals and maintains open spaces. A diversity of vegetation also attracts a wider variety of animal life.
- **Fire releases nutrients into the soil**. It is an important agent in recycling nutrients found in living and dead plant materials. The growth potential for surviving new plant life improves. But without fire, nutrients may not be sufficiently released into the soil for new plant life to emerge.
- **Fire improves grazing**. Park rangers and forest rangers are not the only ones who use fire as a resource management tool. Ranchers use fire to improve gazing. When a fire is well planned and done correctly on ranch lands, the result is forage for cattle. The quality and quantity of grasses and forbs increase because dead materials are removed allowing new growth that is high in protein, phosphorous and calcium.

Fires Caused by Lightning. Lightning causes seventy six percent of the fires in Carlsbad Caverns National Park. These prairie and woodland fires are well documented in historic records from the late 19th Century. Tree ring studies have documented fir scars hundreds of years back. Most of these fires were relatively small, but have burned up to tens of thousands of acres.

Once a lightning fire is detected, park rangers assess the situation. Instead of rushing in and putting the fire out, they answer a few questions:

- Are conditions right for this fire to reduce fuels under the best conditions?
- Is there a threat to life, property, historical or cultural resources?
- Will the long term weather patterns help support the decision?

If these variables are all favorable, then park rangers begin strict monitoring procedure and allow the fire to burn. If any of these variables change, the fire is reclassified as a wildfire and is extinguished.

Fire Studies. Management-ignited prescribed fires are set at two or three locations each year at Carlsbad Caverns National Park. Along the park roadways you will notice a greater diversity of plant and animal life in the burned areas. Past research indicates that carefully managed fires increase the biological diversity of the park. Studies are underway on the effects of fire on plant colonization and distribution. The data will guide the park's prescribed fire program, which is aimed at restoring fire as a force in shaping the ecosystem.

The Bats of Carlsbad Caverns and Elsewhere

***P**lease **P**rotect **P**est Controllers, **P**lanters and **P**ollinators!*

It's a bird; it's a plane; **it's a bat**! A bat is the only mammal that can fly. Its scientific name is Chiroptera (Ki-ROP-ter-ah), meaning *hand-wing*. I guess you can say a bat is handy to have hanging around. After all, bats are great for the ecosystem. Most eat tons and tons of harmful insects. Some species help plant rainforests, while others pollinate plants. The thousand species of bats are divided into two main groups—Megachiroptera (big hand-wing) and Microchiroptera (small hand-wing). We will call them megabats and microbats.

Eyes, Ears, Echoes and Eatables. Most bats are microbats. They live just about everywhere but the polar regions. That's because there isn't much food to munch on at the poles.

Microbats are known for their sound system-echolocation. They produce high-pitched sounds that humans cannot hear. These sounds bounce off objects. By listening to their echoes, these bats are able to judge size, distance and movement of everything in their path. Flaps of extra skin on their ears and noses help microbats catch their echoes.

The bats in the United States are mostly insectivores. Using echolocation, they identify moths, mosquitoes and various they flying insects. Bats usually catch prey in their mouths, but sometimes use the skin flap between their legs to catch insects.

Megabats have large eyes and long noses. Some megabats live in the tropics and eat fruits—frugivores. They swallow the fruit juices and spit out the flesh and seeds of the fruit. The fruit bat is believed to be nature's most important seed-dispersing animal. Plants that are dependent upon the fruit bats include bananas, breadfruit, carob avocados, dates, figs, peaches, cloves, mangos, cashew nuts, and agaves.

One megabat species echolocates. It makes a non-ultrasonic clicking sound that echoes off cave walls. Once the bat is outside its dark roost, it uses its eyes to look for food.

A few bats are carnivores. They eat meat-small mammals, frogs, other bats and fish. Fish eating bats are piscivores. They use echolocation to detect ripples on the water's surface made by fish.

Nectivores pollinate flowers as they feed on pollen and nectar. These bats have long tongues that can reach down into flowers and lap up nectar.

Less than one percent of bats feed on blood. These vampire bats are called sanguivores. They live in Mexico, Central America and South America. There are only three species of vampire bats. Two of the three species feed on the blood of birds, and the other species drinks the blood of mammals-mostly cattle.

If you are worried about a vampire bat sucking your blood, better keep your toes covered! That's right. A bat is more likely to suck the blood from your toes than from your neck.

But should you go through life worried about catching rabies? No, not from bats. Relatively few bats are rabid. If you don't touch a bat, you won't get rabies from it. However, your cats and dogs need their rabies shots. Your own pets are more likely to carry rabies.

Sleep in Peace. Bats are nocturnal, flying in darkness searching for food. During the day, they sleep hanging upside down. Bats huddle closely together. Hundreds can hang out together in a single, square-foot space!

Only bats that live in temperate climates hibernate. Hibernation allows their body temperature to cool down. To conserve body fluids, bats hibernate in cool, damp places like caves. However, Mexican free-tailed bats at Carlsbad Caverns do not hibernate, they migrate south.

Hibernating bats should not be awakened before they are ready. The thirty-minute waking process causes bats to use much of their stored fat. If they cannot find food to replace their lost energy, they die.

Papa Bat, Mama Bat and Baby Bat. Papa bats and mama bats have baby bats—pups. Female bats of the same species gather in nursery colonies to give birth to and raise their pups. Colonies of bats often gather in caves.

Mexican free-tailed bats and most other bats have only one pup a year. Any more than two pups would weight down the mother, making flying very difficult.

Pups usually develop quickly, taking only six to nine weeks to become adult bats. They usually fly for the first time when they are three or four weeks old. By this time, they have permanent teeth, having already lost their milk teeth. Pups keep the Tooth Fairy busy!

Five hundred pups can roost in a one-square-foot area of a cave ceiling. These crowded conditions keep the babies warm. The warmer the pups, the faster they grow.

Mother bats leave their babies behind to find food. At sunrise, do you think a mother bat can return to the roost and locate her own pup, among thousands all huddled together? The answer is yes! We aren't positive HOW, but perhaps the nose knows. It is commonly thought that a mother bat identifies her own pup by recognizing its odor. Perhaps the mother also recognizes her pup's clicking sounds.

Yucky Guano! Some caves have million of bats living in them. At Carlsbad Caverns National Park research is being done to determine just how bats are living in the cave. Park rangers estimate that there are currently between three and five hundred thousand bats. All these bats translate into deep piles of guano!

Jim White, who explored Carlsbad Caverns a hundred years ago, estimated that a hundred-thousand tons of guano (bat droppings) were mined from the cave back in the early 20th Century. The guano was used to fertilize citrus groves in Southern California. Since becoming a National Park site, no guano has been mined.

Guano is more than a fertilizer. Many tiny creatures live and feed on the guano. Larger creatures eat the tiny creatures. It's part of a food-chain.

Who in their right mind would wade through tons of guano for the sake of education? Students might ask their teachers. Some Carlsbad teachers have braved the odor of bat guano. And for what? Just to go back to their classrooms and share first-hand knowledge of Bat Cave.

A Bad Rap! Bats don't deserve a bad reputation; they deserve a bat reputation. Bats don't get tangled in hair; they aren't flying mice; they aren't dirty; they aren't blind; and they aren't evil.

Bats have only a few natural enemies. Their predators include owls, hawks, and snakes. People are bats worst enemies. People ruin bat habitats when they clear forest and pollute. They kill

hibernating bats by waking them. And some people even deliberately kill bats because they believe the bat myths.

However, bats have a fast growing number of friends. Many countries have laws to protect these beneficial creatures. Often cave entrances are covered with grating through which bats can go, but people cannot. Bat houses are becoming so popular throughout the world, that highway departments are building bridges that attract bats.

The City of Carlsbad, New Mexico is a bat friendly community. It is home to the International Bat Festival where bat education is fun for the whole family.

One way to remember WHY people today are protecting bats, is to think **P**. Bats are **p**est controllers, **p**lanters and **p**ollinators.

Batty Facts.

- Fifteen species of bats inhabit Carlsbad Caverns National Park.
- The bat is the symbol of happiness in many parts of the world.
- Some bats reach speeds of 60 miles (97 kilometers) per hour.
- Some bats live 32 years are longer, although most live fewer than 20 years.
- In the United States, rabid bats are rare; less than 1/2 of 1% carry rabies.
- Bats are the only major predators of night-flying insects.
- The smallest bat species weighs less than a penny and is about the size of a bumble bee.
- The largest bat species has a wing of 5'5" and weights about 2 pounds.
- The total population of bats is estimated to be more than ten billion.
- Some bats reach an altitude of 10,000 feet (3,048 meters.)
- A bat's knees bend backwards.
- Most North American bats can be mailed with a 32¢ stamp.
- Baby bats' claws are so sharp they can hang on the imperfections of a light bulb.
- The 20 million Mexican free-tails from Bracken Cave in Texas eat the weight of 63 elephants in insects each night.

A Batty Poem.

Bats are mammals
  like you and me
Some live in caves
  and some live in trees.

Bats are nocturnal
  they are active at night.
No bats are blind,
  some have good sight.

They use echolocation
  to find insects they eat.
They can fly at 60 miles per hour
  and at 10,000 feet!

When the weather turns cold
  and there's no food to eat
Some bats migrate or hibernate in a
  deep sleep.

Some bats are pollinators
  and some eat fruit.
Just look at their noses or ears,
  they are adapted to suit.

So, don't be afraid
  next time you see a bat.
They are part of nature
  and belong just where they're at.

—Arizona Game and Fish Department, WILD Kids, Number 15

For More on Sonar Equipped Bats, Read On… Not all bats use echo ranging. Some nectar-sippers have sonar, but most large fruit bats and the "flying foxes" do not have sonar. They usually search for food by sight or smell. They have good vision, especially night vision. Although their eyes are specialized for night vision, they can see well during the day. Like other mammals with good night vision, bats are color blind.

With its larynx, a sonar-equipped bat makes short pulses of very high-frequency sound. With its nose and mouth, it may channel the wave pulses into a broad beam of sound. The bat uses its relatively large and extremely sensitive ears to detect sound. Its ear canal closes when pulses are produced and opens to receive the echo. Bat brains process sound well. Even when hundreds of thousands of same-species bats are flying in close quarters, like at Carlsbad Cavern, each bat is able to recognize and analyze its own echoes.

The resolution of bat sonar is truly astonishing. Bat sonar can detect wires that are nearly as wide as a human hair. Some species of bats can track a 3 mm fruit fly, and snatch it out of the air in 0.5 second.

Many animals can hear frequencies that are inaudible to people. Most people cannot hear sounds with frequencies higher than about 20,000 Hz. Cats can hear sounds up to about 25,000 Hz; dogs can hear sounds up to 35,000 Hz. But bats can hear sounds with frequencies between 12,000 Hz and 150,000 Hz!

For greater accuracy, most bats emit several frequencies at once, and many slide the frequencies up or down during the pulse. This technique is known as frequency modulation (FM). Because different frequencies are reflected in different ways by different materials, a bat can differentiate an insect from a leaf by sound alone. And you thought people were the only ones who stayed tuned to FM!

The bat evaluates frequency shifts in the echoes in order to determine the speed and direction of the target. One theory states that a bat is able to determine its target's location in relation to itself, by comparing the echo received by each ear. The bat also evaluates other characteristics of the target, such as its size, texture and orientation in space. Unwanted noise is filtered out of the echo by its ears and brain.

Bat sonar has three basic modes of operating—search mode, target mode and terminal mode.

When in cruising flight, a bat uses its sonar in a search mode emitting five to ten short pulses every second. Search mode allows a bat to detect obstacles or potential prey at a distance.

If a bat detects an object of interest, say a moth, it switches its sonar to the target mode. The bat focuses its sonar on a particular object, shortens the individual pulses and increases the number of pulses to between thirty and fifty per second. The bat then reads the echoes for information about the target's size and density, texture, speed, direction and altitude.

In the final tenth of a second, the bat switches its sonar to the terminal mode, increasing the pulse rate to as much as 200 per second. With great precision, the bat snatches its prey out of the air. The bat then returns its sonar to the search mode and continues its flight.

For Comments About Bats of New Mexico, Read On…

Western Pipistrelle—often the first bat out, sometimes even in daylight

Big Brown Bat—prefers human-made structures for roosting sights

Spotted Bat—black fur with three white spots and large pink ears, a late night flier

Pallid Bat—stalks scorpions, centipedes and small reptiles, nickname is "Rambo bat"

Townsend's Big Eared Bat—ears nearly as long as body

Allen's Big Eared Bat—audible calls

Mexican Free-Tailed Bat—largest concentrated groups of mammals in the world, can tolerate ammonia as high as 5000ppm

Pocketed Free-Tailed Bat—long, narrow wings

Big Free-Tailed Bat—likes moths, ants and crickets; communal in small groups of about 100

Western Mastiff Bat—largest bat in NM and USA; must free-fall at least 10 feet to begin flight

Southwest Myotis—daytime roosts still unknown

California Myotis—some hibernate, others do not

Long-Eared Myotis—hunts in tangled vegetation for insects

Little Brown Bat—common throughout USA

Western Small-Footed Myotis—may hibernate under rocks

Fringed Myotis—can rescue fallen pups

Cave Myotis—migratory, ears can touch tip of nose

Long-Legged Myotis—hunts in open country using one prominent harmonic tone

Yuma Myotis—desert hunter that lives close to water

Western Red Bat—red fur, male more colorful than female

Eastern Red Bat—red fur

Hoary Bat—varied vocalizer, CF-FM both

Yellow Bat—fur a dusky yellow

Silver-haired Bat—frosted black fur; roosts and hibernates in frees, forages close to ground

The Geology of Carlsbad Caverns National Park

Coral Reef - Limestone Mountain - Limestone Cave - Decorated Cave

One Theory. None of us witnessed the formation of Carlsbad Cavern. And since time and conditions don't allow us to duplicate the process in a laboratory, we are left with theories based on puzzle pieces. One theory, simplistically stated is…

- A very long time ago, a shallow sea covered Carlsbad Cavern. Plants and animals lived and died in the sea. Their shells and skeletons piled on top of each other, making a reef. Over time, many layers piled up, squashing the shells and making the layers hard, compact and thick.
- The sea dried up causing the reef to be exposed to the air.
- Movements in the earth's crust pushed the reef upwards, forming a limestone mountain.
- Trees and other plants grew on the mountain, covering the old reef and causing cracks to develop in the limestone.
- Rainwater sank into the soil and went down through the plants' roots and finally down through the cracks in the limestone. On its way through the atmosphere and the soil, the water absorbed carbon dioxide. A weak acid was chemically formed when the water mixed with the carbon dioxide. The resulting carbonic acid dissolved the calcite in the limestone.
- At some point, large rocks in the cave ceiling fell. This opened up chambers, like the Cavern's Big Room—25 stories high and a third of a mile wide.
- As water seeped and dripped its way into the Cavern, beautiful formations decorated the cave.

Soluble Rock. The largest and vast majority of caves are formed in soluble rocks—those that can be dissolved by a weak, natural acid. Limestone, dolomite, gypsum and marble are soluble rocks. Carlsbad Cavern, Lechuguilla Cave, Slaughter Canyon Cave and Mammoth Cave are all solution caves.

Cave Formations. A cave formation is a speleothem. The word comes from two Greek words—*spelaion* meaning cave and *thema* meaning deposit. Speleothems are mostly calcite, the same mineral that makes up limestone. When the water table lowers and air enters the cave conditions are right for the process of cave formations to begin. Slightly acidic water percolates through the limestone above the cave dissolving the calcite. When the water reaches the cave, calcite is redeposited.

Two factors that influence the growth rate of the cave formations:

- **Temperature**—The outside temperature affects the rate of decay of plants and animals. The higher the temperature, the faster the decay. As the decay rate increases, so does

the carbon dioxide in the soil. When high levels of carbon dioxide is present, the water flowing through the soil is more acidic.

- **Water**—The more rainfall, the faster the growth.

Two factors determine the shape of cave formations:

- **HOW THE WATER ENTERS**—Does the acidic water enter the cave by dripping, seeping or splashing?
- **WHETHER THE WATER STANDS OR FLOWS**.

Mineral content determines the color of a cave formation:

- Pure calcite is white, almost colorless.
- Iron and other minerals combine with calcite crystals to add red, orange and black.

What's in a Name? In the case of a speleothem, it's as good as a picture.

Soda Straw. A soda straw is hollow on the inside and has water dripping through it. Over time the inside clogs with calcite, causing the stalactite to grow larger.

Drapery. Water in a cave does not always drip. It may seep along a slanted ceiling, forming thin draperies that hang in folds. They are also known as curtains and ribbons.

Flowstone. Flowstone is a cave formation that looks like a flowing stone waterfall. It forms when water seeps down cave walls, over rocks and onto the floor.

Shelfstone*.* A flat shelf of stone can form around the edges of cave pools and around stalagmites in a cave pool. Even if a pool dries up, the shelfstone remains.

Cave Pearls. Cave pearls are stone balls and can be as large as ping-pong balls. A pearl forms around grains of sand. Layers of calcite are added to the grain over time. Dripping water keeps the pearl moving round and round in the pool.

Popcorn. Popcorn is a cluster of calcite balls that build upon the walls of a flooded cave.

Helictites. A helictite is similar to a soda straw, except it curls and twists in every direction, even against gravity. No one is certain how helictites forms.

Totem Poles. A totem pole is as skinny as the stalactite above it. However, some are taller than skyscrapers and bigger than a giant redwood.

Types of Caves

Cave and cavern are different words for the same thing. Caves are underground cavities formed by nature. Mines are manmade. There are more than 40,000 known caves in the United States; 88 have been discovered thus far in Carlsbad Caverns National Park.

Caves harbor rare animal life, fragile mineral formations and irreplaceable archaeological objects. That's why most of Carlsbad Caverns National Park's caves are ***wild caves***. Only explorers who have special permits may enter them. ***Show caves***, such as Carlsbad Cavern, are open to the public. They may have lights, stairs, railings and benches.

With 355 miles of passageways, Mammoth Cave in Kentucky is the **world's longest cave**. Lechuguilla Cave in Carlsbad Caverns National Park is the **deepest limestone cave** in the United States, thus far with more than 100 miles of surveyed passageways. The **world's deepest cave** is Jean Bernard Cave in France at 5,256 feet deep. The **world's largest cave chamber** is Sarawak Cavern in Sarawak, Borneo. The chamber is 2,300 feet long. The **largest room in North America** is Carlsbad Cavern's Big Room.

Caves are formed in various ways...

- **Solutional caves** are formed by weak, natural acid dissolving soluble rocks such as limestone, dolomite, gypsum and marble. Carlsbad Cavern is a solutional cave.
- **Lava tubes** form during the cooling of lava flows. First, a crust forms on the lava as it begins to cool. A break in this crust allows some of the molten lava to flow through the crack leaving long, tunnel-like passages.
- **Sea caves** form from wave action. The waves force water into the cracks in rock, breaking off the rock.
- **Wind caves** form from wind erosion or cliffs or hills. They are almost always small caves that seldom penetrate into total darkness.
- **Talus caves** form from huge rocks that have fallen from cliffs.
- **Glacier caves** form by melting waters moving through glaciers.
- **Soil caves** form when flash floods move through the soils and transport earth with them. They are found in desert areas.
- **Tectonic caves** form by the action of earthquakes.

Safe Cave Exploration

- Never go alone. Always go with at least two friends.
- Tell someone where your group will be caving and when you are going and when you are returning.
- Each caver should carry at least three sources of light.
- As a reserve, carry a waterproof packet of matches and candle.
- Remain in one spot if you become lost or your light fails.
- Wear heavy-duty clothing, high boots, kneepads and a hard hat are essential.
- Carry water.
- Carry a first aid kit.
- Carry tools for repairing lights.
- Carry a space blanket.
- Carry a compass, watch, note pad, pencil for recording your route.
- Only enter caves that you are prepared to enter. Proper training and equipment are need to enter caves with rugged, vertical or steep topography.
- Never trust equipment left in a cave.
- Never cave when you are ill, under medication or under the influence of drugs and/or alcohol.
- Obtain permission from the cave owner before entering.
- Leave the cave as you found it.
- Do not collect souvenirs! If you find an artifact, leave it where you find it. Report your finding.

The Wildlife of Carlsbad Caverns National Park

Members of the animal kingdom are classified according to body structure. The two general groups of animals are vertebrates (animals with backbones) and invertebrates (animals without backbones.) Vertebrates, making up less than one tenth of the entire animal population, include: birds, mammals, reptiles, amphibians and fish. The majority of animals are invertebrates. Invertebrates are divided into three general group—those with jointed feet, those with unusual bodies and those with one-celled bodies.

Carlsbad Caverns National Park has a large diversity of animals, both vertebrates and invertebrates. Because the park is part of the National Park System, its wildlife is protected. Annually, the park participates in the National American Ornithological Union Christmas Bird Count and has many cooperators involved in ongoing studies of bats, birds, mammals and reptiles.

In order to better understand and interpret the variety of wildlife, the park produces a monthly wildlife observation list, which is retained on file. All park employees, cooperating association employees and park visitors are encouraged to contribute to the list. Your group is welcome to submit completed Natural History Field Observation cards to the Surface Natural Resource Office. Cards are available at the visitor center.

Native Species.

Cave Species. Most insects, such as cave crickets, are found near sources of light and food-near bat roosts or along visitor use trails. There is little or no food to support larger animal species. The cave does not have running streams to provide a home for fish or amphibians.

Microorganisms. For thousands of years, microscopic bacteria and fungi have thrived in stable, dark cave environments. In Lechuguilla Cave, over 1,000 strains of microbes from the pools, soils, speleothems, corrosion residues and sulfur deposits have been isolated. On-going research is looking into potential medical application of knowledge gained by studying the microbes.

Bats. A large colony of about 500,000 Mexican free-tailed bats live in Carlsbad Caverns for seven months a year. They use the dry, dome-shaped room of the cave for roosting, birthing and nursing young. Migratory, they leave the park in the early fall and return from Mexico in the spring. In addition to the Mexican free-tailed bat, 14 other bat species live in the park, and two extinct species may have inhabited the park's caves in earlier times. The fringed Myotis and the California Myotis are common, along with Townsend's big-eared bat and Western pipistrel. Like the Mexican free-tailed bats, most of the other bats are seasonal residents.

Cave Swallows. Since the mid-1960s cave swallows have been roosting in mud nests in the twilight area just inside the entrance of Carlsbad Cavern. The Carlsbad Cavern nesting group is one of the largest populations in the United States and is apparently at the northern limit of its range. Visitors often mistake these birds for bats, as they circle near the cave entrance. A local school teacher, Steve West, has voluntarily banded,

weighted, sexed, aged and released more than 10,000 cave swallows. In 1999, local students will enter the data into a database and analyze it.

Surface Species. The park's surface wildlife species includes 331 species of birds, 64 species of mammals and 44 reptile and amphibian species.

Mule deer are plentiful. Large mammal predators include coyote, mountain lion and gray fox. Other mammals include elk, squirrels, bats, porcupines, ringtail, raccoons, badgers, rabbits, skunks, weasels and mice.

Bird species include hawks, ospreys, kites, vultures, falcons, owls, quail, nighthawks, ring-tailed pheasants, wild turkeys and bobwhites. Other birds that are sometimes found in the Rattlesnake Springs unit of the park include grebes, herons, ibis, swans, geese, wading and diving ducks, sandpipers, woodpeckers, flycatchers, swallows, warblers, vireos and hummingbirds. Rattlesnake Springs is recognized as one of the outstanding birdwatching sites in the New Mexico/West Texas region. More than 300 species have been observed. It is the only nesting site in New Mexico for the eastern bluebird. An estimated 90% of New Mexico's population of Bell's vireo nests are at the site.

Also found in the riparian habitat at Rattlesnake Springs are reptiles, amphibians and several fish species. Rattlesnake Springs provides habitat for some species found nowhere else in the United States, for example, the Texas emperor butterfly.

Non-Native Species. Barbary sheep are highly adaptable in their food selection and are able to survive in almost any rugged terrain. The Barbary sheep at Carlsbad Caverns compete with native mule deer and bighorn sheep.

Amphibians and Reptiles

Reptiles. The scientific name for reptile is Reptilia, which means to creep. Snakes lizards, turtles and crocodiles are reptiles. Lizards and snakes are the largest group of reptiles, with nearly 3,000 species of each. At Carlsbad Caverns National Park both are common.

These cold-blooded vertebrates breathe with lungs throughout their lives. They have tough, dry skin that is covered by a protective layer of scales. Scales preserve body moisture enabling them to survive for long periods without water. They live on land and lay eggs. Many species molt several times a year.

Predators of reptiles include birds, mammals and other reptiles. They avoid their enemies by using coloration that blends in with their surroundings.

Amphibians. The scientific name for amphibian is Amphibia, which means both-lived. Frogs, toads, newts and salamanders are amphibians.

Amphibians develop through a process of metamorphosis-they undergo significant changes in form and structure during their life cycle. As larvae, they breathe with gills. After they reach adult-hood, they breathe with lungs. Their skin is smooth and moist. They lay soft-shelled eggs and spend their adult lives either in water or on land.

Some amphibians use coloration to protect themselves; others simply stay out of sight. Some produce poisons that irritate the mouths of their attackers. Their enemies include birds, snakes and mammals. Fish prey on their eggs and larvae.

Slitherers & Croakers.

> *Likenesses.* Both are ectothermic. Most reptiles and amphibians shed their skins and many eat their old skin for protein. Most lay eggs and are able to change colors. All have an organ, which aids their sense of smell—Jacobson's organ.
>
> *Differences.* Reptiles have dry skin covered with scales, while amphibians usually have moist, scaleless skins. Reptiles have claws on their feet, amphibians have none. They have different skeletal features and circulatory systems. Most amphibians lay soft, shell-less eggs in water. Reptiles usually lay shelled eggs on land.

The Cowbirds of Carlsbad Caverns National Park

Cowbirds do not moo, but they are associated with cows. Originally, they followed roaming bison herds in the great planes. They expanded their breeding range into improved habitats such as cleared forests, livestock grazing, agriculture and irrigation. Since the arrival of the Europeans to North America, they have not only increased their range, but also their population.

Brown-head cowbirds do not construct nests of their own, rather they lay their eggs in nests of other *host* species. Cowbirds formerly parasitized about 50 species. They now parasitize at least 220 species. This is a real problem because they decrease the nesting survival of the host species. Cowbird chicks usually require shorter incubation periods than their host species, are often larger, and seek food more aggressively from the host bird.

Declines of migratory songbird species, partially due to parasitism by cowbirds, have been documented throughout the Southwest. Desert riparian areas are of major concern as they are relatively rare, isolated, and provide important habitat for breeding birds. New Mexico has lost approximately 90% of its riparian habitat since European settlement. Over 50% percent of New Mexico's endangered bird species must depend on the remaining 10% of riparian habitat for breeding or foraging.

The riparian area at Rattlesnake Springs in Carlsbad Caverns National Park provides critical nesting habitat for many songbird species, including the New Mexico state endangered Bell's vireo. To determine the extent and effects of the cowbird problem at Rattlesnake Springs, park biologists conducted a program of nest monitoring in 1996-97. They found cowbird eggs in the nests of various bird species, including those of the Bell's vireo. When cowbird eggs were found in nests that were still being incubated by the host bird, biologists shook the cowbird eggs to prevent them from hatching.

The brood parasitism rates discovered during cowbird studies at six other parks in 1995 were low in comparison to rates at Rattlesnake Springs. At Rattlesnake Springs the rate is 33 percent. The highest parasitism rate of the six parks studied was at Point Reyes National Seashore – 10.7%.

Biologists continue to monitor nests and conduct point counts to determine the number of cowbirds that use the Rattlesnake Springs area. Cowbird eggs are shaken and replaced in the nests of state or federally endangered species (e.g., Bell's vireo and southwester willow fly-catcher) to increase breeding success of these sensitive birds. Cowbird eggs will not be addled or removed from non-listed host species in order to determine the effects of brood parasitism on host success. Long-term mitigation measures, such as cowbird removal by trapping or shooting, possible habitat improvement for nesting birds and irrigation practices at Rattlesnake Springs will be critically reviewed and recommendations made for future management.

*Source: *Research in Carlsbad Caverns National Park: Scientific Exploration and Discovery*, 1997 Editor: Gary Vequist.

Mountain Lions at Carlsbad Caverns National Park

It has been blamed for crimes it never committed, described as having attributes it never possessed, and has been credited with feats it could not possibly accomplish. It has been considered a varmint, a livestock-killer, and a competitor for game animals. Homesteaders and ranchers shot the animal on sight. Many more were poisoned and tracked down with dogs. As a result of this indiscriminate killing, the cougar disappeared from the eastern United States and the prairies.

The cougar, like many predators, has gained a bad reputation, partly because it lives a secretive lifestyle shrouded in mystery. Unfortunately, the unknown cultivates fear and myth, and myths have perpetuated misunderstanding. Is the cougar the culprit legend has made it out to be, or is this animal a critical member of the Chihuahuan Desert ecosystem deserving of our protecting? Recently, a great deal of biological study has taken place and, as a result, the image of the cougar is slowly changing.

Cougars are in the cat family Felidae. They are large, unspotted cats: hence the name *Felis concolor,* or cat of one color. Colors vary from gray, brown, gold-tawn to russet, depending on where it lives. Underparts, chin and throat are dull white; the sides of the muzzle, back of the ears and tip of the tail are black.

One of the most outstanding characteristics of the cougar is the long heavy tail, which measures two-thirds the length of the body and head. Here, in the Chihuahuan desert, adult males average 125 to 160 pounds and adult females 90 to 110 pounds.

The genus *Felis*, or small cats, includes the cougar, lynx, bobcat, ocelot and the house cat; the cougar is the largest member of this genus. Cats in this genus purr but cannot roar.

As predators of large quarry, cougars have features that enable them to catch and kill prey. The teeth are large, especially the canines. Sharp claws are necessary for seizing and controlling prey. Eyes are important for predation. Cougar eyes are close together and face forward. This arrangement limits the total field of view but gives the cougar better depth perceptions, increases accuracy when attacking prey. Even the tongue is specially adapted with sharp protuberances that help to remove meat from bones.

Critics have charged that the National Park Service (NPS) areas are protecting large numbers of predators. The truth is that the nature of large predators requires a low density of the animals throughout their range. Many predators, including the cougar, need a lot of space to find sufficient food. In the Chihuahuan Desert, biologists estimate that cougar density is three to five animals per 100 square miles. For perspective, human density in New Mexico is about 1,200 people per 100 square miles. Biologists estimate that to maintain a genetically viable cougar population for the next 100 years, a minimum of 500 adults would be required. All the NPS areas in the state of New Mexico combined would not be large enough to maintain healthy cougar population.

Cougars have been blamed for preying on large numbers of domestic animals, particularly sheep. Unguarded sheep can be easy prey for cougars and significant economic losses may be incurred as a result of cougar predation. Although predation of livestock may occasionally occur, it is not typical of cougar hunting behavior. The cougar's major prey species is mule deer,

making up approximately 75% of their diet. Also, there is a need in young cougars to have items identified as food. Thus, the prey they are taught to kill by their mother becomes an important component in their adult diet. A female that has not learned to kill cattle or sheep will not teach her young to do so.

Another common misconception is that cougars devastate deer and elk populations. In a study conducted by Sweanor and Logan in the San Andres Wildlife Refuge, findings show that even with cougar predation, deer populations have been steadily increasing. They also found that deer populations fluctuate more due to environmental conditions such as drought rather than predation. Some studies even suggest that cougars may be critical to maintaining healthy deer populations. By keeping deer numbers in check, cougars reduce competition between members of the prey species and keep deer moving, which in turn avoids overbrowsing.

What happens when predators are removed from the ecosystem? This question is still being studied. With research comes understanding, and with understanding may come a desire to restore and protect these elusive and beautiful animals.

—by Park Ranger Lynn Carranza, *Felis concolor*, Spring 1998

During the mid-1980s, 22 mountain lions were radio-collared in and around Carlsbad Caverns National Park. Biologists estimated that an average of 58 mountain lions roamed the 400-square mile study area each year. Twice yearly, biologists travel the same trails keeping their eyes on the ground looking for signs-scat, tracks, scrapes and lion-killed deer. Signs indicate that then lion population is stable.

The State of New Mexico is devising a statewide plan for managing mountain lions. The data collected at Carlsbad Caverns and Guadalupe Mountains National Parks will help park managers to speak intelligently about the status and trends of the lion population in the Guadalupe Mountains.

The Rodents of Carlsbad Caverns National Park

The Forgotten Animal. The simple fact is that park visitors come to see the cave, and frequently, the bats. Sighting mule deer is an unexpected plus for most visitors; unless, of course, the deer they see run into their car. Rattlesnakes also get their share of attention from park visitors. You can be certain that people return home with tales about the cave, the bats, the mule deer, the snakes and even the furry tarantulas.

But has any visitor ever gone back home talking about the rodents of Carlsbad Caverns National Park? Not likely. Until recently, almost nothing was known about the most diverse group of mammals inhabiting the park. Most information on this group was based on a few museum specimens and a publication written almost seventy years ago.

Rodent Survey. In the early 1990s, the National Park Service funded a study to determine the kinds, distribution and relative abundance of rodents living within the park's boundaries. The survey found 27 rodent species including squirrels, pocket gophers, kangaroo rats, pocket mice, harvest mice, woodrats and porcupines. Six species were reported in the park for the first time. The results of the survey provided basic ecological data for making park management decisions and for designing accurate interpretive programs. The baseline information can be used for monitoring population trends. Studies will continue at the park because rodents are indicators of habitat quality in the park.

Focus: The Kangaroo Rat. Among the rodents of Carlsbad Caverns National Park is the tiny kangaroo rat. It is one of the few animals that never needs to drink water. It gets its moisture from the plants, insects and dry seeds. When a kangaroo rat finds food, it may stuff some of it into its cheek pouches, then carry the food to its burrow for storage.

All mammals, including rodents, produce water as they digest their food. While all mammals produce this water, only the kangaroo rat can survive on the tiny amount it produces. The kangaroo rat is the expert when it comes to using water efficiently.

***** Source: *Research in Carlsbad Caverns National Park: Scientific Exploration and Discovery, 1997,* Gary Vequist, Editor.

The Vegetation of Carlsbad Caverns National Park

The lower elevations of Carlsbad Caverns National Park are located in the Upper Chihuahuan Desert; upper elevations are a transition zone between desert and the Southern Rocky Mountains, making the park's flora very diverse and more characteristic of areas to the north, south and west.

Native Species. As part of the northern Chihuahuan Desert vegetation zone, the park consists mostly of shrub and grassland. The park has about 800 plant species. Desert shrub is found mainly at the lower elevations. Common plant species include sotol, creosote bush, redberry juniper, white-thorn acacia, prickly pear, algerita, desert willow, Mexican buckeye, toothed maple, lechuguilla, ocotillo, Torrey yucca, catclaw, and grasses.

Common in high elevations and on north-facing slopes are sotol, oak, mahogany, lechuguilla, New Mexico agave, catclaw mimosa and grasses. The highest elevations at the park's west end have a very unique flora - primarily a grassland or savanna with scattered pinyon pine, alligator and rocky mountain juniper, ponderosa pine, and other oaks. There are more flowering forbs in the higher elevations. Two distinct blooming periods occur: in the spring and late summer. The distinctive New Mexico agave and maguey plant can also be found at these high elevations.

Vegetation changes have occurred from trespass grazing and from fire in historic times. Most park boundaries have now been fenced, eliminating trespass grazing and allowing the return of more natural vegetation.

An indicator plant is a plant that is found only in a certain area. Indicator plants of the Chihuahuan Desert are lechuguilla, tarbush, sotol, and candelilla.

Non-Native Species. There is a dozen known nonnative plant species in the park. Common nonnative plant species in the park include Johnson grass, tree of heaven, common horehound and yellow star thistle. The common horehound and yellow star thistle might easily spread and displace native plants.

Within the Rattlesnake Springs unit of the park there is a historic district. The district's nonnative fruit trees and ornamental trees and shrubs are part of the area's history. Nonnative Russian olive trees and salt cedar trees are present at Rattlesnake Springs both within and outside the historic district. In most circumstances, Nonnative plants in the park are inventoried and some pulled by hand.

Survival Tricks.

> **Transpiration Tricks.** Desert plants use the sun's energy to convert carbon dioxide and water into sugar. During this process of photosynthesis, small pores (stomata) on a plant's leaves and stems open to absorb carbon dioxide from the air and release oxygen. Each time the stomata opens, water is lost. This water-loss process is known as transpiration.
>
> If desert plants were to lose a large amount of water through transpiration, they would be unable to replace the water easily and would die. Luckily, they have some water-saving tricks:

- smaller, fewer and deeper stomata
- waxy coverings
- open stomata at night to carry out transpiration at night
- little leaves or no leaves at all to lessen the surface area exposed to the sun and wind
- roll leaves to hide from the sun
- drop leaves during droughts

Sucking It Up Tricks. Desert plants get as much water as possible. Some have very deep taproots; some have huge, tangled networks of shallow roots that spread out in all directions; and many have both a deep taproot and a network of shallow roots.

Shrinking and Swelling Trick. Many desert plants store the water that their roots soak up and then use it during periods of no rain. Succulent plants store the water in their fleshy leaves and stems. Some succulents have folds that allow them to swell with water during wet periods.

Hairs and Spines Tricks. Hairs and spines reduce moisture loss by breaking the wind. They also cast shadows on desert plants helping them hide from the sun. Some hairs and spines are shiny and reflect the sunrays. They also protect the plant against hungry animals.

Chemical Trick. Chemicals of some plants, keep other plants from growing nearby, thus reducing competition for the scarce water supply.

Seed Tricks. Some seeds wait out dry spells in a dormant state—sometimes for decades. Some seeds are covered with natural chemicals, called inhibitors. The chemical keeps the seeds from germinating until enough rain falls.

The Backcountry of Carlsbad Caverns National Park

Carlsbad Caverns is best known for its caves, but there is another part of the park that few visitors ever see—33,125 acres of wilderness. With a little extra time and preparation, the opportunity exists to explore beyond what the average person will experience.

This is desert country, full of deep rugged canyons and tree-lined mesas far from the stresses of civilization. One can hike in the backcountry for days and never encounter another person, hear traffic, or smell car exhaust. The 60 miles of hiking trails offer places for quiet contemplation as well as for friends to get away together.

Hiking in the desert is a challenging, yet rewarding, experience. To fully enjoy and appreciate your hike, remember that desert hiking requires time and preparation. Trails have been left undeveloped to preserve and enhance the wilderness experience. You may find yourself walking on narrow ledges or down steep, rocky draws. Carrying a topographic map and a compass is highly recommended. Climate is hot and dry in the summer, cold and dry in the winter. Over the year, temperatures may range from nearly zero to above one hundred degrees. Temperatures may change as much as fifty degrees in a twenty-four hour period. Summer rains may bring flash flooding in canyon bottoms.

If you are lucky, you will see wildlife—jackrabbit, ringtails, mule deer and roadrunners. Typical plants include sotol, agave, lechuguilla, juniper and desert grasses. Trees are found in the elevations. After a spring rain, you may see the desert come alive with flowers.

Be sure to wear sturdy and comfortable hiking boots and long pants to protect yourself from spiny desert plants.

Except for a few permanent seeps draining down canyon walls, water is scarce and unreliable in the backcountry. Be sure to bring at least one gallon per person, per day.

Rock Art

Rock art, as with any type of artifact, is a remnant of a culture. It may be prehistoric, historic or even modern. Pictures made on rock can be seen in many parts of the world. Only the person who created the rock art knew the meaning and why it was created. Experts, however, may attempt to understand by describing and classifying the rock art. But, even without exact meanings, we can all enjoy and learn from rock art. Native American people created rock art on the surface or in the mouth of caves at Carlsbad Caverns National Park. Throughout New Mexico and around the world, many people of many different cultures produced various kinds of rock art. **Rock art** is of two types—**petroglyphs** and **pictographs**.

Petroglyphs are carvings of symbols into rock. *Petro* means rock or stone, and *glyph* means a carving or marking. Pictures and designs were cut into or carved in relief on large rocks, rock faces of caves, sheer rock cliffs or other similar places, using several methods. One method of making petroglyphs was by pecking. This was often done by means of a direct blow with a hammerstone, a tool sometimes found in association with petroglyph archeological sites. This method did not provide precise control over the placement or size of the dent, and produced rough or uneven looking petroglyphs. Sometimes the designs were made up solely of evenly spaced holes which produces a “stippled” effect petroglpyh. In other parts of the world are found percussion formed holes called *cupulas* which cover entire boulders, but are without an apparent overall design.

Chiseling is another method used to produce petroglyphs at Carlsbad Caverns National Park and other areas. Using two stone tools, one being used as a hammerstone and the other a chisel, the artist could produce carvings of much finer detail than those made by using a hammerstone alone.

A third method used in making petroglyphs is called incising. This consisted of rubbing, grinding, scratching or carving a picture or design into a rock face with either a sharpened bone or hard stone tool. In historic times, iron and steel tools were used to make incised petroglyphs throughout the Southwestern United States.

A fourth method, not common in the park, is drilling holes or marks into the rock.

Pictographs are rock paintings, usually found in more protected and concealed areas than petroglyphs, possibly because of their higher vulnerability to weathering. Pictographs are the most common type found at Carlsbad Caverns National Park. Colored rocks and minerals were powdered for pigments and produced reds, yellows, whites, blacks and even some greens and blues for use in paintings. The powders were mixed with a binding agent to help the paint adhere to a rock surface and to be fairly durable. Binding agents may have been plant juices, animal fats, raw bird eggs, water or even saliva.

Hematite, an iron oxide mineral, can make a red to reddish-brown paint. Limonite, another iron oxide mineral, often referred to as yellow ochre, produces many shades of yellow. A white pigment can be obtained by grinding white clay, chalk, gypsum, calcium carbonate or any other white mineral. A black paint can be obtained by using powdered charcoal. This source for pigment would have been readily available since fires were a very common occurrence for cooking, firing pottery or just to keep warm. Uncommon colors such as blue or green could be

produced by grinding up a mineral with a high copper content such as turquoise, malachite or azurite. Instead of a copper mineral, sometimes green paint was produced from an iron mineral called chlorite.

Rock art has been broken down into three classifications, for clarity. Drawings of any type of human figure are known as *anthropomorphic*, while animal figures are called *zoomorphics*. A symbol that cannot be classified into either of the other categories is simply called *geometric*.

Where does one find rock art? It is often found on vertical cliffs facing either south or east, but it can be also found in other localities such as inside of caves, in rock shelters, overhangs, near or around dwelling or storage sites, or on boulders. Areas of frequent travel such as trails have a large amount of rock art associated with them, as well as areas that are near water, or near unusual physical features.

Interpretation of rock art is very controversial. No one really knows what the symbols represent, but some commonly seen symbols or *glyphs*, seem to carry a meaning agreed upon by people of many different cultures. Spirals or concentric circles are believed to denote the sun. Others, however, suggest spirals represent water. The Hopi people believe that they show migration routes of their ancient ancestors. Handprints are said to be the signature of the artist who designed that specific rock art panel, but it has also been suggested that handprints denote a sacred area. There are numerous handprint sites found in many localities around the world. Interpretation is probably best when done by members of the cultural group which made the rock art. However, only the person who created the rock art really knew the meaning.

Common game animals such as big horn sheep or deer are often depicted in rock art and are thought to be ritual or hunting scenes. Many times hunters with weapons are shown along with the animals. Of course, rock art located in places other than the United States portray animals common to that particular place. In Australia, for example, kangaroos and echidnas are just as common in aboriginal rock art as bighorn sheep are here in the desert Southwest. Other types of animal life have also been represented in rock art, including bears, bison, cougars, coyotes, rodents, bats, scorpions, snakes, lizards, fish stingrays and birds. Even petroglyphs of animal pelts are sometimes seen!

Pottery and blanket designs are other common elements found in rock art. But human figures are probably the most widespread symbol. Men are represented in everything from hunters to possible *warriors* or ceremonial figures. Sometimes males are represented in very elaborate dress, and at other times, just as plain entities. A frequently seen male personage is a humpbacked flute player, often referred to as *Kokopelli*. He is believed to be a supernatural fertility being. He may also represent a trader carrying a backpack or a person afflicted with tuberculosis. Even though representations of men seem to be more numerous than those of women in rock art, occasionally one finds a glyph that is unmistakable a female. In Ancestral Puebloan rock art female figures can be identified by their distinctive hair style. Even today, some Pueblo women wear their hair arranged in two buns on either side of their head to signify they are of marriageable age. For some reason, plants are only seldom seen as rock art components. But occasionally, they too are represented. Growing corn plants are sometimes found in the *Four Corners* area of the Southwest.

Other things represented in rock art are astronomical in nature. Along with the commonly seen sun, moon and stars, sometimes more unusual sky events are recorded. Chinese records indicate that a star exploded within the constellation Taurus on July 4th 1054 A.D. This star, known today as the Crab Nebula Supernova, flared up to be ten times more massive than our sun, and it outshone everything in our galaxy for almost two months! Before dawn on the morning of July 5th, the crescent moon was approximately two degrees north of the supernova.

It is believed by some that this phenomenon was recorded by ancient man in rock art at Capitol Reef National Park in Utah, Chaco Canyon in north-central New Mexico, and many other sites in the *Four Corners* area. Many rock art specialists feel that crescents in conjunction with stars, spirals or sun symbols are representations of this unique sky event.

One of the major problems when studying rock art is how to date it. The ability to date a particular site absolutely is rare, but various methods provide means of *relative* dating. The amount of desert varnish, or patination as it is called, is an important means of determining the relative ages of petroglyphs made at different times on the same surface. Desert varnish or patina is the formation of a black or brown stain of manganese or iron oxides on rock surfaces. When a petroglyph is made, the design is pecked or scratched through this surface exposing the lighter unoxidized rock beneath the patinized surface. This lighter surface begins to oxidize as soon as it is exposed. The older the design is, the darker it becomes. If two or more designs on a surface were made at different times, the more recent one will be lighter in color. But because patina varies with the composition of the rock, exposure to sun and rain, and location, the degrees of patination alone is not an absolute guide for dating.

Superimposition is another way to determine the relative age of rock art. Designs were sometimes painted or pecked on top of older ones, and in some cases the figures of several different styles and time periods were made in the same spot. Figures on top are considered younger than those underneath. The association of house ruins with rock art is sometimes a very helpful dating method. Frequently, these archaeological sites can be placed in a given time frame by dating charcoal or other organic material with one of the many scientific methods of absolute dating or by the pottery types or other artifacts present. A useful approach of ordering the chronology of certain rock art styles has been the comparison of rock art figures with those on datable artifacts such as pottery, clay pipes or wall plaster in the ruins themselves.

Relative dates are sometimes provided by the content of the art itself. The first appearance of the bow as a hunting weapon, replacing the spear and the atl (spear thrower), is dated in Arizona as early as 200 A.D. It spread eastward across New Mexico, reaching West Texas between 600 and 1000 A.D. The appearance of the bow in rock art has been helpful in establishing the earliest possible date for these pictures. Conversely, rock art that displays atls or spear throwers are thought to predate those panels that show humans using bows and arrows.

The horse is another element that is useful for relative dating. The presence of this animal on rock art indicates beyond any doubt that one is dealing with art of the historical period. First brought to this continent by the Spaniards in the 16th Century, the horse was becoming popular among the Apaches of New Mexico as early as the first half of the 17th Century. Horses also began to appear in Navajo art in the 17th Century. Some Navajos and other Native Americans show the arrival of the European into the southwest as people in 17th Century. Spanish costumes are depicted on rock art panels. Rock art from even later periods symbolizes the technology of the times as it displays trains and Euro-American houses.

A very commonly asked question concerning rock art is, “Why was it drawn?” Since no one knows the answer for sure, this question only leads to more questions. Could they just be doodles? Do they tell a story? Were they for religious reasons? Or ceremonial? Are they recording historical or prehistoric happenings? Some people believe rock art is actually a form of writing, and each symbol can be read like hieroglyphics. Others say rock art is just that—art—something to be gazed upon and enjoyed. Only the artist who made the petroglyph or pictograph would know for sure. Whatever their meaning or why they were made, the rock

carvings and paintings by themselves are irreplaceable records and monuments to the artists who made them. They are a very unique and valuable tradition of human endeavor.

One thing that keeps us from ever finding the answers to rock art's mysteries is vandalism. Shooting bullets, scratching names and pictures on or near rock art, spraying paint, or defacing them in any way, forever destroys the chances of discovering their meaning. Even touching rock art or making rubbings of the symbols does irreversible damage to these priceless works of art! Presently, all cultural resources such as rock art and all other archaeological materials on federal lands are protected by the Antiquities Act of 1906, the Archaeological Resources Protection Act of 1979, and many other laws and regulations. The National Park Service, US Forest Service and Bureau of Land Management all work to enforce the laws which protect our rich heritage of cultural resources. Similar state and, often, local laws protect archeological resources on state and private lands.

So, please, allow others who follow to experience the same satisfaction in discovering rock art as you have. By conserving ancient rock art maybe someday more of their mysteries may be revealed.

As you have probably figured out by now, the study of rock art has much speculation and many educated guesses at best. Maybe no one will ever decipher all the petroglyphs and pictographs. Maybe no one will ever find out the reasons they were made. But if nothing else, rock art says, "I was here."

—Edited by David Kayser, Museum Technician

Jim White

In 1925, Jim White's friend, author Carl B. Livingston, wrote an article entitled *Through the Carlsbad Cavern with Jim White*, and said:

Jim White is not the explorer with the pith helmet, tight-legged pants and horn-rimmed glasses—but the genuine article of cowboy tradition. There is a difference between the "high-brow" explorer with money and prestige as speedsters to fame, and the prowess of the pioneer who blazes the way over a new horizons with just nothing save a step that is true and a light in his eye that knows no fear. There was no crowd of reporters to hang on Jim's every word. Had he failed in his purpose, there would have been none of the soothing ointment of consolation that comes to explorers of position in the shape of "victorious defeat" when they do not succeed. Had Jim been killed, he would not have been a national martyr in the cause of science, but just a "durn" fool—he did succeed though and the hats are off to him.

White did not fail and was not killed. And, he was not a fool. Today, our hats are still off to Jim White. He first entered the cavern in 1898. Although he was not the cavern's discoverer, he explored it the most extensively. He privately guided tours from the early 1900s to 1923; he guided the 1923 General Land Office survey expedition; and, he guided the 1924 six-month National Geographic Society expedition. From 1923 through 1929, White guided visitors at Carlsbad Cave National Monument.

Jim White, with his equivalent of a third-grade education, spoke softly and infrequently. Livingston pointed out that:

Jim White does not talk much, except to a few, and not very often then. And I have it straight that what he says is not "windys" (sic) invented to entertain the dudes.

Willis T. Lee, 1924 NGS expedition leader, wrote in the National Geographic Society magazine that:

> *Like other guides before him, he has discovered that tourists appreciate hair-raising yarns more than hair-splitting distinctions. According to his own statement, our guide does not allow dull fact to interfere with a good story.*

Eventually White guided a few people in the cavern who could show surface-bound people the wonders of the caverns—photographers. By 1923, cavern photos appeared in the *New York Times* and Carlsbad Cave National Monument was created.

White died in 1946 at the age of 64. In 1953, Congress appropriated money to erect a visitor center plaque honoring his accomplishments. Today, more than a hundred years after 16-year-old White ventured into the cavern, no single person's name is more synonymous with the caverns than that of Jim White!

—*Park Historian Robert Hoff*

Carlsbad Caverns National Park Area History, 1848-1998

By Robert Hoff, Park Historian

1848. February 2, the Treaty of Guadalupe Hidalgo is signed with Mexico after the Mexican War, transferring about 1.2 million-square miles of the Southwest, including Texas, to the United States.

1854. Captain John Pope of the Army Topographical Corps crosses the Guadalupe Mountains surveying possible routes for the railroad.

Dr. George Getz Shumard, a New Jersey-born military surgeon on the expedition, discovers Permian age fossils in the Guadalupe Mountains.

1858. The route of the Butterfield Overland Mail runs through the Guadalupe Mountains. A stage station is established at Pine Springs.

1866. Charles Goodnight and Oliver Loving begin driving cattle north along the Pecos River on the route that will become known as the Goodnight-Loving Trail. Loving is severely wounded in an Indian fight at Loving Bend on the Pecos River.

1867. John Simpson Chisum drives his first herd of cattle along the trail from Texas into New Mexico. He begins a ranch that soon extends from near Fort Sumner to the Black River.

1870. Seven Rivers (originally called Dogtown because of the prairie dog colonies there) is settled by the Herskill Jones family of Virginia. Situated where seven arroyos lead into the Pecos River, it will become an important trading post on the cattle trail from Texas.

Outlaw Billy the Kid frequently visits Seven Rivers. Billy the Kid will remain one of the post popular figures in Western history and a person who is looked at through the lense of mythology.

1875. John Chisum moves his cattle north from Black River. He continues to graze as far south as Seven Rivers.

1878. Dogtown is renamed Seven Rivers for the seven arroyos flowing into the Pecos at that point. Seven Rivers is just north of present day Carlsbad.

The Tenth Cavalry, an all Negro regiment (nicknamed the “Buffalo Soldiers”) establishes a permanent camp at the old Pine Springs stage station in the Guadalupe Mountains. In October, Colonel Benjamin Grierson visits the camp and explores the Black River canyon.

1880. The Tenth Cavalry under Colonel Grierson crosses the Guadalupes and camps near the mouth of Black River on their way to the Fort Stanton reservation. There are several skirmishes with Apache parties supporting Victorio.

Dan Lucas begins ranching along the Black River on the property that is now Washington Ranch (Current-Argus, 8/19/31). This is the ranch which Jim White was working for when he first came across the cavern entrance.

1881. Henry Harrison arrives from Indiana and homesteads at Rattlesnake Springs. Cavalry patrols use his farm as a point of supply during the 1880s (Caverns, 39). In 1934, the National Park Service will acquire Rattlesnake Springs as a water source. From 1938 - 1942 Rattlesnake Springs will serve as a Civilian Conservation Corps camp. In 1963 Rattlesnake Springs will become a detached part of the National Park.

Colonel Nelson Miles and the Ninth Cavalry use Rattlesnake Springs as a rendezvous and supply camp in 1881-1883 (Current-Argus, 7/21/31).

1882. William C. Sublett finds gold nuggets in the Guadalupe Mountains eight to twelve miles from Pine Springs. Speculation is that the nuggets came either from a lost mine or from a cache of gold stolen from the Butterfield stage (Current-Argus, 6/4/30).

Jim White is born in Mason County, Texas on July 11. White will become the singularly most identified person with Carlsbad Caverns history.

1884. Charles B. and John Eddy form a livestock company with Amos Bissell to operate in southeastern New Mexico. One of their first ventures is the Halagueno Ranch which covers the area from Seven Rivers to La Huerta. (Halagueno is Spanish for promising and attractive.)

1885. The Valley Land Company owned by Dan Harroun holds the first water rights on the Pecos River.

1886. This is known as the year of the “big die.” Drought causes the loss of about thirty-five percent of area cattle.

1887. Charles B. Eddy builds the Halagueno diversion ditch on the Pecos River three miles above the later site of Avalon Dam and incorporates the venture as the Pecos Valley Land and Ditch Company.

1888. Former sheriff Pat Garrett (Garrett shot and killed 22-year old Billy the Kid on July 14, 1881; 48-year-old Garrett will be assassinated on February 29, 1908 near Las Cruces, New Mexico) and promoter Charles Greene join with Charles Eddy to create a system of canals and flumes for diversion of water to their properties. Greene secures potential investors from the East including Robert W. Tansill, manufacturer of the Punch five cent cigar. Plans for a new town on the Pecos River are laid out by Eddy and his partners. A street and dam are named after Tansill and a street after Greene.

September 15, the town of Eddy is christened in champagne on the south bank of the Pecos River.

1889. February 25, Eddy County is created. The first county seat is at Seven Rivers.

James John Hagerman, miner and railroad builder, becomes a partner in the Pecos Irrigation Company.

October 6, the first school in Eddy opens on South Main with thirty-five pupils.

The first newspaper in Eddy, the Eddy Argus begins weekly publication with Richard Rule as editor.

Future caverns guano miner John B. Forehand establishes a ranch on the Black River (Current-Argus, 11/7/57).

1890. March, the Witt brothers complete construction of a wooden flume near Eddy. The purpose of the flume is to carry river water “across itself” for irrigation purposes.

The county seat changes from Seven Rivers to Eddy by a vote of 331 to 83.

The bridge over the Pecos River at Greene Street in Eddy is completed. So many Carlsbad servicemen suffer in the Bataan Death March during World War II that later the bridge is renamed the Bataan Bridge.

Avalon Dam and many of the canals leading from it are completed, financed by James J. Hagerman.

1891. Vaud, at the present site of Loving, is settled by fifty-four Swiss immigrant farmers.

Kirkwell, a station on the Pecos Valley Railway is also settled by Swiss farmers. Its name is changed to Malaga after a type of grape grown there.

January 10, the first railroad train arrives in Eddy on the newly completed line from Pecos, Texas, to the south.

A second newspaper, the Eddy Current, is founded by William Mullane.

Jim White's family settles at Lone Tree, a ranching community eight miles east of Eddy. Future cave explorer and guide Jim White is nine years old.

1892. Jim White goes to work for the X-X-X Ranch, belonging to John and Dan Lucas, about three miles from the cavern's natural entrance.

1893. The settlement of Otis is named for T. E. Otis, a director of the Santa Fe Railroad.

Heavy rains in July and August cause floods that wash away Avalon Dam, the wooden flume and the Greene Street bridge.

A school building is completed in Eddy at the present site of Edison School.

1894. By October, the railroad is complete from Eddy to Roswell.

1898. The first hospital and library are started in Eddy.

Main Corridor rock inscription inscribed "J White" and "1898," suggests that White may have entered the cavern for the first time in 1898.

1899. A post office is established at the present site of Artesia. It is named Stegman for a local land promoter whose wife, Sallie, is a niece of John Chisum. On their ranch is the first artesian well in the area.

May 23, Robert W. Tansill proposes changing the name of Eddy to Carlsbad after the mineral water spa in Czechoslovakia. This is approved by general city election.

1900. James W. Tulk secures water rights from the Queen Ranch to open a general store. In 1904, Tulk opens his store and post office establishing the town of Queen, 40 miles southwest of Carlsbad. Early population figures show about sixty inhabitants.

The Carlsbad Irrigation Project is reorganized and refinanced under the direction of Francis Tracy.

1903. Stegman changes its name to Artesia with the discovery of Artesian water in the area.

A cement flume, replacing the wooden one that washed away, is completed at Carlsbad. This structure requires 6,000 barrels of concrete.

June 16, Abijah Long establishes placer mining claim, 20 acres around natural entrance to caverns. Long heads up the first bat guano (droppings) mining company and sells out within a couple of years.

1903 – 1923. Main period of guano mining at the cavern. Thousands of tons of guano are mined during this period and is shipped mostly to California as a fertilizer. High shipping rates and intensive labor cause guano mining company ownership to change seven times. Jim White serves as a guano miner and foreman during this period and uses his free time to explore the cavern and to guide others into it.

About 1915, he takes in photographer Ray V. Davis whose photographs make the publicizing of the huge cavern easier than ever before. Soon the government sends a survey expedition (April - May 1923) and the National Geographic Society sponsors a day trip expedition which takes six months to complete.

1906. June 8, the Antiquities Act gives the President power to proclaim national monuments and also prohibits excavation or appropriation of antiquities on federal lands.

1911. February 11, Jim White's sister, Rosa, scratches her name on wall in the Appetite Hill area. In 1914 Rosa will marry Mr. Henry Samples, a friend of Jim's and an early National Park Service guide in the 1920s.

1912. January 6, New Mexico becomes a state, 62 years after becoming a territory. The same month 30-year old Jim White marries 18-year old Fannie Hill.

1916. August 25, Congress establishes the National Park Service. This is 44 years after the establishment of the first national park, Yellowstone, in 1872.

1917. April 6, U.S. proclaims war against Germany.

1918. First photographs in the Caverns' Scenic Rooms and Big Room are taken by Ray V. Davis. His photographs stimulates interest in the caverns. Davis photos will appear in 1923 New York Times. In 1927, Davis will start the Cavern Supply Company the concession company which provides food, souvenirs and other services to visitors.

1923. April 6 - May 8, Robert Holley, General Land Office (In 1947 the General Land Office and the U.S. Grazing Service will become the Bureau of Land Management.), surveys and maps cave, guided by Jim White and photographed by Ray Davis of Carlsbad. Recommends establishment as a national monument.

August 6, Major Richard Burges, prominent El Paso lawyer and long-time National Geographic Society member, begins campaign to make Caverns a national monument. He brings it to the attention of the National Geographic Society and to the United States Geological Survey.

Burges proposes construction of a tunnel from the plains into the Caverns to reduce difficulty of access. Tunnel idea is supported by NPS Director Mather until the $30,000 estimated price tag makes it impracticable. Also making the non- selection of the tunnel option easier is that in 1925 the Carlsbad Chamber of Commerce donates the money to build a 200 step wooden stairway at the natural entrance.

September 19 - October 3, Dr. Willis T. Lee first explores caverns and recommends national monument status, joining General land Office Mineral Examiner Robert Holley's earlier recommendation based on his April - May 1923 expedition. Lee's article appears in January 1924 National Geographic magazine. Lee states in the article about Jim White:

The guide is the only source of such meager information as may be obtained. Far be it for me to cast aspersion on an estimable guide whose business it is to entertain his guests. Like other guides before him, he has discovered that tourists appreciate hair-raising yarns more than hair-splitting distinctions. According to his own statement, our guide does not allow dull fact to interfere with a good story.

October 25, President Calvin “Silent Cal” Coolidge speaks up and proclaims Carlsbad Caves National Monument.

1923 – 1927. W.F. McIlvain, a Carlsbad Chamber of Commerce President, serves as first custodian (superintendent), overseeing first trails, stairs and lights. He supervises Jim White, works with Willis T. Lee, coordinates with city officials and makes $12.00 a year.

1924. March 20 - September 15, Dr. Willis T. Lee, sponsored by National Geographic Society and assisted by Jim White, extensively explores Caverns. Lee employs 21-year old daughter Elizabeth and 19-year old son Dana in the expedition. Dana keeps a detailed and interesting diary of the expedition. Within one week of the start of the expedition, a movie company arrives to shoot footage in the cavern.

(Willis T. Lee came to this area around the turn of the century on assignment with the United States Geological Survey to determine why some area dams were leaking from their reservoirs. He returned in 1923, again to investigate similar problems, and became interested in the cavern. Taking a period of leave from his United States Geological Survey in 1924, he organized and led the 1924 expedition. An inexhaustible worker, Lee promoted the cavern at every opportunity, writing and speaking about it, even on the radio.)

Lee, in April 1924, writes to Director Mather and suggests that when the tunnel is built into the Big Room that visitors be allowed to drive their cars through it and into the Big Room. Luckily, this idea was never put into effect.

Lee will leave in 1925, but will remain interested in the cavern’s affairs, even discussing with NPS Director Mather in Washington, the reports from the caverns, including Jim White’s projects in progress and requests for permission for various projects.

Lee will work on a Carlsbad Cave manuscript, never finishing due to his death in 1926 at age 61. Like White, Lee stands out as an energetic and devoted supporter of the caverns.

NPS Director Steven Mather visits in April and is photographed in a guano bucket with Willis T. Lee.

1925. Staircase from natural entrance to Bat Cave is installed, eliminating use of guano bucket to enter cave. Bucket material is donated by Carlsbad Chamber of Commerce through efforts of the first custodian (the 1920s term for Superintendent), W.F. McIlvain.

September, Willis T. Lee’s second National Geographic article, detailing his second visit, is published.

1926. First trail established by NPS, dirt path and wooden stairways through Main Corridor, King’s Palace, Queen’s Chamber and 3/4 of Big Room. First electric lighting system via Main Corridor and King’s Palace is installed. King’s Palace has a telephone.

Willis T. Lee named the King’s Palace “Shinav’s Wigwam.” His place names, with Native-American origins, were simply too difficult to pronounce and remember, and will be renamed.

1927. May 16, Col. (an honorary title) Thomas Boles enters on duty as first Superintendent and will serves until 1946. At retirement Boles will note that he spent approximately $3 million in appropriated park funds during his tenure and collected in fees about $3.5 million during the same period. Along with White and Lee, Boles deserves the recognition of being an extraordinary promoter of the cavern.

Boles travels as far away as California to promote the park (while on other park-related business). He speaks on a ham radio in Carlsbad to 2,000 listeners on the east coast. He promotes the building of roads and installation of elevators. Politically sensitive and aware, Boles never misses an opportunity to extend friendly and enthusiastic welcomes to visiting congressmen.

Boles promotes high quality and entertaining visitor services. His Rock of Ages ceremony gains fervent visitor support and is presented for 17 years in the Big Room at the cavern until national level forces deem it not suitable for a park program.

(Former Park Guide-Nurse and later Park Guide Supervisor (1943-1973) Olive “Johnny” Johnson said in a 1994 oral history interview that she had never met anyone who cared more about Carlsbad Caverns than the Arkansas-born, civil-engineer trained Tom Boles. Jim White, Jr. reported that his Dad and Boles didn’t get off on the right foot together, but that they became friends. In 1946, the year that Boles was reassigned to Hot Springs National Park, he served as a pallbearer at Jim White’s funeral in April.)

Boles will die in 1972 at the age of 90 and will be buried in a Carlsbad cemetery. Just months before his death he would travel to nearby Guadalupe Mountains National Park to attend its dedication.

Trail past Bottomless Pit opens. School for employees’ children is established in park. The Cavern Supply Company is established. Fees to enter caves are $2.00 per person.

June 23, first wedding ceremony is held in cave, performed at Rock of Ages.

1928. February, Charlie White (no relation to Jim White) homesteads 120 acres at Walnut Canyon, the future White’s City.

May 16, Cavern Supply Company begins serving lunches in cave.

June, trail from top of Appetite Hill to Lunchroom opens.

November, electric lighting in Big Room is completed. Guides carry lanterns for emergencies only.

1929. July 27, First Rock of Ages ceremony is held. The presentation of this ceremony will continue until December 5, 1944, when will it cease due to broader agency directives. For years after its cancellation, visitors complain vehemently.

March, tunnel through Devil’s Den is completed and opened. No longer is climb on a wooden staircase over Devil’s Hump necessary.

May, first stone quarters is completed and occupied.

June 26, Jim White resigns due to failing health. White later changes his mind about resigning, but never re-enters the National Park Service. In 1936, White receives a permit to sell his life story pamphlet in the underground lunchroom.

June, Green Lake Room and King’s Palace is connected by tunnel and trail constructed.

August, park personnel wear uniforms for first time.

September, first Bat Flight program is presented. This program continues to be very popular today.

November, nature trail opens to public.

1930. March, trail from Lower Cave Overlook to Top of the Cross opens, eliminating need to double back to the Totem Pole during tours.

February 18, Lake of the Clouds is discovered. At 1,037' beneath the visitor center, this is the lowest point in the Carlsbad Caverns.

February 20, Frank Ernest Nicholson with 14 assistants arrives to explore. According to Superintendent Boles, Nicholson's expedition stories were written for 55 newspapers and seem elaborate and unreal and his activities lacked anything of scientific value, but the park welcomes the associated publicity of his visit.

The Carlsbad Cave National Monument seeks to gain support for conversion to Carlsbad Caverns National Park.

April 16, tunnel at entrance is completed, and the staircase to Bat Cave area that had been used since 1925, is abandoned.

May 14, Congress designates Carlsbad Caverns National Park.

1931. August, elevator shaft is completed.

November, first elevator is installed.

1932. January, elevator goes into use. Interestingly, this $100,000 elevator is installed during the Great Depression, but the cavern visitation is around 90,000 a year and the cavern is making money.

Lights are installed in Green Lake and Papoose Rooms, completing original electric lighting system.

June, first permanent female guides are employed.

July 3, tunnel between Papoose Room and King's Palace is dynamited, completed and opened, thereby connecting entire cave trail system.

1934. April 7, almost three thousand plus (2,871) people accompany the 10:30 a.m. guided tour, making this the largest single guided tour through the caverns to date.

1935. June 24, Rattlesnake Springs replaces Oak Springs as park water source.

1936. February 9, Jim White begins selling his book (ghostwritten by Frank Ernest Nicholson) in the cave. On his 1930 visit, Nicholson was a pseudo-explorer, would-be broadcaster and newspaper adventure writer who carefully blended facts and fantasy into exciting misinformation.

White's wife, Fanny, continues to sell Jim White's Own Story until her death in 1964.

1937. July, Tom Tucker discovers Slaughter Canyon Cave. Since the early 1970s, the National Park Service has provided tours of this primitive trail cave.

September 28, park receives the one-millionth visitor. This took 14 years to accomplish.

1938. February 16, discovery of Slaughter Canyon Cave (New Cave) is announced to public.

July 1, Civilian Conservation Corps (CCC) camp is established at Rattlesnake Springs, and will operate until April 1942. CCC boys build several buildings here and help repair rain storm-damaged Walnut Canyon road in September 1941.

First major renovation and improvement of the lighting is begun.

1939. Second group of employee housing is under construction (tri-plexes constructed of adobe and stuccoed) by CCC workers and will be completed in 1942.

January 25, Park Ranger Leslie Thompson falls down elevator shaft and manages to grab hold of cables at 125 feet into shaft; he suffers minor blistering to hands; he returns to work two days later. Thompson, a patrol ranger, will die of a heart attack in 1953 in his mid-fifties at Rattlesnake Springs.

February 10, President Franklin Roosevelt signs legislation adding approximately 39,000 acres to the park, including Slaughter Canyon. This occurs during the time F.D.R. stilled faced huge problems of poverty and unemployment at home and the rising spectre of Hilter's aggression in Europe.

Superintendent Boles accidentally met Eleanor Roosevelt in El Paso and invites her to visit the caverns, but her busy schedule does not permit.

Superintendent Boles invites famous people to the cavern. He shows the cavern to aviator Amelia Earhart, entertainer/philosopher Will Rogers, baseball player Ty Cobb, and others

June 2, Robert Ripley (Ripley's Believe It or Not) makes radio broadcast from Rock of Ages hill. Broadcast is carried by telephone cables to surface and carried nationwide on CBS radio. Boles, White and the New Mexico Governor John Miles took part.

1940. May 10, Sewage system and first flush toilets go into service in the Underground Lunchroom area. Replaces privy system installed in 1926. (This is only one of many examples of the incredible technology and hard work that has made the cave easily accessible to visitors.)

1941. December 8, U.S. proclaims war against Japan. Several NPS staff go off to fight. Many soldiers visit here. General visitation down due to gas rationing. A group of scientists try to develop idea of equipping sedated bats with incendiary bombs for dropping over enemy territory. Bats from caverns are "drafted" for the project. An accident resulting in burning government buildings puts the damper on further project development.

1943. April, shortcut under Iceberg Rock constructed.

1944. May, Superintendent's office moves from town of Carlsbad into park.

September, CCC buildings at Rattlesnake Spring are removed.

December 5, Rock of Ages ceremony discontinued. Becomes the most common visitor complaint for next ten years!

1945. September 8, Visitor fee for elevator use is eliminated.

1946. April 26, Jim White dies at age 64. U.S. Congress authorizes a plaque for the visitor center in 1953 to honor his achievements. (Although he did not discover the cavern, he was the

first to explore it extensively. White promoted it, guided it and built facilities at it. In 1998, on the 100th anniversary of White's probable first entry into the caverns, it is safe to say that no man's name is more synonymous with Carlsbad Caverns than Jim White's name. What Jim White, the mostly quiet and soft-spoken Texas native contributed to the history of the caverns, will continue to speak loudly for years.)

1948. January, first Park Ranger is permanently stationed at Rattlesnake Springs.

September, sloth bones found at Devil's Den.

1949. June 8, commercial electric power begins, replacing the park generator. Powerhouse is converted to vehicle garage, and its use as part of maintenance yard facilities will continue.

1950. March, motion picture "King Solomon's Mine" is filmed at Slaughter Canyon Cave (New Cave).

1951. Paving of cavern trail begins.

January, seating area at Rock of Ages hill is removed. Stairs from Whales Mouth to Devil's Den removed, is replaced by inclined trail.

March 14, construction employee Mr. Earl Rupe is killed by dynamite blast during construction in cave.

1952. August 19, Tex Helm takes the "Big Shot" of the Big Room using 2400 flashbulbs.

1953. Paving of existing trails is completed.

1954. January, Bat Cave seating area is completed.

March, Iceberg Rock seating area is completed.

Lighting system improvements and repairs, begun in 1952 completed.

July 8, second elevator shaft is completed. (Construction was begun in January 1954.)

1955. New elevators are installed and put into service. First fluorescent lights are installed in cavern.

Walk out tours are discontinued with advent of new elevators.

May, Top of the Cross seating area is completed.

1956. October, Carlsbad Caverns Natural History Association begins. (current name: Carlsbad Caverns Guadalupe Mountains Association)

March, stairway from Iceberg Rock to Green Lake Room is replaced by incline trail.

May, Putnam Cabin is constructed to facilitate overnight backcountry operations.

1957. August, camel bones are found in Slaughter Canyon Cave (New Cave).

September, all guano mining operations are halted at Slaughter Canyon Cave (New Cave); by the end of September, all mining equipment is removed from cave.

1958. January, jaguar bones are found at Slaughter Canyon Cave.

January 20, quit claim on the 40 acres over Bat Cave are filed, giving the NPS full control of the area.

1959. March, construction of the current Visitor Center is completed; old stone buildings near cave entrance are removed and tour operations are transferred to the visitor center.

Adjacent parking areas, originally constructed in 1940 as overflow are now used as primary parking, with the lower parking area designated as overflow and Bat Flight parking.

June, motion picture, Journey to the Center of the Earth, with Pat Boone and James Mason, is filmed in the King's Palace and Boneyard.

July, visitor center is formally dedicated.

1960. November, television show "Route 66" films an episode in the King's Palace.

1961. December 10, Project Gnome, a 5 kiloton nuclear weapon test, is detonated underground, 34 miles southeast of the caverns. (This test was to determine the feasibility of using nuclear power to generate electricity.)

1963. Bat Flight amphitheater at the natural entrance is constructed and placed into operation. First requested some 16 to 17 years earlier for seating area for Bat Flight viewers.

April 3, Civil Defense supplies are stored in the Underground Lunchroom area and the caverns are designated as a shelter for Roswell, Artesia, Hobbs, Carlsbad and adjacent areas. Plan unrealistically specifies that 25,000 people could use shelter at once.

May 13, Walt Disney visits the caverns and is personally guided by the park superintendent.

1966. June 26, Guadalupe Room, the 2nd largest room in the cavern, is discovered.

1967. June, self-guided trips through the Big Room are begun. Rangers are stationed at points (standing "beats") throughout the Big Room and interpret their section as visitors pass by. Tours are still guided through Main Corridor and Scenic Rooms.

1972. January 6, self-guided tours of entire cavern are initiated. Guided tours, which had been the primary method used to show visitors the caverns, come to an end.

1974. August, Telesonics radio interpretive system is placed into operation. Visitors begin carrying "players" for getting more information.

1975 – 1977. Caverns lighting system is replaced, a project long overdue.

1976. June 28 - July 4, during the Bicentennial Year, Tom Rohrer, assisted by Ron Kerbo, leads expedition into what is later named "Liberty Dome" over the Bottomless Pit (a 370' expanse top to bottom). Last time that mountain climbing "pitons" are permitted to be used in the caverns for the most part.

October 4, Park employee Tom "Boomer" Bemis explores a room with an opening so small that only he is the only park employee small enough to get into it. Room named "Bemis Chamber."

1977. January, current lighting and wiring system is completed. Emergency light system is installed, eliminating use of lanterns during power failures.

1978. November 10, under Public Law 95-625, 33,125 acres of Carlsbad Caverns National Park is designated as wilderness.

1979. July 10, four armed men enter the Underground Lunchroom area and “take over the cave,” securing hostages. Local newspaper editor volunteers to negotiate with perpetrators. Incident ends several hours later with arrest of the terrorists.

1980. May 17, Interior Secretary Cecil Andrus visits the park.

October 11, eighteen-year-old visitor is killed in accidental fall at the Natural Entrance.

1981. Ten other caves in the park open for recreational caving with permits subject to skills and experience of applicants.

March 16, NPS group, including Jimmy Sillas and Ron Kerbo, covers guano mining shafts for safety. Originally blasted in the early 1900s for the bat guano mining, the shafts, by the 1980s, were impacting on the nursery activities of the thousands of Mexican freetailed bats who annually arrived at the caverns.

July 9, Actor Ron Howard, formerly “Opie Taylor” of the Andy Grifith show and future Apollo 13 and Backdraft director, visits the Caverns.

1982. Project to remove utility wires and pipes from elevator shaft to separate utility shaft (from front of visitor center down to pump room) is completed.

October, Cave Specialist Ron Kerbo and Geologist Mike Queen use light cord, balsa wood and helium balloons to float cord to area 200' above Baby Hippo area, snagging a stalagmite. Later, both climb rope into area later named Balloon Ballroom Climb. Sixteen years have passed since the Guadalupe Room was discovered by searching into horizontal tunnels.

1983. June, wheelchair-bound visitor makes trip through the Natural Entrance and Main Corridor.

September 17, Interior Secretary James Watt visits park.

1984. June, a group of Colorado cavers receive permission to dig in the already disturbed floor of 90' deep with 200' of passageway in Lechuguilla Cave to investigate “blowing leads.” Six trips to dig out the loose dirt will occur between November 23, 1984 and May 25, 1986 when a small alcove is discovered. After taking steps to shore up the dug tunnel, the explorers hit pay dirt. By May 31, 1986, Lechuguilla will be surveyed at 3500' long and 703' deep.

1985. December 15, Cave Specialist Ron Kerbo, BLM employee Jim Goodbar, and Geologist Mike Queen again use helium balloons to float a cord to the ceiling area in the Big Room, 255' high, later named Spirit World. This is the same “technology” used three years earlier at the Ballroom Balcony Climb in the Main Corridor.

1986. Actor Pernell Roberts (Bonanza and Trapper John) visits the cavern.

August, actor Anson “Potsy” Williams (of “Happy Days” fame) visits the cavern.

September 5, Lechuguilla is surveyed at 7400' long and 927' deep.

October, NBC sent a cameraman/reporter on a “Spirit World” climb with Kerbo, Goodbar and others. Segment airs on the Tom Brokaw Evening News.

1987. June, Dr. Merlin Tuttle, president of Bat Conservation International, visits the park and says Carlsbad Caverns is likely the most important site in the world for public education about bats.

October 14, Lechuguilla is surveyed at 37,500' long and 1,207' deep.

1988. The Caverns Historic District and the Rattlesnake Springs Historic District is created. At the caverns architectural styles exist from the 1920s - 1930s, the 1940s and the 1960s.

February 26, Cave Specialist Ron Kerbo departs on a one month trip to the People's Republic of China as a member of the first American caving expedition to that country.

May 30, Lechuguilla is surveyed at 86,000' and 1,501' deep.

1989. Cave Specialist Ron Kerbo visits the Soviet Union August 22 - September 10 to reciprocate a Soviet cavers trip to America.

1991. March 31, Caver Emily Davis Mobley breaks her left leg about 1,000' down in Lechuguilla Cave. More than 150 rescuers team to bring her back to the surface in four days. Nation-wide press coverage results.

1992. January 4, Cristobal Colon, 20th generation descendent of Christopher Columbus, visits the park, arriving in a New Mexico State Police helicopter. Rangers give Mr. Colon a tour of the cavern.

1994. April, Lechuguilla surpasses 70 miles of known passageway.

December, a National Aerospace and Aeronautics Association (NASA) and National Geological Service team makes its 2nd five day trip into Lechuguilla Cave.

1995. December, Carlsbad Caverns National Park becomes a World Heritage Site.

1997. February, "The Gash," a 210' long cave, becomes the park's 85th cave.

1998. May, large elevators are replaced. New elevators have windows so that visitors may view the 75 story stone shaft as the elevator ascends and descends.

Employees prepare for October's 75th anniversary of the park's establishment, October 25, 1923.

Before summer, known passageways in Lechuguilla Cave is surveyed at 96 miles.

—Robert Hoff, Park Historian

Section 3 – History Activities

- **Carve a Petroglyph**
- **Paint a Pictograph**
- **Cave Ceiling Art**
- **History in the Making**

Carve a Petroglyph

Pre-Visit or Post-Visit Activity

Primary/Elementary and Intermediate Levels

Social Studies (Geography), **Art** (Visual)

45 Minutes

Objective(s). Students will design representations of petroglyphs in much the same way as American Indians carved petroglyphs in rocks.

Related NM Content Standards with Benchmarks. SS11-E2, SS11-M2, AE3-M9, AE6-E7

Method. Students carve *petroglyphs* on plaster of paris slabs.

Materials. plaster of paris, cookie sheets, brown tempera paint, large paintbrush, *a* non-stick spray, knife, pictures of petroglyphs, small rocks, sticks

Key Vocabulary. petrograph, petroglyph, pictograph

Background. Rock art, or petrographs are common in the Southwest. Native Americans created rock art on cliffs, in rock shelters and other areas.

See “Rock Art” in Section 2 – Just the Facts.

Suggested Procedure for Preparations of Carving Surface

1. Spray cookie sheets with a non-stick spray. Mix plaster of paris according to package directions. Pour into cookie sheets (about a half inch). Allow plaster to set up for the time recommended in the instructions (overnight, if possible).
2. When plaster is thoroughly dry, paint a thin coat of brown tempera paint over the entire plaster surface. Let dry.
3. When paint is dry, lightly score plaster sheet into pieces about 2 ½" X 3".
4. To make the *rocks* on which to carve petroglyphs, break plaster along the scored lines.

Suggested Procedure for Carving Petroglyphs

1. Show the class the petroglyph pictures. Discuss some aspects of rock art such as those mentioned in “Rock Art” – Section 2.
2. Give one plaster carving surface to each student.
3. Have students select a rock or a stick as a carving tool.
4. Instruct students to carve pictures or designs into the plaster by gently rubbing through the painted surface and allowing the white plaster interior to show through. Students may carve something they saw in the rock art pictures, something from memory or something from their imagination.

5. Display their rock art on a flat surface to prevent breakage. This makes a good open-house exhibit. Students may also wish to invite a park ranger to tour their *art gallery*.

Paint a Pictograph

Pre-Visit Activity

Primary/Elementary and Intermediate Levels

Social Studies (Geography), **Art** (Visual)

45 Minutes

Objective(s). Students will create representations of pictographs and explain the difference between a pictograph and a petroglyph.

Related NM Content Standards with Benchmarks. SS11-E2, SS11-M2, AE4-E8, AE4-M11, AE6-E7

Method. Students create their own pictograph on plaster of paris slabs using native and synthetic materials. (American Indians made paint by mixing fine soil and animal fat. This made a paste that would stick to the rock. Berries and other plant parts were used to dye the paint. However, in this activity, students use glue instead of animal fat.)

Materials. plaster of Paris, cookie sheets, a non-stick spray, knife, yucca leaves or paint brushes, plants used for dying (prickly pear fruit, sumac, algerita, etc.), tempera paint or food coloring, glue, different color fine grain dirt, toothpicks or something to stir the paint

Key Vocabulary. pictograph, petroglyph

Background. Pictographs can be seen in Southeastern New Mexico around the area of Carlsbad Caverns. In fact, there are pictographs painted in the mouth of Carlsbad Cavern. If your class takes the Natural Entrance Route, look for two pictographs.

See “Rock Art” in Section 2 – Just the Facts.

Suggested Procedure

1. Show students the pictograph pictures, explaining the difference between pictographs and petroglyphs. Tell students that they will be painting pictographs. Discuss why American Indians may have drawn pictographs.
2. Spray cookie sheets with a non-stick spray. Mix plaster of Paris according to package directions. Pour into cookie sheets (about a half inch). Allow plaster to set up for the time recommended in instructions (overnight, if possible).
3. When plaster is thoroughly dry, lightly score plaster sheet into pieces about 2 ½" X 3".
4. To make the *rocks* on which to paint the pictograph, break plaster along the scored lines.
5. If you are using yucca leaves, they will be the *paint brushes.* To make brushes, use a rock or other blunt object to beat the ends until the fibers are exposed.
6. If you are using natural plants for dyes and are not familiar with making dyes, use fruits or plants that have lots of juice such as prickly pear fruit.

7. Depending on the group size, you may want to divide students into small groups when mixing the paint. Mix dirt, glue and water to the consistency of paint. Add plant dye or food coloring to get the desired color. When food color (or dye) is mixed with different color soils, the outcome is also different. Experiment with the different color soils to get different colors.

8. Give one plaster painting surface and a paintbrush to each student.

9. Instruct students to paint pictures or designs on the plaster with their *paintbrushes* to create a pictograph. Students may paint something they saw in the rock art pictures, from their memory or from their imagination.

10. Have students display their rock art gallery on a flat surface to prevent breakage. Invite other classes and/or a park ranger to view the exhibit.

Cave Ceiling Art

Pre-Visit or Post-Visit Activity

Primary/Elementary and Intermediate Levels

Social Studies (Geography), **Art** (Visual)

40 minutes

Objective(s). Students will model the experience of drawing on a cave ceiling.

Related NM Content Standards with Benchmarks. SS11-E2, SS11-M2, AE6-E7

Method. Lying on their backs, students draw representations of pictographs.

Materials. colored chalk, mural, butcher or sheets of manila paper, tape, tables or desks

Key Vocabulary. pictograph, prehistoric, culture

Background. Prehistoric cultures painted their rock art in many different locations. Pictographs are sometimes found in unusual places, such as on cave ceilings. In what position would a person need to be in order to paint on a ceiling?

See “Rock Art” in Section 2 – Just the Facts.

Suggested Procedure

1. Tape mural, butcher or sheets of Manila paper to the underside of desks or tables.
2. Have students lay on their backs and draw with the chalk.
3. Display the *cave* art on the ceiling of the classroom.

History in the Making

Pre-Visit and/or Post-Visit Activities

Intermediate and Secondary Levels

Social Studies (Unifying Concepts, History, Geography),

Language Arts (Unifying Concepts)

15 Minutes Daily for 1 Month

Objective(s). Students will review and appraise recent newspaper articles, television news stories, magazine articles, World-Wide-Web articles, etc., in order to determine their significance to the future of Carlsbad Caverns National Park.

Related NM Content Standards with Benchmarks. SS3-M2, SS3-H2, SS4-M4, SS12-M8, SS12-H8, LA2-M1, LA2-H1, LA2-M2, LA2-H2

Materials. publications about or relating to Carlsbad Caverns National Park (current newspaper clippings, current video of television news stories, current magazine articles, current articles appearing on the internet, etc.)

Key Vocabulary. Vocabulary will vary depending upon current news.

Background. See “Carlsbad Caverns National Park Area History” in Section 2 –Just the Facts.

Suggested Procedure

1. Have each student critically read/review current newspapers and magazines for articles about Carlsbad Caverns National Park. Encourage students to surf the internet and watch the news for events that might have an effect on the future of Carlsbad Caverns. Clippings and videos should be brought to class.
2. Have each student present and interpret one article or video to the class.
3. Facilitate a class discussion after each presentation. As a class, decide whether or not the information in these articles might change the future of Carlsbad Caverns National Park and whether it will be remembered or simply be forgotten.

Additional Activities

1. Have students research their family trees to determine if their families were part of Carlsbad Caverns National Park’s history.
2. Have students bring old photographs. Instruct students to write a story about the photographs. Students may write individually, or write collectively in small groups.
3. Invite grandparents or seniors citizens to share the old days in Eddy County.
4. Invite the Historian at Carlsbad Caverns to conduct a slide program on the history of Carlsbad Caverns. The park historian may also be contacted for suggestions on source materials.

Other Suggestions. By deriving historical meaning from people and events in Carlsbad Caverns National Park's past, students can better understand the relationships between people and their environment. They can better understand human motivations and actions and the consequences of their actions. Have students select a research topic from those listed below and prepare a written/oral report in order that they might better understand how different people in different situations develop different perspectives.

1. Jim White and his central role in the Carlsbad Caverns story
2. Bat guano mining at Bat Cave
3. The importance of photographer Ray V. Davis' work in the Caverns
4. The establishment of Carlsbad Cave National Monument, October 25, 1993
5. Willis T. Lee and the 1924 national Geographic Society-sponsored tour of six months
6. The family of Willis T. Lee – Daughter Elizabeth, Son Dana
7. The first boss at Carlsbad Cave National Monument–W.F. McIlvain
8. Colonel Tom Boles, the park's first superintendent (19 years)
9. The Monument becomes a National Park
10. Frank Earnest Nicholson
11. Building trails and stairways at Carlsbad Cave National Monument
12. Hooking up the electricity and water at Carlsbad Cave National Monument
13. Past and present tours of the underground
14. Laying out the park's surface–buildings, parking lots, landscaping
15. Promoting the Caverns
16. Shafts and elevators at the Caverns
17. The Rock of Ages Ceremony, 1927 – 1944
18. Exploring the Caverns.

Section 4 – Earth Activities

- **Dissolving Limestone with Acid**
- **Grow Your Own Speleothems**
- **A Recipe for Speleothems**
- **Let's Make a Cave**
- **Are All Caves the Same**
- **How's the Climate Down There?**
- **Mapping a Cave**
- **Down to the Core**
- **A Key to Rocks**
- **Make a Fossil**

Dissolving Limestone with Acid

Pre-Visit or Post-Visit Activity

Primary/Elementary and Intermediate Levels

Science (Unifying Concepts, Physical, Earth)

45 Minutes

Objective(s). Students will apply the trial and error method to test which rock/shell samples react with hydrochloric acid.

Related NM Content Standards with Benchmarks. SC2-E3, SC9-E2, SC9-M2, SC12-E3, SC12-M3

Method. In pairs, students place drops of cold, dilute hydrochloric acid on rock/shell samples, then record the results. Students formulate and write their conclusions on the worksheet provided.

Materials.

Each Student: copy of chart, pencil, safety glasses or goggles

Each Pair of Students: bottle of hydrochloric acid, jar or beaker, dropper, student worksheet

The Class: rock samples of limestone, granite, sandstone and seashells; paper towels

Key Vocabulary. mineral, carbonic acid, limestone, calcite, chemical reaction, hydrochloric acid

Background. 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, diluted, hydrochloric acid, will produce a bubbling reaction upon contact when calcite is present in an object.

See “The Geology of Carlsbad Cavern” in Section 2 – Just the Facts.

Suggested Procedure

1. Explain safety procedure to be followed. Because the acid will burn skin and clothing, young students should observe a teacher perform the demonstration.
2. Distribute a chart to each pair of students.
3. Mix a solution of HCL and water in a ratio of 10 parts water to 1 part HCL.
4. Label rock samples A, B and C.
5. Using the dropper, place one drop of hydrochloric acid on each rock sample.
6. Observe what happens and record observations in the proper column.

7. Wipe acid droplets off samples with paper towels, being careful not to allow the acid to touch skin.
8. Test a seashell with the acid. Observe and record observations. Write conclusions on the chart.
9. Use the data in this activity to make generalizations correlating it to geology of Carlsbad Cavern.

STUDENT WORKSHEET

ROCK SAMPLES	ACID REACTION	NO REACTION
A		
B		
C		
Seashell		
CONCLUSIONS:		

Grow Your Own Speleothems

Pre-Visit or Post-Visit Activity

Primary/Elementary and Intermediate Levels

Science (Unifying Concepts, Earth)**, Math** (Measurement)

One 45- Minute Session, then 10 - 15 Minutes Daily (5 Days)

Objective(s). Students will demonstrate knowledge of the scientific method by investigating the growth of models of stalactites and stalagmites.

Related NM Content Standards with Benchmarks. SC2-E3, SC12-E3, SC12-M3, MA9-E2, MA9-M3

Method. Students review the scientific method, construct a model of a cave, observe the growth of stalagmites and stalactites, and draw conclusions.

Materials. Epson salts (magnesium sulfate), pan to heat water, spoon, food coloring, jar for storing extra solution, craft knife, pictures of stalactites and stalagmites, small sturdy cardboard box, 3-5 oz. paper cups, 12 pieces of blue yarn (9" long), 12 pieces of red yarn (14" long), heavy weight aluminum foil, paper towels, copies of *Speleothem Growth Observations* student worksheet

Key Vocabulary. speleothem, stalactite, stalagmite

Background. See “The Geology of Carlsbad Cavern” and “A Good Scientific Investigation” in Section 2 – Just the Facts.

Suggested Procedure for Cave Construction

1. Mix 4 cups of water and 5 cups of Epson salts in a pan. Heat to the boiling point, stirring constantly. Allow students to observe and describe what happens.

2. Turn box on its side with the front facing the students. Using 1 cup as a pattern, trace 3 circles on the top of the box. Poke a series of 6 pencil holes through the top of the box, around the circumference of each of the 3 circles. Two holes are needed for the longer piece of yarn and 1 hole for each of the 4 shorter pieces. These holes should be large enough for the yarn to pass through easily.

3. Place an empty cup right side up on each of the circles. Measure 1 piece of blue yarn approximately 9 inches so that it is lightly stretched from the inside bottom of the cup, up and over the edge, and down through a hole. Use a pencil to poke the yarn through the hole. Cut off the yarn so that it hangs 1 to 2 inches down from the top of the box. Using this measured piece of yarn, cut 11 blue pieces of yarn to this same length. Set all 12 pieces aside. Take a piece of red yarn approximately 14 inches and place one end in the bottom of a cup; draw the other end, down through a hole, up through an adjacent hole, and then back into the bottom of the same cup, leaving a loop hanging down about an inch.

4. Place a sheet of aluminum foil onto your work surface. Turn up and crimp the edges to make a waterproof tray with sides about 1 inch high. Make a pad of a dozen paper towels and place it under the box in the foil tray.

5. Place each of the 3 cups within a circle. Pour solution into the cups until they are half full. Place all yarn pieces into the cups of solution, 4 short and 1 long, to wet them.

6. Remove the yarn. Push the longer red pieces of yarn down through 1 hole and up the next. Leave enough yarn in the cup so that both ends reach the bottom. Place the shorter blue yarn pieces with their ends hanging down into the *cave*. Make sure that all strings are suspended in the solution, gently pushing the strings toward the bottom of the cups using a spoon. Repeat for all cups.

7. Add several drops of food coloring to each cup. Add more solution, filling each cup to the brim. Most of the yarn will be *wicking* the solution.

Suggested Procedure for Speleothem Growth

1. Check the fluid level of the cups twice during the day. Add more solution, as needed, to keep them filled to the brim. Store extra solution in closed jars.

2. Distribute copies of the student worksheet. Daily, have students observe the speleothem growth and record their observations on the chart.

3. After 5 days of observation, have students interpret what they observed and formulate their conclusions.

SPELEOTHEM GROWTH OBSERVATIONS

Student Worksheet

	CUP 1	**CUP 2**	**CUP 3**
DAY 1			
DAY 2			
DAY 3			
DAY 4			
DAY 5			

CONCLUSIONS:

A Recipe for Speleothems

Pre-Visit or Post-Visit Activity

Primary/Elementary and Intermediate Levels

Science (Unifying Concepts, Physical, Earth)

30 Minutes Each Demonstration, Several Days to See Results

Objective(s). Students will construct a model to demonstrate the growth of speleothems and crystals.

Related NM Content Standards with Benchmarks. SC2-E3, SC9-E2, SC9-M2, SC12-E3, SC12-M3

Method. Students mix a solution, then observe the growth of speleothems and crystals during a period of several days.

Materials.

> **Growing Speleothems:** water; thick, natural fiber string; cardboard; 2 jars; Epsom salts
>
> **Crystal Garden:** pie tin, pieces of charcoal, ½ cup water, ½ cup salt, ½ cup liquid bluing, 1 cup ammonia, food coloring (do not use red), mixing bowl, spoon

Key Vocabulary. speleothem, crystal

Background. Speleothem is the name given to any secondary deposit (decoration) inside of a cave. The ones which hang from the cave ceiling are stalactites. The ones that rise from the cave floor are stalagmites. Formation of any speleothem takes a long period of time. Each drop of water leaves a tiny amount of mineral residue on a cave ceiling, floor, wall or other feature, adding to the growth of the speleothem.

Speleothems form at different rates. Several factors can determine the rate of growth. Two important factors are rainfall and the outside temperature. As the temperature goes up, so does the decay rate of plants and animals. The more organic material there is in water, the more calcium bicarbonate there is in the water; and thus, the more acidic the water is. The rate of speleothem growth increases with the amount of water and with the acidity of the water.

See “The Geology of Carlsbad Cavern” in Section 2 – Just the Facts.

Suggested Procedure for Growing Speleothems

1. Fill each jar with water.
2. Add enough Epsom salts in each jar of water to form a thick solution.
3. Place the jars on the piece of cardboard about six inches apart.
4. Soak the string in the solution until it is completely saturated.
5. Place one end of the string in one jar of solution. Place the other end of the string in the other jar of solution.

6. Leave enough slack so that there is a bow in the string, but do not let the string touch the cardboard.
7. Leave the jars and the string in an accessible and observable location for several days while a stalactite and stalagmite form.
8. Explain the role of time in this model compared to “The Geology of Carlsbad Cavern” in Section 2 – Just the Facts.

- ***CAUTION:*** Once these *speleothems* begin to form, any movement of the string could cause breakage.

Suggested Procedure for Growing Crystal Garden

1. Place pieces of charcoal into pie tin (enough to cover the bottom of the pan).
2. Mix water, salt, bluing and ammonia in the mixing bowl.
3. Carefully pour this solution over the charcoal so that all pieces are wet.
4. Squirt a few drops of food coloring over the charcoal (do not use red).
5. Allow the pan sit overnight. By the next morning, small crystals should have begun to form on the charcoal.

Let's Make a Cave

Pre-Visit and Field-Trip Activities

Primary/Elementary Level

Science (Unifying Concepts, Physical)

1 ½-Hours Session plus Field Trip

Objective(s). Students will demonstrate how to avoid touching artificial speleothems while using large motor skills to negotiate an obstacle course.

Students will practice good stewardship behavior, such as not touching speleothems during their field trip.

Related NM Content Standards with Benchmarks. SC2-E3, SC7-E1, SC9-E2

Method. After studying the main types of speleothems, students exhibit stewardship behavior by negotiating a teacher-constructed obstacle course.

Materials. large cardboard box (such as a furniture or appliance box), yarn, large nail, plastic drinking straws, large plastic cups, wooden dowel (height of the box's width), tape

Key Vocabulary. secondary deposit, cave, exploration, speleothem

Background. Speleothem is the name given to any secondary deposit (decoration) inside of a cave. Stalactites are speleothems that hang down from the cave ceiling, and stalagmites are speleothems that rise up from the cave floor. Formation of any speleothem takes a 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 should be extremely careful while exploring.

See "Safe Cave Exploration" in Section 2 – Just the Facts.

Suggested Pre-Visit Procedure

1. The cave obstacle course is made up of drinking straw *stalactites*, plastic cup *stalagmites* and a large cardboard box. Lay the box down so that 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 knotted to secure it. Hang numerous straws, at various levels, in one area of the cave. Allow enough room for 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. Mark a trail with the *stalagmites* leading to one open end of the box, through it, and out the other end to the other 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.

2. Talk about the terms stalactites and stalagmites.

3. Ask students to pretend that they are cavers exploring a newly discovered cave. It is their responsibility to not damage any speleothems.

4. Individually, the student will approach the cave in an upright position being careful not to kick any *stalagmites*. When the student reaches the box, he/she will crawl through, not hitting any *stalactites* or *stalagmites*. When each student has had a chance to negotiate the cave, lead a short discussion on maneuvering methods that they invented or used. Have students try another trip through the cave to see if there has been any improvement from their first trial.

Suggested Field-Trip Procedure

1. As you tour Carlsbad Cavern, remind students of their obstacle course experience.

2. Point out speleothems that have been touched or broken. Look for signs of renewed growth of broken speleothems.

3. Encourage students to protect the cave as they go through it, and to be aware of their impact upon the cave.

Are All Caves the Same?

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Unifying Concepts, Earth)**, Mathematics** (Unifying Concepts)**,**
Social Studies (Geography)

1 Hour

Objective(s). Students will discuss several types of cave environments.

Students will explain one reason why people should not remove rocks, speleothems or other features of the caves.

Related NM Content Standards with Benchmarks. SC2-E3, MA1-E1, MA1-E4, MA1-E5, MA3-E1, MA3-E2, MA4-E5, SS12-E3

Method. Students compare and contrast rocks representing different cave environments. Students solve mathematical problems to represent visitor impact on the cave environment.

Materials. plastic cups, rocks, measuring tape, scale

Background. Caves differ in temperature and moisture. Some are cold and wet, others are cold and dry, still others can be warm and wet, or warm and dry.

See “Types of Caves” in Section 2 – Just the Facts.

Suggested Procedure

1. Exhibit 4 rocks – one in a cup of water at room temperature, the second in a cup of water that has been refrigerated for several hours, the third dry and at room temperature, and the fourth dry and cold (kept in a refrigerator). Explain that these rocks came from your garden, not a cave or a park.
2. Allow students to touch and handle the rocks.
3. Begin a class discussion contrasting the differences in the rocks (wet, dry, warm, cold). How do rocks feel in a cave? Do rocks in caves feel different than the ones in the classrooms?
4. Have students solve the following problems:
   - How many classes are in your school? _____
   - How many schools are in your community? _____
   - How many schools are in your county? _____
   - How many counties are in your state? _____
   - If each year _____ (fill in the blank) school classes from the state were to remove 4 rocks from Carlsbad Cavern, how many rocks would be removed…

…in a year's time? _____

…in 5 years? _____

…in 10 years? _____

…by the time you graduate from high school? _____

- If each rock weighed 3 lbs., how many tons of rocks would be removed?
- Find a rock that weighs _____ (fill in the blank). Measure the area. Compute the area in square feet that would be missing from the cave yearly. (Use an object like a building to compare your figures to, so you have a visual aid to assist with the concept.)
- Are the rocks/speleothems in Carlsbad Cavern being replaced?
- Do speleothems grow at fast rates?
- How can your students help promote cave conservation?
- ***Note:*** These exercises could also be done using Carlsbad Caverns National Park's annual visitation of 650,000.

How's the Climate Down There?

Pre-Visit, Field-Trip and Post-Visit Activities

Primary/Elementary and Intermediate Levels

Science (Inquiry)

30 Minutes Pre-Visit, Field Trip, 30 Minutes Post-Visit

Objective(s). Students will observe and measure the differences in temperature and humidity within the cave and on the surface.

Related NM Content Standards with Benchmarks. SC5-E2, SC5-M2, SC6-M5, SC6-M6

Method. Students compare the temperature and humidity at their school site, the park visitor center, the mouth of the cave and various spots within the cave.

Materials. thermometer, sling hygrometer, paper, pencil

Key Vocabulary. weather, humidity, hygrometer, temperature, thermometer, twilight zone

Background. The cave's temperature is a constant 56°F. Humidity is about 95%. Students may notice a temperature change between the parking lot and nature trail. Relative humidity and temperature will change dramatically between the amphitheater and the end of the twilight zone. If differences are noted between the elevator area and other areas of the cave, it may be due to air coming down the elevator shaft, refrigeration equipment in the rest area or the large number of people in the general vicinity.

Suggested Pre-Visit Procedure. Introduce students to the concepts of temperature and relative humidity. Demonstrate how to use the thermometer and the hygrometer. Prepare a worksheet to record these measurements. Each entry should include date, time, place, temperature, relative humidity, plant life and wildlife. Take several measurements and record data for several days prior to the field trip.

Suggested Field-Trip Procedure

1. On the morning of your trip, have students measure and record the temperature and relative humidity at the school.

2. Upon arrival at Carlsbad Caverns National Park, have students measure and record the temperature and relative humidity in the parking lot. Also take measurements in front of the visitor center, on the trail to the cave entrance, in the cave entrance amphitheater, at the end of the twilight zone, at the elevators and at two or three spots along the cave trail. Have students make notes about the kinds of plant life seen along the nature trail and on into the entrance. Record any wildlife seen along the way.

Suggested Post-Visit Procedure

1. Have students hypothesize reasons for the differences noted in their observations.

2. Facilitate a discussion on the impact of visitors on the temperature and humidity of the cave. Does the weather of the surface affect the type of wildlife and plant life found on the surface? How does the plant life change as one approaches the entrance to the cave? Why?

Note: This activity can also be used on a visit to Slaughter Canyon Cave. Take measurements at the parking lot, beginning of the trail, halfway point (sign), cave entrance and several stopping points in the cave.

Mapping a Cave

Pre-Visit or Post-Visit Activity

Intermediate Level

Science (Inquiry, Earth)**, Mathematics** (Unifying Concepts, Measurement)**,**

Social Studies (Geography)

1 Hour

Objective(s). Students will interpret a written set of instructions and a pattern of markers.

Students will use mathematical procedures and measurements to accurately solve problems.

Related NM Content Standards with Benchmarks. SC5-M2, SC12-M6, MA2-M3, MA4-M4, MA9-M3, SS12-M1, SS12-M2

Method. Students use a compass and make a map similar to those made by explorers.

Materials. The Class: 36 paper cups (recycled), something to weigh down the cups

Each Group of 3: compass, tape measure, graph paper, student sheet

Key Vocabulary. topographic

Background. Proper documentation of a cave is important in determining its scientific value and significance. Cave mapping is the foundation of any type of cave research.

Since the 1960s, Carlsbad Caverns National Park has had coordinated survey groups for both Carlsbad Caverns and some the park's remote caves. The largest mapping project at the park began in 1986 and is Lechuguilla Cave. Thus far, more than 100 miles of passages have been surveyed and the end is not in sight. It is the deepest known cave in the continental United States.

Cave survey teams have three or four members. At Carlsbad Caverns National Park each survey team consist of four people—a sketcher, an instrument person, a lead tape person and one person taking inventory of cave features. The collected data is entered in a computer mapping program and database.

Recently, cave mapping has taken a new turn with the Geographic Information Systems (GIS). Archeological, historical, biological, paleontological and mineralogical sites will be tied into the nearest survey station GIS for cave management and is limited only by the imagination.

Suggested Procedure

1. Have students arrange the paper cup markers on the gym floor or outdoors. Set the markers in a grid with each cup being of equal distance (at least 10 feet) from the cup behind, in front, and to each side of the other cups. Put a weight in each cup to keep it from moving around. The grid can be 6 rows by 6 columns, or larger, as long as the number of columns equals the number of rows.

X	X	X	X	X	X
X	X	X	X	X	X
X	X	X	X	X	X
X	X	X	X	X	X
X	X	X	X	X	X
X	X	X	X	X	X

2. Teach students how to find direction by using a compass. Show them the four cardinal directions of north, south, east and west; how to find northeast, southeast, northwest and southwest; and, how to use a tape measure.

3. Divide the class into groups of three students. (A caver has at least two other cavers with him/her.) Give each group a copy of the student sheet. Assign group numbers 1 through 5. The written instructions will direct each group along its personalized path through the grid markers. Any marker may be the starting point.

4. After each group has finished going through the course, have students plot the information on graph paper and show the route they took through the grid.

Mapping a Cave

Student Sheet

You are a group of cavers about to enter a wild cave. One caver reads the instructions and the compass to direct the group. One caver takes measurements from marker to marker and labels each marker with a number. One caver records the path: number of marker, direction to next marker and distance from the last marker.

GROUP ONE

Marker 1	Enter cave at SW corner.
Marker 2	Move to next NE marker.
Marker 3	Move to next N marker.
Marker 4	Move to next NE marker.
Marker 5	Move to next N marker.
Marker 6	Move to next W marker.
Marker 7	Exit cave at next SW marker.

GROUP TWO

Marker 1	Enter cave at SE corner.
Marker 2	Move to next W marker.
Marker 3	Move to next W marker.
Marker 4	Move to next N marker.
Marker 5	Move to next NE marker.
Marker 6	Move to next S marker.
Marker 7	Exit cave at next NE corner.

GROUP THREE

Marker 1	Enter cave at NE corner.
Marker 2	Move to next SW marker.
Marker 3	Move to next SE marker.
Marker 4	Move to next S marker.
Marker 5	Move to next NW marker.
Marker 6	Move to next N marker.
Marker 7	Exit cave at next E marker

GROUP FOUR

Marker 1	Enter cave at NW corner.
Marker 2	Move to next SE marker.
Marker 3	Move to next S marker.
Marker 4	Move to next E marker.
Marker 5	Move to next SW marker.
Marker 6	Move to next S marker.
Marker 7	Exit cave at next NW marker.

GROUP FIVE

Marker 1	Enter cave at N side, one marker from the NE corner.
Marker 2	Move to next SW marker.
Marker 3	Move to next S marker.
Marker 4	Move to next W marker.
Marker 5	Move to next W marker.
Marker 6	Move to next NW marker.
Marker 7	Exit cave at next N marker.

Down to the Core

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Unifying Concepts, Earth)

45 Minutes

Objective(s). Students will make a model of the earth in order to reinforce vocabulary, issues of geology and the general make up of the earth.

Related NM Content Standards with Benchmarks. SC2-E2, SC2-E3, SC12-E1

Method. By cutting through clay and cupcakes, students learn how the earth is layered.

Materials. clay (brown, gray, red, black), clear straws, layered cupcakes, plastic knives, scales, rulers, paper, pencils

Key Vocabulary. hypothesis, crust, mantle, core, mineral

Background. Earth is made of layers. The top layer, on which we live, is the earth's crust. Below this is a thick layer called the mantle. Still deeper within the earth's crust is the outer core. In the center is the inner core. The deepest drillings have only penetrated the earth's crust.

Geologists explore the earth by sampling the top layer of the earth—the crust. Some knowledge has been gathered by using other methods, such as analysis of earthquake waves passing through the earth (seismology); analysis of the composition of meteorites; and by calculations using the earth's size, shape and density.

Scientists believe that the inner core is a solid ball of iron and nickel. They believe the mantle is made of molten iron and nickel.

Suggested Procedure

1. In partners, have students construct a clay model of the earth showing four layers, each a different color. After the ball is completed, allow the clay set for thirty minutes. Cut ball in half.
2. Have students record their findings. The Earth has different layers and together they are the Earth as a whole.
3. Cupcake core sampling: Independently, have students predict the inner layer of the Earth's crust and use a cupcake as a model. Have students establish a hypothesis, sample the cupcake models using clear straws, write a conclusion and eat!
4. Remind students that at Carlsbad Cavern is almost 800 feet below the surface—not enough to put a scratch the Earth's crust.

A Key to Rocks

Pre-Visit or Post-Visit Activity

Intermediate and Secondary Levels

Science (Inquiry)

50 Minutes

Objective(s). Students will identify *unknown* minerals by testing their properties.

Related NM Content Standards with Benchmarks. SC6-M4, SC6-M6, SC6-H4, SC6-H6

Method. Using a dichotomous key, students identify minerals.

Materials. variety of minerals and/or rocks or a pre-made sampling set of minerals; copies of mineral identification key (dichotomous key); small panes of glass; unglazed porcelain tiles; rock and mineral, geology or mineralogy book for reference; pencils, paper, chart paper, marker

Key Vocabulary. karst land, dichotomous key, rock, mineral

Background. Most karst lands are underlain by rocks, such as limestone, dolomite, gypsum or marble. These rocks are called solutional rocks because they can be dissolved by acidic rainwater to form cave. Most large caves are formed in solutional rocks. The most common solutional rocks is limestone. Limestone, composed of the mineral calcite, is a sedimentary rock formed in layers.

Rocks are made up of minerals. There are hundreds of different minerals in the world, each with unique physical properties, chemical composition and origin. Geologists can determine a mineral's name by classifying its properties. Those who do have little experience classifying minerals are able to identify some of the more common ones by using a dichotomous key. Dichotomous keys are used in fields, such as biology, botany and entomology.

Suggested Procedure

1. Before identifying rocks, facilitate a class discussion of terminology. Have students define the following terms: acid test, cleavage, conchoidal fracture, florescence, hardness, luster, specific gravity, streak color and surface color.
2. Divide students into pairs.
3. Distribute copies of the *Mineral Identification Key*. (You may prefer to use a key from your textbook or another source.)
4. Using the key, have pairs determine the names of minerals specimens or identify individual bits of a mineral in a rock, using the key.
5. Have students write their findings.
6. Facilitate a class discussion and make a classroom chart of the mineral specimens the class has identified.

Mineral Identification Key
How to Identify 26 Common Minerals

Identification keys are useful for the study of natural objects. Use this key to identify a specimen of a single mineral, or to identify individual bits of a mineral in a rock. First find the hardness, cleavage, color, color of the streak and luster of the mineral, as explained in a general physical geology book or a book about rocks and minerals. From your findings, answer *Question A*. Your **yes** or **no** answer will guide you to the next question to answer. By moving step by step through the key as directed, you can identify the mineral, if it is one of the 26 listed.

Many of the minerals you find will not be included here. If this is the case, check your findings of the physical properties with the mineral descriptions in a book about rocks and minerals.

Question A. Is the specimen's hardness less than 2? (Can you scratch it with your fingernail?)

If yes, see **#1** below.

If not, go to *Question **B***.

#1 Is cleavage perfect in one direction?

If yes, see **a**, **b** and **c** below.

a. If thin sheets are transparent, if thicker pieces are colorless or light in color and if the cleavage surfaces are very shiny, the mineral is MUSCOVITE MICA.

b. If the description above applies, except the color is dark brown to black, the mineral is BIOTITE MICA.

c. If there is a second cleavage direction, and if a silky to satiny luster is evident, the mineral is GYPSUM.

If not, see **# 2** below.

#2 If there is no definite cleavage, see **a**, **b** and **c** below.

a. If the mineral is mostly white with a dull luster and has an earthy odor when moistened the mineral is KAOLIN.

b. If the mineral is mostly white or greenish white, with a silky luster, and feels slippery to the touch the mineral is TALC.

c. If the mineral is mostly black, with a metallic luster, and feels slippery to the touch, the mineral is GRAPHITE.

Question B. Is the hardness more than 2 ½, but less than 5 ½? (Is it too hard to be scratched by a fingernail, but will not scratch glass?)

If yes, see **#1** below.

If not, go to *Question **C***.

#1 Is cleavage three-directional?

If yes, see **a** below.

a. Do all cleavage surfaces join at right angles?

If yes, see **(1)** and **(2)** below.

(1) If the mineral is black, with a metallic luster and shows a black streak, the mineral is GALENA.

(2) If the mineral is light in color, and tastes salty, the mineral is HALITE.

If not, see **b** below.

b. If the cleavage surfaces fail to meet at right angles, and if the mineral is mostly white or milky white in color with a pearly luster, the mineral is CALCITE.

#2 Is the cleavage generally two-directional?

If yes, see **a** below.

a. If the two cleavage surfaces are at acute angles, if the mineral appears translucent to transparent, and if it shows a rather glassy luster, the mineral is FLUORITE.

If not, see **#3** below.

#3 If there is no definite cleavage, see **a** below.

a. Is the luster metallic?

If yes, see **(1)** and **(2)** below.

(1) If the mineral has brownish red streak, the mineral is HEMATITE.

(2) If the mineral is yellow, has a brassy luster, and leaves a black streak, the mineral is CHALCOPYRITE.

If not, see **b** below.

b. Is the luster dull?

If yes, see **(1)** below.

(1) If the mineral has a rusty yellow to pale orange streak, the mineral is LIMONITE.

Question C. Is the hardness more than 5 ½, but less than 7? (Will the mineral scratch glass?)

If yes, see **#1** below.

If not, go to *Question **D***.

#1 When you press a sharp edge of the mineral against the glass, does it leave only a faint scratch?

If yes, see **a** below.

If no, skip to **b**.

a. Is cleavage two-directional?

If yes, see **(1)** below.

(1) Do the cleavage surfaces join at right angles?

If yes, see **(A)**, **(B)**, **(C)** and **(D)**.

(A) If the mineral is salmon pink or tuna-fish pink, the mineral is ORTHOCLASE FELDSPAR.

(B) If the mineral is white or gray, and contains very faint parallel striations on a well developed cleavage surface, the mineral is ALBITE FELDSPAR.

(C) If the mineral is dark gray, contains very faint parallel striations on a well-developed cleavage surface, and shows an internal peacock blue and iridescent blue-green play of color, the mineral is LABRADORITE FELDSPAR.

(D) If the mineral is dark green to black, the mineral is AUGITE.

If not, see **(2)** below.

(2) If the two cleavage surfaces do not meet at right angles, and the color is dark green to black, the mineral is HORNBLENDE.

b. If there is no definite cleavage, see **(1)** below.

(1) Is the luster metallic?

If yes, see **(A)** and **(B)** below.

(A) If the mineral is yellow, and leaves a black streak, the mineral is PYRITE.

(B) If the mineral is black, leaves a black streak, is quite dense and may be magnetic, the mineral is MAGNETITE.

#2 When you press a sharp edge of the mineral against glass, does it leave a deep scratch?

If yes, see **a** below.

a. Is the luster glassy, rather than metallic?

If yes, see **(1)**, **(2)** and **(3)** below.

(1) If the mineral is deep wine-red in color, the mineral is GARNET.

(2) If the mineral is colorless, milky, or smoky, the mineral is QUARTZ.

(3) If the mineral shows a granular texture, and is rather olive green, the mineral is OLIVINE.

If not, see **b** below.

b. Is the luster dull and rather waxy? If yes, see **(1)** below.

(1) If the mineral shows a distinct conchoidal fracture which leaves smooth curved surfaces that have sharp edges and corners, the mineral is QUARTZ CHALCEDONY.

Question D. Is the hardness greater than 7? (Does the mineral leave a deep scratch on the glass and a faint scratch on the porcelain tile plate?) If yes, see **#1** and **#2** below.

#1 If the mineral is commonly black, green or pink in color, with a glassy luster, and the long crystals show numerous fine grooves running parallel to each other for the length of the crystal faces, the mineral is TOURMALINE.

#2 If the mineral is generally greenish blue, pale yellowish, yellowish green, or pale pink to lilac in color, and shows an irregular to conchoidal fracture with a glassy luster, the mineral is BERYL.

Make a Fossil

Pre-Visit or Post-Visit Activity

Primary/Elementary and Intermediate Levels

Science (Unifying Concepts, Earth)

45 Minutes

Objective(s). Students will demonstrate how a fossil is formed.

Related NM Content Standards with Benchmarks. SC2-E3, SC12-E5

Method. Students make models of fossils.

Materials. clay, plaster of Paris, water, old bowl and spoon, shells or bumpy rocks

Key Vocabulary. fossils, brachiopods, trilobites, sediments, organism

Background. Most animals and plants never become fossils. Most sediments are laid down at sea, so most fossils are of creatures which lived and died in the sea.

Carlsbad Caverns lies in an ancient fossil reef. Most scientists believe that a sea existed in the Delaware Basin nearly 250 million years ago. In this ocean lived many sea creatures such as brachiopods (clam-like animals), trilobites, sponges, nautiloids (nautilus-like animals) and algae. When these organisms died they built up and turned to rock, making the Capitan reef today. A fossil was made when an organism died and its body settled into the sediments on the sea floor. More sediments covered the organism; and over time, the organism became rock.

Suggested Procedure.

1. Pass around fossils to show students. Ask students to describe fossils and to explain how they think fossils were formed. Inform students that they will make their own model of a fossil to better understand how they are formed.
2. Give each student a lump of clay. Flatten the clay a little. This represents the mud on the bottom of the sea.
3. Give each student a shell or rock. Press it gently into the clay, not too far. This represents an organism that has died and settled at the bottom of the sea.
4. Carefully take the shell or rock out of the clay. This represents the organism turning to rock.
5. Mix Plaster of Paris according to the directions. Spoon the plaster into the print in the clay. This represents the next layer of sediment and mud that covers the organism and print.
6. When the plaster is dry, peel away the clay to reveal the fossil.

Section 5 – Bat Activities

- **How About Those Bats?**
- **Comparing Bats and Birds**
- **Bat Wings**
- **Beneficial Bats Puppet Show**
- **Bat and Moth**
- **The Nose Knows**
- **What Big Ears You Have**
- **The Better to Hear You With, My Dear**
- **Bat Math Quiz**
- **Bat, May I?**

How About Those Bats?

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Life)**, Art** (Unifying Concepts**)**

Two 45-Minute Sessions

Objective(s). Students will differentiate between myths and realities about bats.

Related NM Content Standards with Benchmarks. MA2-E2

Method. By reviewing background information and drawing pictures of bats, students learn more about these flying mammals.

Materials. graph with three columns, light colored construction paper, white construction paper, scissors

Key Vocabulary. myth, anatomy

Background. Bats are unique animals. They are the only mammals that are true fliers. They have specialized wings that are made of tough skin. Bats have long *fingers* that spread and support the wings. The skeleton and soft anatomy in the wing of a bat may be directly compared to the arm and hand of a human. Bats live on all continents except Antarctica. They make up nearly a quarter of all animals on earth. There are nearly 1,000 species of bats. Carlsbad Caverns National Park has 15 species of bats. The park is famous for its large colony of Mexican free-tailed bats.

See “The Bats of Carlsbad Caverns and Elsewhere” in Section 2 – Just the Facts.

Suggested Procedure

1. Create a large graph that the entire class can see. You may want to use the blackboard. The graph should contain three columns: “I like bats” and “I don’t like bats” and “I’m not sure.”

2. Ask, “How do you feel about bats?” Give each student a 3" X 5" piece of white construction paper. Ask each student to draw a picture of a bat. When they have completed their pictures, allow them to place their pictures on the graph, indicating how they feel about bats.

3. After placing all the bats on the graph, ask students to state three things that are true about the graph. Discuss findings. Ask them to observe the details in the pictures. Encourage students to notice the similarities and differences in the illustrations.

4. Have each student fold a 9" X 12" piece of construction paper in half, lengthwise. Instruct students to fold the long slender rectangle in half and in half again.

5. Have students open the paper to the original fold. Place the fold away from you and open the flap. Cut along the other three fold lines up to the original fold.

6. Have students write a question about bats on the top of each of the flaps. When they have written their questions, have them open the flap and write information they may know about the question on the inside top of the flap.
7. At this time, do not have students write anything on the lower interior part. Collect the booklets for later use.
8. After the class has studied bats, have students write the answers to their questions on the inside of their booklets.

Comparing Bats and Birds

Pre-Visit or Post-Visit Activity

Primary/Elementary and Intermediate Levels

Science (Life)

30 Minutes

Objective(s). Students will compare and contrast bats and birds.

Related NM Content Standards with Benchmarks. SC10-E1, SC10-M2

Method. Students complete a chart deciding which animal has the characteristic listed.

Materials. copies of “Comparing Bats and Birds” student worksheet , pencils, illustrations and/or models of birds and bats

Key Vocabulary. compare, contrast, echolocation

Background. The bat is the only mammal that can truly fly. Birds fly, but they are in a separate scientific classification. Other than the characteristic of flight, are bats and birds alike in other ways? How are bats and birds different?

See “The Bats of Carlsbad Caverns and Elsewhere” in Section 2 – Just the Facts.

Suggested Procedure

1. Have students complete their student worksheets, with what they believe to be the characteristics of bats, birds or both.
2. Facilitate a class discussion comparing and contrasting the two animals, making a classroom *master* chart.
3. Use illustrations or models of birds and bats to emphasis the characteristics.

Key

Characteristics	Bat	Bird
The animal has an inside skeleton.	X	X
The animal has feathers.		X
The animal has fur.	X	
The animal makes a nest.		X
The animal hangs upside down to sleep.	X	
The animal lays eggs.		X
The animal gives birth to live babies.	X	
The animal has teeth.	X	
The animal has a beak.		X
The animal flies.	X	X
The animal uses echolocation to catch food.	X	
The animal breathes air.	X	X
The animal uses its eyes and ears to get food.	X	X

COMPARING BATS AND BIRDS

Student Worksheet

Name: _____

Date: _____

Directions: Place an **X** for the statements that are true for bats, birds or both.

Characteristics	Bat	Bird
The animal has an inside skeleton.		
The animal has feathers.		
The animal has fur.		
The animal makes a nest.		
The animal hangs upside down to sleep.		
The animal lays eggs.		
The animal gives birth to live babies.		
The animal has teeth.		
The animal has a beak.		
The animal flies.		
The animal uses echolocation to catch food.		
The animal breathes air.		
The animal uses its eyes and ears to get food.		

Bat Wings

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Unifying Concepts, Life)**, Art** (Visual)

45 Minutes

Objective(s). Students will illustrate the similarities of a bat skeleton and the human body.

Related NM Content Standards with Benchmarks. SC2-E3, SC10-E1

Method. Students construct a simplified model of the wing structure and body of a bat.

Materials. finished model of bat wings, copies of bat wing pattern, black or brown construction paper, white or manila paper, scissors, glue

Key Vocabulary. symmetrical, anatomy, skeleton

Background. Bats are unique animals; they are the only true flying mammals. Bat wings are actually modified arms. The bones are like those in a human arm and hands, except a bat has very long fingers. The wing's front edge is supported by the upper arm, forearm, second and third fingers. The rest of the wing is supported by the fourth and fifth fingers. The wing has two thin layers of flexible skin stretched between these fingers. The skin is so thin that you can almost see through it. The thumb of a bat is like a claw; it is used to help the bat move across rough surfaces of cave walls or tree bark.

See "The Bats of Carlsbad Caverns and Elsewhere" in Section 2 – Just the Facts.

Suggested Procedure

1. Facilitate a class discussion about how a bat's wing is like a human hand to assess what students already know. Let them share ideas. Show students the bat wing pattern. Bats have many more bones in their wings than the pattern shows. Because a bat is symmetrical, it will usually have the same number of bones on both sides of the body at approximately the same location.

2. Make copies of the bat wing pattern. Give each student a copy of the bat wing pattern, a sheet of black or brown construction paper, a sheet of white or manila construction paper, scissors and glue.

3. Have students cut out wings and trace them twice onto the construction paper. Instruct students to cut out the two wings. Then have them cut out the bat wing bones from the pattern piece and trace them twice onto the white or manila paper and cut along tracings.

4. Using the finished model of the bat wings for reference and to self-correct, students glue the *arm* and *finger* bones on the wings in their proper locations. When students have completed their bat wings, have them put their names on the backs of both wings. Collect wings for use in the *Beneficial Bats Puppet Show*.

BAT WINGS PATTERN

Beneficial Bats Puppet Show

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Life)**, Language Arts** (Unifying Concepts, Expressive Language**),**
Art (Visual, Theatre)

Four 40-Minute Sessions

Objective(s). Students will identify at least three ways bats are beneficial.

Related NM Content Standards with Benchmarks. SC10-E1, LA2-E1, LA5-E3, LA5-E5, AE1-E10, AE1-E15, AE3-E11

Method. Students script and perform in a puppet show to illustrate the benefits of bat conservation.

Materials. finished bat puppet, copies of bat pattern, paper lunch bags, glue, scissors, student's bat wings from the "Bat Wings" activity

Key Vocabulary. symmetry, anatomy, pollinate

Background. Bats have been the subject of much misrepresentation and bad publicity. Maybe it is due to their ability to fly. Or maybe it is because of the places they inhabit, such as caves. But for whatever reason, bat species are declining at an alarming rate, mostly due to human impact. Bats are beneficial to man and the environment. They have a vital role in the balance of nature—controlling the night-flying insect populations, scattering seeds for new plant growth and pollinating plants. Therefore, people need to help keep bat populations stable.

See "The Bats of Carlsbad Caverns and Elsewhere" in Section 2 – Just the Facts.

Suggested Procedure for Session One

1. Give each student a copy of the bat pattern, a paper lunch bag, scissors and glue.
2. Have students cut out the bat body parts from the pattern. Place the lunch bag with the flap up and the opening down.
3. Using the finished puppet for reference and to self-correct, have students glue the bat's body parts in their proper locations. The eyes and nose are glued on the flap, with the flap acting as the mouth. (Do not glue the flap down.) Glue the ears on the back of the bag, so they stick up above the head. The feet are glued near the opening of the bag.
4. Give each student his/her own pre-made bat wings from the *Bat Wings* activity. Have students glue the wings in the side folds of the lunch bag.

Suggested Procedure for Session Two

1. Divide students in groups of four.

2. Instruct each group to write a funny, short script to explain how bats benefit people. Students will be either bats and/or people—according to the script. Allow students to write their lines on index cards.

Suggested Procedure for Session Three. Have students practice and rehearse their shows.

Suggested Procedure for Session Four. Have students conduct their puppet shows for the lower elementary grades.

PAPER BAG PUPPET PATTERN
Bat

Bat and Moth

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Unifying Concepts, Life)

45 Minutes

Objective(s). Students will demonstrate how insectivorous bats catch prey in the dark.

Related NM Content Standards with Benchmarks. SC2-E3, SC10-E1

Method. Through physical activity, students simulate how a bat uses echolocation to find its prey.

Materials. blindfolds

Key Vocabulary. echolocation, insectivorous

Background. Some bats make a high pitched squeaking sound to find insects. These sounds (usually too high-pitched for human ears to hear) bounce off objects in their path. Bats are able to determine what an object is and their distance from it, simply by listening to their own echoes. Bat also make noises that human can hear—clickings, whinings and squeaks. A bat echolocation tape is available through Bat Conservation International in Austin, Texas.

See “The Bats of Carlsbad Caverns and Elsewhere” in Section 2 – Just the Facts.

Suggested Procedure

1. Blindfold one student. He/She will be the *bat*. Designate 4 to 6 other students to be *moths*. The remaining students form a circle around the bats and moths.

2. Both the *bat* and the *moths* can move. The *bat* calls out “bat,” and the *moths* respond “moth.” Using the sounds, the *bat* must find and tag the *moths*. Tell students that every time the *bat* calls out “bat,” he/she is pretending to be a bat sending out a high-pitched sound. When the *moths* reply “moth,” they are pretending to be the bat’s echo bouncing off the moth and back to the bat’s ears. As the moths are tagged, they join the students forming the circle.

3. Another variation is to add another *bat*. Be sure they do not collide with one another. Try adding some *trees*. When the *bat* calls out “bat,” the *trees* respond “tree.” The *trees* must stand still. If a *bat* runs into a *tree*, the student must join the students in the circle.

The Nose Knows

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Unifying Concepts, Life)

1 Hour

Objective(s). Students will model how a mother bat finds her own baby among hundreds of pups.

Related NM Content Standards with Benchmarks. SC2-E3, SC10-E1

Method. Using scents and sounds, students theorize how a mother bat finds her pup.

Key Vocabulary. mammal, pup, colony

Materials. cinnamon oil, clove oil, mint extract, vanilla extract, lemon extract, construction paper, yarn, scissors, blindfold

Background. Many mother mammals use the sight, sound, taste and smell of their young to recognize them as soon as they are born. In a cave environment, mother bats cannot use sight to recognize their babies. It is theorized that mother bats identify their young by using sound and smell.

In Bat Cave, at Carlsbad Caverns National Park, Mexican free-tailed bats hang upside down touching each other, covering the ceiling in single-layered groups with up to 500 pups (baby bats) huddled together in one-square-foot space. This closeness raises the temperature of the cave, keeping the pups warm while their mothers are flying the night skies in search of food. Upon returning to the cave, each mother bat finds her own baby in total blackness. How can this be?

See “The Bats of Carlsbad Caverns and Elsewhere” in Section 2 – Just the Facts.

Suggested Procedure

1. Explain to students what a nursery colony is and what would life be like.
2. Have each student draw a bat on the construction paper and cut it out. Using the yarn, make a necklace from the paper bat.
3. Designate 5 students to be *adult bats.* Designate 5 other students as *pups*. Have students leave the classroom. Place a couple of drops of cinnamon oil onto one of the adult necklaces. Using the same oil, place a couple of drops onto one of the baby necklaces. Repeat this step using the various scents to pair adult necklaces with baby necklaces.
4. When students return to the classroom, tell them you have put a scent on their *bats*, and they are not to discuss their scent with each other. Separate the *adults* and *pups*. Have each student put on their bat necklace. On one side of the room have the *pups* line up against the wall. On the other side of the room, blindfold *one adult*. Tell the *adult* to walk

across the room and find the *pup* that matches his/her scent. Record how long it takes to find the matching *pup*. Next, blindfold the second *adult* and repeat the process. Continue until each *adult* has found its own *pup.* Repeat #3 and #4 to allow 10 other students to participant.

5. Have the original 10 students trade necklaces and reverse their previous roles. Pair each *new adult* with its correct *pup*. Have each pair agree on a special click.

6. Have *pups* go to one side of the room. Blindfold the first *adult* on the other side of the room. Mix *pups* around. Have *pups* do their special click quietly. The *adult* will try to find its *pup* by using not only scent, but also sound. Have each blindfolded *adult* find its *pup*. Record the time it takes for the *adult* to find the *pup*. Is it quicker than with just smell alone? Repeat #5 and #6 to allow the second group of 10 students to participate.

7. Have the original 10 students once again trade necklaces. Pair each *adult* with its own *pup.* And again ask them to agree upon a click sound. Allow each *adult* to place its *pup* in a position along the wall. All the *pups* can then pick a spot along the wall. The *adult* is then blindfolded and sets off to find the *pup* using smell, hearing (the clicks) and memory. Allow each *adult* to find its *pup*. Record the time it takes for each adult to find its pup. Is it quicker than the previous ways? Repeat #7 to allow the second group of 10 students to participate.

What Big Ears You Have

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Unifying Concepts, Physical, Life)

15 Minutes

Objective(s). Students will model and describe sound waves. They will then describe how a bat uses sound waves for survival.

Related NM Content Standard with Benchmarks. SC2-E3, SC9-E1, SC10-E1

Method. Students illustrate sound waves using water.

Materials. tape player, tape of soft music, glass pan or clear container, water, dropper filled with water, overhead projector

Key Vocabulary. sound waves, sonar system, echolocation

Background. Although bats are not blind, most of them (70%) use a sonar system, called echolocation, to navigate in the dark. The sound that these bats make are high-pitched—most too high for people to hear. As the sound waves coming from the bat hit objects (trees, buildings, people or potential food), they are reflected back as echoes and are collected by the bat's ears. Using sound alone, the bat can tell the size, texture and even the direction of a moving insect. Echolocation tells a bat, not only the location of the object, but what the object is.

See "The Bats of Carlsbad Caverns and Elsewhere" in Section 2 – Just The Facts.

An echolocation tape is available through Bat Conservation International in Austin, Texas.

Suggested Procedure

1. Have students close their eyes. Play a tape of soft music. Next have students cup their hands behind their ears and continue to listen.

2. Ask students the following questions:

   "Does cupping your hands behind your ears help you hear the music better?"

   "How are your cupped hands like a bat's big ears?"

   "Why do you think a bat has such big ears?"

3. Fill the pan with about one inch of water. Place the pan on the overhead projector. Turn the projector on and let the water settle. When the water is calm, instruct a student to drop a couple of drops of water from the dropper into the middle of the pan.

4. Ask students the following questions:

   "What happened?"

   "Could you see the ripples move out from the source?"

“What happened when the water waves reached the edges of the pan?”

“Compare the water waves to sound waves from a bat.”

5. Ask who has witnessed a bat flight program at Carlsbad Caverns National Park. Ask the following questions to those who have witnessed a bat flight.

   “Did you hear the bats echolocate?” (No.)

   “Did you see any of the bats hit trees, people or other bats?” (No.)

   “Were you close enough to hear the bats just before you saw them?”

   “If you answered yes, what sound did you hear?” (Suggest wings flapping, clicking, whining or squeaks.)

The Better to Hear You With, My Dear

Pre-Visit or Post-Visit Activity

Primary/Elementary and Intermediate Level

Science (Unifying Concepts, Physical, Life**)**

45 Minutes

Objective(s). The students will illustrate basic wave patterns.

Related NM Content Standards with Benchmarks. SC9-E1, SC9-M1

Method. Using water and a wave generator, students sketch sound wave behaviors in various situations.

Materials. overhead projector, screen, ripple tank, water, wave generator with parallel-wave and circular-wave attachments, various types of barriers for the tank

Background. Review the different types of wave behavior (interference, refraction, reflection, diffraction).

See “The Bats of Carlsbad Caverns and Elsewhere” in Section 2 – Just the Facts.

Suggested Procedure

1. Set up the equipment, using enough water to completely cover the bottom of the tank and still obtain a clear image of wave fronts on the screen. It may be necessary to readjust the focusing after the tank is filled with water. CAUTION: Spilled water may damage equipment and cause electrical shock. Unplug immediately, if water spills.
2. Set up barriers and waves for each situation.
    - straight-line waves
    - parallel straight-line waves off a straight barrier
    - parallel straight-line waves moving towards a triangular glass plate
    - circular (curved waves)
    - reflection of curved waves off a straight barrier
    - reflection of curved waves of a convex barrier
    - interference of curved waves from two wave sources
3. Have students sketch the resulting waves on the student worksheet. It may be easier to start with a single pulse before generating a steady wave train.

OBSERVATION OF SOUND WAIVES
Student Worksheet

Sketch and label the wave patterns produced in each of the situations demonstrated in the ripple tank.

straight generator	barrier straight generator	glass plate on bottom straight generator	Barriers ------- -------- straight generator	
circular generator	circular generator	circular generator	circular generator	

Bat Math Quiz

Pre-Visit or Post-Visit Activity

Intermediate Level

Science (Life)**, Mathematics** (Unifying Concepts, Statistics)

30 Minutes

Objective(s). Students will solve bat-related math problems, and then draw and write conclusions based upon their answers.

Related NM Content Standards with Benchmarks. SC10-M1, MA1-M1, MA1-M6, MA4-M4, MA10-M3

Method. By solving math problems, students draw several conclusions about bats.

Materials. paper, pencil

Background. After solving the math problems, students should draw the following conclusions:

- An active bat's heart beats much faster than an active human heart.
- A bat's heartbeat is dramatically slower when it hibernates. (Carlsbad Cavern's famous colony of Mexican free-tailed bats does not hibernate. When the weather turns cool, they fly south for the winter.)
- Some bat species eat a lot of harmful insects. (Most species of bats are insect-eaters. Carlsbad's Mexican free-tails eat mostly moths. Research is currently being conducted to estimate how many thousands of bats live in Bat Cave. One can only try to image the tons of moths that these bats eat.)
- See "The Bats of Carlsbad Caverns and Elsewhere" in Section 2 – Just the Facts.

Suggested Procedure for Question One and Two. Tell students that a human's active heartbeat is about 150 times per minute. An active bat's heartbeat averages 900 beats per minute.

- When compared to a human, how many more beats does the bat make per minute? Answer: 750
- How many times does a bat's heartbeat a second? Answer: 15

Suggested Procedure for Question Three. Tell students that when the average bat hibernates, its heart rate drops to about 20 beats per minute.

- How many times will a hibernating bat's heart beat in one day (24 hours)? Answer: 28,800
- What do you think would happen to hibernating bats, if human activity woke them frequently? What is your explanation for the answer you gave?

Suggested Procedure for Question Four, Five and Six. Tell students that insectivorous bats can eat half their weight in insects each night.

- If the bat weights 16 grams and a moth weights 0.4 grams, how many moths will the bat eat before it is full? Answer: 20
- If the bat ate only moths, how many moths could it eat from May to September (150 days)? Answer: 3,000
- How many could a colony of one billion bats eat? Answer: 3 billion
- Why do farmers like bats? Why should everyone like bats?

Bat, May I?

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Life)

30 Minutes

Objective(s). Students will recall answers to a variety of bat-related questions.

Related NM Content Standards with Benchmarks. SC10-E1, SC11-E1, SC11-E6

Method. Students play a game of *Bat, May I?* as a review of the information they have learned about bats.

Background. See "The Bats of Carlsbad Caverns and Elsewhere" in Section 2 – Just the Facts.

Suggested Procedure

1. Divide students into two or more groups. Groups are to stand in the middle of the playing field.
2. The leader will ask bat-related questions. The first group decides how many steps to the finish line they are willing to risk (up to 3 steps). The leader then asks a bat-related question. The group asks, *Bat May I?* (The leader should respond, *Yes, you may.*) The group gives its answer. If the group answers correctly, then they may advance the number of steps they were willing to risk. If they answer incorrectly, then they must go back the number of steps they risked. The second question goes to group two. Once again they decide how much to risk and a question is asked. After saying *Bat, May I?* and answering the question, they either advance or retreat. The third question goes to the next group and so on. The group who arrives at the finish line first wins the game.

Section 6 – Animal Activities

- **Riparian Area Activities**
- **Bird Watching**
- **Fishing for Bugs**
- **Habitat Cards**
- **Whoooo's Been Here?**
- **Home is Where the Nest is**
- **Camouflage**
- **Freeze**
- **Alike and Different**
- **Sometimes Alike**

Riparian Area Activities

Pre-Visit, Field-Trip and Post-Visit Activities

Intermediate Level

Science (Inquiry, Life)**, Mathematics** (Unifying Concepts, Numbers & Operations)

Monitor One Week at Home, 45-Minute Session, 2-Hour Field Trip

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Objective(s). Students will investigate water usage, water flow and pond life in order to better understand and appreciate the Rattlesnake Springs Unit of Carlsbad Caverns National Park.

Students will determine impact of a riparian zone in a desert environment.

Students will identify Rattlesnakes Springs as a riparian zone by determining the characteristics of a riparian zone.

Related NM Content Standards with Benchmarks. SC5-M2, SC6-M2, SC10-M1, MA2-M2, MA4-M2, MA7-M4

Method. Students conduct activities at home, in the classroom and at Rattlesnake Springs.

Materials.

- Water, Water, Everywhere: paper, pencils
- Water Speeds: ping-pong balls, stopwatch, paper, pencils
- What's Bugging You?: jars, white trays for viewing, insect and pond life identification books
- Flyin' High: bird feathers, glass of water, glass of oil, soil

Key Vocabulary. riparian, velocity, preen

Background. Rattlesnake Springs is an area known as a riparian zone. The term riparian refers to an area bordering a stream, lake, spring or tidewater. Carlsbad Caverns National Park has a few riparian areas within its boundaries. In stark contrast to the dry areas of the Chihuahuan Desert, these water-available zones are alive with plant and animal life in a way that one would expect to find in a more temperate climate.

Suggested Procedure for "Water, Water Everywhere." Inform students that they will monitor water usage for a week. Make two small charts. The first chart will be used by each student to measure his/her individual water usage. The second chart will be used by each student to measure his/her household water usage. A third chart will be larger. It will be used by all students to record the amount of water students use collectively while at school. At the end of the week have students answer the following questions:

- How much water was used in a week per student?
- How much water was used in a week per household?
- How much water was used in a week by the class during school hours?

During the field trip, have students count the Cottonwood trees at Rattlesnake Springs. Inform students that each mature Cottonwood tree at the Springs uses 250 gallons of water per day. Then ask students the following questions:

- How much water is used daily by the Cottonwoods? Per week?
- How much water is used by the Cottonwoods weekly?
- How much water is used by the Cottonwoods monthly?
- How much water is used by the Cottonwoods yearly?
- What is the average amount of water charted at the Springs for the year?
- What is the average rainfall for the area?
- Where does the water come from?

Suggested Procedure for "Water Speeds." As a post-visit/homework assignment, have students measure water flow (velocity) by floating ping-pong balls in water at various locations. Instruct students to measure the time it takes for the distance covered.

Suggested Procedure for "What's Buggin' You?" During the field trip, have students carefully catch insects in jars without harming any. Using white trays for viewing and insect/pond life identification books, have students identify what common insects live in a riparian area. Are there some insects that live in the water? Release all insects back to their proper environments upon completion of this activity. Remind students that it is against park regulations to collect insects at a national park—even for a required insect collection project!

Suggested Procedure for "Flyin' High." Discuss with students that clean water is important in many ways. During the field trip, collect three bird feathers **from the ground**. Show students how the feather's barbs separate and then close the barbs back up. Discuss bird preening.

Teacher's Note: Questions for discussion and demonstrations.

Ask why birds have feather? Dip one feather in a glass on water, one in a glass of oil and one feather in some soil. Next, *rough up* the feathers and discuss the results. Soil comes off quickly. Water does not stick to the feather. But what about oil? On some rivers you will see oil slicks or film just on the surface. What problems does this cause for water birds? What would be possible consequences of oil on their skins?

Note: Please be sure that your class remains on national park land. One area is a Nature Conservancy Preserve.

Bird Watching

Pre-Visit, Field-Trip, Post-Visit Activities

Primary and Intermediate Levels

Science (Inquiry, Life)

One Class Session and a Field Trip

Objective(s). Students will exercise observation skills.

Related NM Content Standards with Benchmarks. SC5-E2, SC6-E1, SC10-E1

Method. After a bird study, students will sharpen their observation skills through bird watching.

Materials.

- Each Student: small notepad, pencil, binoculars (if available)
- The Class: several good field guides to share, bird calendar

Key Vocabulary. ornithologist

Background. An ornithologist is a scientist who studies birds. But, you do not need to be a scientist to learn the art of birdwatching. Millions of people from all around the world enjoy birdwatching. The Rattlesnake Springs unit of the park is a popular place to watch birds because more than 300 species birds have been spotted there. Some bird watchers come equipped with only an observant mind; others bring along a pair of binoculars. Many bird watchers rise early to spot birds that are most active at dawn. The goal of some bird watchers is to see for themselves as many of the more than 8,600 species of birds in the world as they can. To keep track of the birds they have seen, they keep a *life list*. It is a list of every type of bird that they have ever identified. An average list for a bird watcher in North American might have seen between 300 and 500 birds. Bird watchers who travel the world, have more than 6,000 birds on their lists.

You too can be a bird watcher. Just remember that there is more to birds than counting them. Take your time, observe each bird's way of life and its beauty. With practice, you will sharpen your observation skills and be able to identify birds by their body structure, by their colors, by their habits and by their songs.

Migration provides a wonderful opportunity to watch birds. You may see birds that you would never otherwise see. Migration generally occurs in the spring and fall, along routes that run north and south. Migrating birds follow the same routes year after year. These routes are called *flyways*. The birds exhibit an extraordinary sense of direction and an ability to recognize landmarks. Some birds navigate by the sun and moon, others by the positions of the stars and constellations. Some birds have a built-in *compass* which enables them to sense the earth's magnetic field. Just as the sun rises in the east and sets in the west, you can count on the flyways of migrating birds.

Suggested Procedure for Pre-Visit Activity. Following a study unit on birds, use one class period to prepare students for a bird watching field trip to the Rattlesnake Springs unit of the park. Below are listed points that should be covered.

1. Birds have very keen senses and some are wary of people.
2. Pay attention to your appearance. Wear clothing that blends in with the surroundings in which you will be watching for birds. Avoid bright colors.
3. Pay attention to the noise you make. Wear clothing that you can move silently in. Avoid making sudden movements or noises; be still and quiet as much as possible.
4. You will describe birds better when you know what to look for. As you watch birds, ask these questions:
    - What size and shape is its body?
    - What does its tail, head and bill look like?
    - Does the bird have a distinctive pattern of color?
    - Does it flick its tail as it perches?
    - Does it run down the tree trunk or climb up it?
    - Does it feed on the ground?
    - What does its song sound like?

    To accurately describe a bird, you will need to know terms for the parts of the bird and for other characteristics that vary from bird to bird. Features of a bird include the following: tail feathers, tail coverts, rump, back, mantle, nape, crown, forehead, bill, chin, ear coverts, throat, wing coverts, breast, belly and flank.

Suggested Procedure for Field Trip Activity. If your school is able to visit Rattlesnake Springs, plan your field trip in advance so that arrangements can be made for a park ranger to assist the group with bird watching. The park has a number of binoculars that students may use.

Suggested Procedure for Post-Visit Activity. Make a bird calendar on which to record the arrival of birds to your area in the spring. On the calendar, have columns for the name of the bird, the date it was observed, where it was seen and who saw it. Consult a field guide to determine which birds are migrants from or to your area and which birds are year-round residents.

Bird Calendar				
Bird	**Date**	**Location**	**Seen By**	**Migratory**

Fishing for Bugs

Field-Trip Activity

Primary/Elementary, Intermediate and Secondary Levels

Science (Inquiry, Life)

2-Hour Field Trip

Objective(s). Students will identify several types of aquatic insects.

Related NM Content Standards with Benchmarks. SC6-M1, SC10-E1, SC10-E2, SC10-M2, SC10-H2, SC11-E2, SC11-M2

Method. Students observe and identify insects from the canal at Rattlesnake Springs.

Materials. insect and pond life identification books, jars, magnifying glasses, shallow white pan or bowl

Key Vocabulary. aquatic, insect, specimen

Background. Numerous types of insects live in the waters of Rattlesnake Springs. Many cling to the bottom side of rocks. Some even build tiny rock homes around them. These insects are easy to find by just simply picking up rocks and looking at the rock closely. You may also place the jar just down stream of a rock, then lift the rock gently. Some insects may float right into the container!

Suggested Procedure

1. Ask students what they expect to find in a canal.
2. Have students collect a few specimens of insect life. Place about a half-inch of water from the canal into the pans, then add the insects.
3. Use the magnifying glass to get a closer look. Using the guides, identify each organism. Are they all insects? What is unique about these animals? How do they breath? How do they stay on the rocks without being swept away by the water? What do they eat? What eats them? What stages of insect life are represented? How will the larvae look as adults? How do they get around?
4. Stress to students that the organisms are to be released unharmed and undamaged. Remind students that all living creatures play important roles in the ecosystem.
5. Have students return the insects to the canal after observing them.

Habitat Cards

Pre-Visit or Post-Visit Activity

Intermediate Level

Science (Life)**, Language Arts** (Unifying Concepts, Expressive Language),

Art (Visual)

Two 50-Minute Sessions

Objective(s). Students will compare and contrast habitats found in Carlsbad Caverns National Park.

Students will distinguish the flora and fauna that live in those habitats.

Students will use related vocabulary.

Related NM Content Standards with Benchmarks. SC10-M2, LA1-M2, LA5-M3, AE8-M9

Method. Students study vocabulary words pertaining to wildlife (flora and fauna) and their habitats.

Students design and produce a mural depicting one or more habitats and their inhabitants.

Materials. habitat cards (17 vocabulary words made according to directions), clock or stopwatch, paper, pencils, copies of “Habitat Survey” student worksheet

Key Vocabulary. habitats, flora, fauna, indicator species, sotol, lechuguilla

Background. Carlsbad Caverns National Park is one of the few protected areas within the Chihuahuan Desert ecosystem. What at first glance appears to be a sparse wasteland, actually provides habitat for a rich diversity of breeding birds, mammals, reptiles and insects. The Chihuahuan Desert, the largest of four major desert regions in North America, has unique ecological features that create a living observatory for biological discovery.

The Cavern supports the northernmost and largest colony of cave swallows in the United States. The park has 76 species of mammals, including mule deer, rock squirrel, ringtail and the Mexican free-tailed bat.

Many of the 800 plant species found in the park are at the edge of their geographical distribution, including several threatened and endangered species. The lechuguilla plant and the sotol plants grow only in the Chihuahuan Desert, making them indicator species of the Chihuahuan Desert.

See “Wildlife at Carlsbad Caverns National Park” in Section 2 – Just the Facts.

Suggested Procedure

1. Discuss with your class various habitats found at Carlsbad Caverns National Park, as well as plant and animal life found in each.

2. Have students research each habitat. Make a class list of characteristics specific to each habitat, as well as examples of flora and fauna common to each.

3. While students work, prepare seventeen vocabulary words that name something found in Carlsbad Caverns National Park. (Use flora, fauna and various habitat words—cavern walls, desert floor, riparian area, etc. Write one-half of each word on different pieces of colored poster board. For example, if you choose the word *peregrine*, write *pere* on a green piece of poster board and *grine* on a blue piece of poster board. When the green and blue sections of poster board are placed correctly side by side, they spell out the word *peregrine*.

4. Shuffle the completed cards and give each student one card, face down. At a given signal, have students show their cards and try to find their mate in three minutes or less.

5. When time is up, review and define the vocabulary words with your students.

6. Ask the pairs who are displaying the habitats to spread out across the room. Ask the remaining pairs to locate and stand behind the habitat which is common to their vocabulary word.

7. Facilitate a class discussion about the selections made by each pair. Are there other possibilities? What happens to habitats when pollutants are introduced? How might development change various habitats? What natural factors cause destructions of natural habitats?

8. Instruct students to choose their favorite habitats and complete the student worksheet. Upon completion, allow students to share their surveys within groups of seven.

9. Have students design a mural depicting one or more habitats and their inhabitants. Place mural in school hallway to exhibit their knowledge of life science and their artistic talents.

Habitat Survey

Student Worksheet

Choose a Habitat

What is your favorite plant or wild animal?

What habitat are you presently “standing” in?

How much moisture is available?

Species Diversity

List two plants that live here.

List two animals that live here.

Does your favorite plant/animal live in this habitat?

Whoooo's Been Here?

Pre-Visit or Post-Visit Activity

Intermediate Level

Science (Unifying Concepts, Inquiry, Life**), Language Arts** (Receptive Language)

45 Minutes

Objective(s). Students will dissect owl pellets to determine owl diet and determine their contents.

Students will make determine the position of the owl in the food chain.

Related NM Content Standards with Benchmarks. SC4-M3, SC5-M2, SC10-M2, SC 11-M2, LA4-M1, LA4-M4

Method. Students listen to a story. Students study the diet of a carnivorous bird by dissecting sterilized, regurgitated owl pellets and classifying the bones and other hard remains of consumed prey. Students make generalizations about the food eaten by owls while studying the food chain to which the owl belongs.

Materials. *Owl Moon* (source: school library, public library, book store), one owl pellet per student (source: Pellets, Inc., 3004 Pinewood, Bellingham WA 98225; or, Carolina Biological Supply Company, 2700 York Road, Burlington NC 27215, 1-800-334-5551), tweezers, metric rulers, metric weights, balance scale, chart paper, mark, toothpicks, copies of a bone sorting chart (included in the Owl Pellet Study Kit ordered through Carolina Biological Supply Company)

Key Vocabulary. raptor, bird, mole, rodent, shrew, regurgitate

Background. Owls are a type of bird known as a raptor, which means they hunt at night for rodents and small birds. When they catch something, they eat it whole. Later they regurgitate the bones and fur as a small oval-shaped pellet. Most raptors use this behavior.

When visiting the Rattlesnake Springs Unit of Carlsbad Caverns National Park, be sure to look for a horned owl in one of its natural habitats.

Suggested Procedure

1. Order owl pellets.
2. Have a student volunteer to read the book, *Owl Moon,* aloud to the class.
3. Facilitate a class discussion about how owls eat and hunt.
4. Give each student an owl pellet and a metric ruler. The student is to measure the pellet and record its length and its weight.
5. Supply students with bone sorting charts for identification purposes.
6. Give students tweezers and a few toothpicks. Have them separate the pellet and remove the bones. Instruct students to match and sort the bones by type.

7. Have students make a class chart of their discoveries.
8. Discuss impact on owls when the food source population grows or depletes.

Home is Where the Nest is

Pre-Visit and Field-Trip Activities

Primary/Elementary Level

Science (Unifying Concepts, Life**)**

1 Hour

Objective(s). Students will construct a model of a nest without using their thumbs and then explain how a bird builds a nest.

Students will describe where a bird may build its nest and what materials could be used.

Students will identify bird nests on a field trip to Carlsbad Caverns or Rattlesnake Springs.

Related NM Content Standards with Benchmarks. SC2-E3, SC2-M3, SC11-E1, SC11-E7

Method. Students search for places that appear safe from predators and direct sunlight. They will then build nests using the same materials a bird would use. By taping their thumbs to their hand, students create the nest mimicking the manner in which a bird builds a nest.

Materials. camera and film, bird research books, nesting materials, tape (masking, packaging or adhesive)

Key Vocabulary. predator

Background. Birds build nests in a variety of places—in trees, in caves, floating in marshy areas, even in cacti! Nest building supplies may include any of the following: mud, sticks, stones, grass, cacti, spider webs, snake skins or feathers. Some birds are very choosy where they build their nests and the materials they use. Others are not.

Suggested Pre-Visit Procedure

1. Select birds common to your area, such as the Cave Swallow and Canyon Wren, and any that may be nesting in your school yard or a nearby park. Divide students into groups, assigning each a different bird.

2. Have students research the bird's nesting habits (what the nest is made of, where the bird prefers to build its nest, etc.) What considerations does a bird take into account when building a nest? Discuss.

3. Take students to the school yard or park and ask them to find a good nesting site for their bird. Remind them that most birds build their nests where they are sheltered from rain, sun and predators. After visiting the *nest sites*, have the class collectively decide which is the best site.

4. Using the same materials the bird would use, have each group build a nest. Before they begin tape their thumbs to their hands. Explain that birds do not have thumbs to help them build nests and that they should build their nests similar to the way the bird does. Each nest should be approximately the correct size and shape. You may elect to have all the teams work together to find materials. When they are finished, display the nests

and talk about each one. Show your students that you are pleased with their efforts by taking pictures of the process from beginning to end.

5. Arrange to have their nests displayed at the park's visitor center during migratory bird week.

Suggested Field-Trip Procedure. Take your students on a field trip to Carlsbad Caverns National Park to look for different types of nests. The Guano Trail and Rattlesnakes Springs are both excellent areas for hiking. If you hike portions of the Guano Trail in the spring or summer, stop by the natural entrance of the cave to see Cave Swallows. Look at the cholla plants for the Canyon Wren. Keep your eyes open because they are well hidden!

Camouflage

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Unifying Concepts, Life)

45 Minutes

Objective(s). Students will simulate how predators use their eyes to find food.

Students will describe ways in which animals use camouflage.

Related NM Content Standards with Benchmarks. SC2-E3, SC10-E1, SC11-E1

Method. Students play a game in which they are the hungry predator.

Materials. 15 gray pieces of yarn, 15 green pieces of yarn, 15 red pieces of yarn, 15 yellow pieces of yarn, 15 purple pieces of yarn, 15 pieces of yarn that matches the color of the playing surface (Yarn pieces should be two inches long.), poster board

Key Vocabulary. predator, camouflage, prey

Background. Many animals camouflage themselves in their surroundings for survival. Rabbits with their brown fur blend with brown grass. Lizards who have gray bodies and darker gray patches blend with the rocks. Camouflage is a disguise, keeping predators from spotting potential victims. Predators also use camouflage. Those who blend in with their surroundings are able to hide as they draw closer and closer to their prey.

Why do soldiers or hunters dress in camouflage? Why do soldiers now have two different colors and patterns of camouflage—one with shades of green and the other with shades of tan? Which color of camouflage would be most usual in a Middle East desert environment? Which color of camouflage in a forest?

Suggested Procedure

1. Before students arrive, scatter the pieces of yarn around the playing field.
2. Explain the term camouflage. Ask students to think of animals that use camouflage. How does camouflage help them survive?
3. Divide the group into two to four equal teams. Tell them that they will be *birds* and they will have to hunt to survive.
4. Show students the *worms*.
5. Arrange the groups at the starting line. Tell them that when you say “go,” they must run out into the playing field and find a *worm*. When they do find a worm, they must run back and sit with their group. The first group to have each *bird* find a *worm* and return, wins.
6. After one round, record the results onto the poster board. What color worms were found? What color was the most common? What color was the least common? Why?

7. Have the teams repeat the game. Record the results. Was it harder to find the worms this time? Why?
8. Repeat the game until all the *easy* colors have been found. After most of the *worms* have been found, discuss the results. Do not forget to collect all your *worms*!

Freeze

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Unifying Concepts, Life)

45 Minutes

Objective(s). Students will define predator and prey.

Students will describe the importance of adaptation.

Students will participate in a food gathering model in order to better relate to predator and prey.

Related NM Content Standards with Benchmarks. SC2-E3, SC10-E1

Method. Students play a modified version of freeze tag.

Materials. red material, pieces of cardboard for food tokens (3 per student), 4 or 5 hula hoops

Key Vocabulary. predator, prey, adaptation, native species, non-native species, ecosystem, negative impact

Background. Animals display a variety of behaviors in predator/prey relationships. These adaptations help them survive. Some animals run to get away from a predator. Animals may also signal to others that danger is near. If a predator is too close to the prey and cannot run away or hide, the prey may freeze. Sometimes being very still can help the animal go unnoticed by the predator. Also, the color of the prey's body can help it camouflage itself.

By law, wildlife within the boundaries of Carlsbad Caverns National Park is protected. In most cases, park rangers do nothing to protect animals against their animal predators. That is because it is often best to allow nature to take its own course. However, to preserve a natural ecosystem, park rangers sometimes have had to protect native species from their non-native predators. Animals, such as mule deer, raccoons, rock squirrels, several species of rattlesnakes and lizards, ringtails, coyotes and mountain lions are native to Carlsbad Caverns National Park. On the other hand, Bayberry sheep and cow birds are not native. These non-native species have negative impacts on some of the park's native species.

Suggested Procedure

1. Select predators and have them wear a red piece of material to identify themselves as predator. (There should be 1 predator for every 4 to 6 prey). Using a gym or playing field, identify one end as the food source and the other end as shelter. In between these areas, scatter the hula hoops around on the ground. These will represent temporary shelters. Scatter the food tokens (pieces of cardboard) on the ground in the food source areas.

2. The prey must collect 3 food tokens to survive. They must do this, however, without being caught by a predator. The predator must catch 2 prey in order to survive.

3. To begin, all the prey should be in the permanent shelter. The predators should be scattered about between the permanent shelter and the food tokens.

   At the command of go, each prey moves toward the food source. Prey can avoid being captured by a predator by having one foot in a temporary shelter. A predator cannot tag prey that is in a shelter. Prey can also avoid capture by freezing when a predator is within 5 feet. A predator cannot tag a prey that is frozen.

   Each prey tries to move to the food source without being tagged. He/She tries to pick up 1 food token at a time and return to the permanent shelter. Efforts continue until each prey has 3 tokens. However, if a prey is tagged in the process, he/she must stand on the sidelines.

4. Play several rounds and allow each student to be both a predator and a prey. After the game, discuss which ways of escape worked best. Which were easiest? What did predators do when the prey froze?

Alike and Different

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Life)**, Language Arts** (Unifying Concepts)**, Art** (Theater, Visual)

2 Hours

Objective(s). Students will compare and contrast reptiles and amphibians.

Students will explain the importance of a healthy, global ecosystem.

Related NM Content Standards with Benchmarks. SC10-E1, SC10-M2, LA1-E2, LA1-M2, AE1-E10, AE1-M10, AE1-E14, AE1-E15

Method. Students reach stated objectives by making puppets and presenting a puppet show.

Materials. The Class: pictures of reptiles and amphibians, chart paper, copies of play, stapler, 2 long tables for a stage, two bed sheets

Each Student: copies of the puppet show script, old socks, construction paper or felt, glue and/or tape, crayons or markers, thin cardboard, scissors, rulers, pencils or small sticks

Key Vocabulary. amphibians, reptiles, metamorphosis, global ecosystem, tuatara, herp

Background. See “Reptiles and Amphibians” in Section 2 – Just the Facts.

Suggested Procedure

1. Hang pictures of reptiles and amphibians on a bulletin board. Place a table under the pictures with an aquarium containing an easily cared for amphibian. Another aquarium could contain reptiles. Have students observe and discuss what they notice about amphibians and reptiles. Have students dictate a class list comparing and contrasting the animals.

2. Tell students that they will be taking part in a play about amphibians and reptiles. Distribute copies of the script and assign parts. Prepare the puppets, using as a reference, pictures of amphibians and reptiles. And let the show begin!

3. After the show, review the similarities and differences between reptiles and amphibians.

Puppet Preparation of Snakes and Caecilians. Use long socks to cover the hand and arm. The mouth is made between the thumb and hand inside the sock. Make eyes and tongue from construction paper or felt, then glue in place. Use colored socks (green, brown, etc.) or color with crayons or markers to look like the animal.

Puppet Preparation of Other Animals. Fold thin cardboard in half and draw the animal’s face and front of body on one side. Cut out the animal holding both halves together, giving a front and back to the puppet. Staple or glue the edges of both sides together, leaving the bottom open. On the second half, draw the back side of the same animal. Color both halves, then insert a ruler, pencil or small stick in the bottom. Glue, tape or staple the puppet in place.

Tips

- Because there are only 13 characters, present the show twice so all students may participate. The repetition will help students learn.
- Allow the class to read from their scripts.
- Cover a long table with a sheet for a stage. Have students kneel down behind the table with their puppets showing above the table. All puppets remain on stage at all times. Each puppet moves as it says its lines.

Script for Alike and Different Puppet Show

Cast of Characters:

Narrator: Fancy Frog
Amphibian Chairperson: Caesar Caecilian
The Reptiles: Bossy Boa
Granny Gecko
Too-Old Tuatara
Iffy Iguana
Colorful Chameleon
Timely Turtle
Alley Alligator
The Amphibians: Tidy Toad
Buddy Bullfrog
Salamander Sal
Spanky Spadefoot Toad

Fancy Frog. Amphibians and reptiles from all over the world have gathered to discuss an important issue. They're tired of being thought of as creepy, crawly, unimportant animals. Let's listen . . .

Caesar Caecilian. As chairperson, I call to order the first meeting of SARA—Society for the Advancement of Reptiles and Amphibians. We all know why we're here, right?

Tidy Toad. We're going to show everyone that we are important animals worth knowing.

Bossy Boa. Yes, let's put the squeeze on those who think we are worthless and gross.

Everyone. (Cheer with your animal sounds!)

Caesar Caecilian. Order, order! (Pound on table.) Does anyone here have some serious suggestions for what we should teach others?

Buddy Bullfrog. I have one! We should tell them what it's like to be cold-blooded.

Timely Turtle. That's a good idea, Buddy. Cold-blooded animals like us spend a lot of time looking for places where we won't get too hot or too cold. We don't need as much food as warm-blooded animals, so we eat less than birds and mammals.

Buddy Bullfrog. That's for sure! Some mammals never stop looking for food. I bet Sylvester the Shrew hasn't ever taken a break to sit in the sun; he's always running around looking for insects and salamanders to eat.

All Amphibians. (Gasp.) How Horrible!

Granny Gecko. Hey, I think this skin thing is really important. Some folks think that it's disgusting that we shed our skin all at once and then eat it. Well, don't they know that they shed tiny pieces of skin every day?

Iffy Iguana. That's true, but I must admit, people don't shed their skin so obviously. And people don't eat their own skins. (pause) However, I have seen more than one person eat chicken skins!

Everyone. (Laugh with your animal sounds.)

Iffy Iguana. Personally, I like the taste of my own skin—and it's full of protein!

Salamander Sal. Well, I have a complaint. I'm tired of being called a lizard. Lizards are okay, but I'm an amphibian. I think we should make it clear that we salamanders are not reptiles.

All Amphibians. (Cheer with your animal sounds.)

Colorful Chameleon. I'm soooo confused! What IS the difference between reptiles and amphibians?

Timely Turtle. Colorful, sometimes I think you have the IQ of an earthworm. There are some big differences!

Caesar Caecilian. Now, now, Timely. You must remember that we are not here to make fun of each other.

Alley Alligator. Caesar, for one thing, most amphibians have smooth, moist skins, unlike us reptiles. Special glands in their skin keep them slimy. And other glands make them taste bad to predators.

Bossy Boa. You aren't kidding! Have you ever tasted a toad?

Salamander Sal. And the eggs that amphibians lay don't have shells. We lay our eggs in water, which keeps them from drying out. At least, that's what most of us do.

Granny Gecko. So that's why so many of you amphibians live in wet places!

Iffy Iguana. We reptiles have dry, scaly skin. And our eggs have shells. We can lay our eggs on land. If it doesn't get too hot, they won't dry out.

Spanky Spadefoot. What a minute! I'm an amphibian, but my skin isn't moist. It's bumpy and dry. And I live in the desert!

Buddy Bullfrog. That's right, Spanky. There are some exceptions. You have a lot of neat tricks for staying alive in the desert, like burrowing three feet under the ground before the hot summer season hits.

Timely Turtle. And that's another thing—we aren't all the same. There are a lot of unusual reptiles and amphibians in the world!

Salamander Sal. Hold on, Timely! Don't forget the one thing that makes most of us amphibians—METAMORPHOSIS!

Timely Turtle. Wow, I sure would have felt silly if we forgot that one!

Salamander Sal. Many of us amphibians hatch from eggs laid in water. Then we go through metamorphosis and become adults. After that, many of us spend a lot of time on land.

Alley Allegator. Most reptiles also hatch from eggs, but we lay our eggs on land. And unlike most of your amphibians, we don't go through metamorphosis.

Caesar Caecilian. Well, now that we've talked about the differences between amphibians and reptiles—hat else do we think others should know about us?

Bossy Boa. That they'd better watch out for toads—they give you warts!

All Reptiles. (Laugh with your animal sounds.)

Tidy Toad. That's not true, and you know it! You're just an old, dry, scaly-skinned creep!

Everyone. (Reptiles and amphibians start arguing.)

Caesar Caecilian. Order! Order! (Pound on table.) Must I also remind you, Tidy AND Bossy, that we are not here to make fun of each other.

Fancy Frog. I would like Too-Old Tuatara to speak.

Everyone. (Pause for a moment of silence as Too-Old Tuatara slowly comes to a stand.)

Too-Old Tuatara. (Use a shaky, old voice.) I've been alive for more than a hundred years. That's more than most of you put together. I'm a reptile and I'm also a herp. There are lots of important things about both amphibians and reptiles that we can teach others. For example, Colorful Chameleon can change the color of her skin in less than a minute. There are other animals that cannot change the color of their skin in an entire life time. Have you noticed park ranger skin? No matter where they work or travel, their skin never changes color.

Colorful Chameleon. Well now, Timely. I guess it doesn't matter if I do have the intelligence of an earthworm. After all, I have a colorful way of surviving!

Too-Old Tuatara. That's right, Colorful. And some snakes and lizards, and even toads like Spanky Spadefoot, can survive in desert temperatures over 130° F. In those high temperatures finding food and water is difficult.

Spanky Spadefoot Toad. You can say that again! I hung out in my burrow for two years during the last big drought. I pity humans who have to carry gallon bottles of water with them to just survive a few days in the desert.

Buddy Bullfrog. Oh my, what a heavy load they must carry!

Too-Old Tuatara. Before I take my seat, I want to make one thing perfectly clear. We all live on the same planet. All plants and all animals, including humans, have important roles to play in our global ecosystem. Not only must we value each other to survive; we must also respect our natural resources, such as soil, water and air.

Colorful Chameleon. Thanks, Too-Old. I think everyone here today has learned a lot.

Bossy Boa. I think that I'll put the squeeze on some on mammals, birds, insects, and fish to attend our next meeting. We all have our place in a healthy, global ecosystem.

Granny Gecko. I make a motion that we rename our society. I suggest SAL for Society for the Advancement of Life.

Caesar Caecilian. Does anyone wish to second the motion?

Salamander Sal. I will.

Caesar Caecilian. Sal has seconded the motion, those in favor say "aye."

Everyone. Aye!!!

Caesar Caecilian. Those opposed?

Everyone. (Total Silence.)

Caesar Caecilian. The ayes have carried the motion. For generations to come, our organization shall be known as the Society for the Advancement of Life—

Salamander Sal. (Speak with great expression.) SAL!!! Imagine that, a society named for ME!!!

Everyone. (Very cheerfully laugh with your animal sounds.)

THE END

Sometimes Alike

Pre-Visit or Post-Visit Activity

Primary/Elementary and Intermediate Levels

Science (Life)

30 Minutes

Objective(s). Students will compare and contrast reptiles and amphibians.

Related NM Content Standards with Benchmarks. SC10-E2, SC10-M2

Method. Using a Venn diagram, students classify characteristics as to belonging to reptiles, amphibians or both.

Materials. copies of *Venn* diagram student worksheet, pencils

Key Vocabulary. reptiles, amphibians, intersect, *Venn* diagram

Background. See “Reptiles and Amphibians” in Section 2 – Just the Facts.

Suggested Procedure

1. Distribute copies of the student worksheet.
2. In the left section, have students list the unique characteristics of amphibians.
3. In the right section, have students list the unique characteristics of reptiles.
4. Where the two circles overlap, have students list characteristics that reptiles and amphibians share in common.

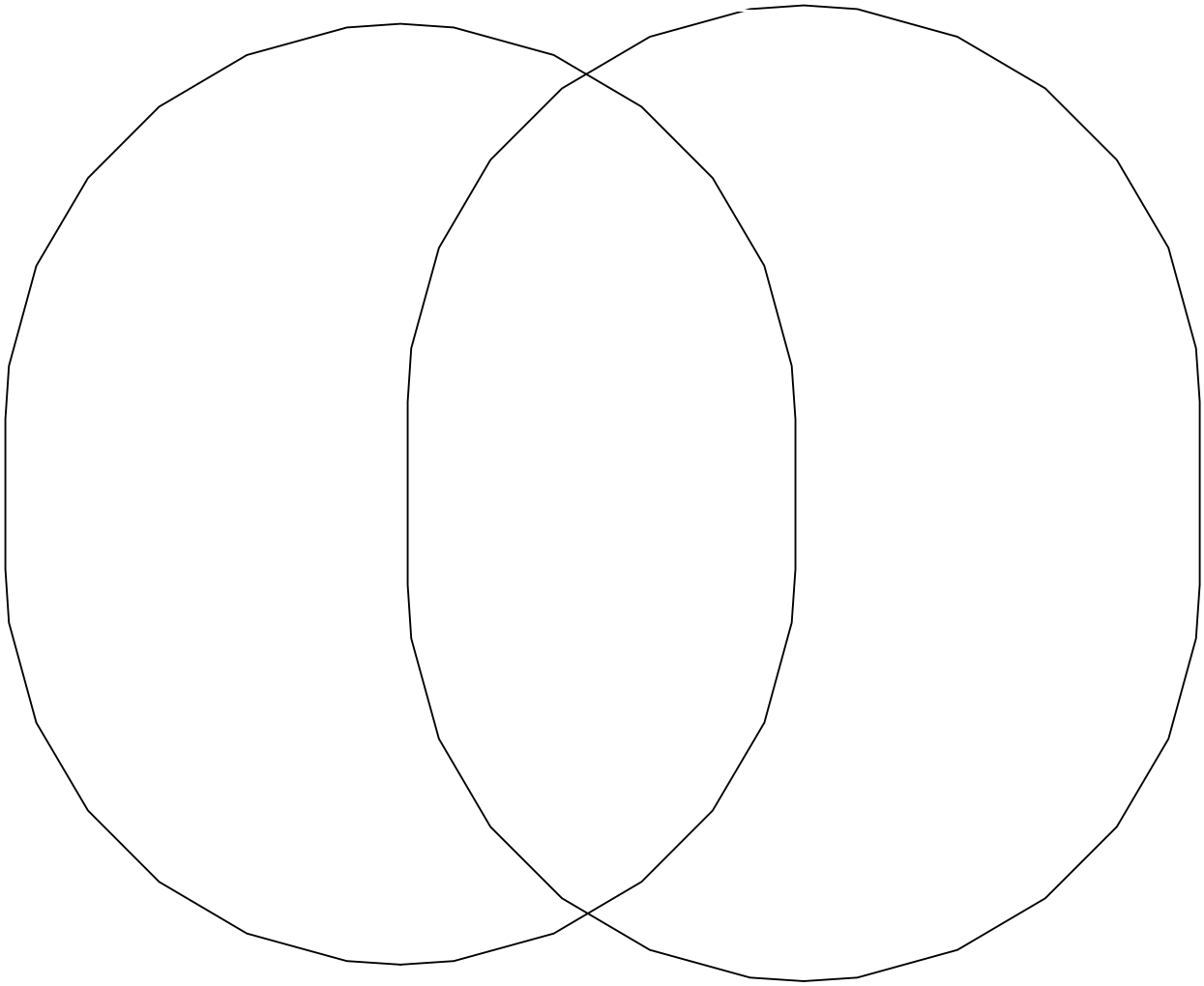
Sometimes Alike

Student Worksheet

Amphibians Only

Both Amphibians & Reptiles

Reptiles Only



Section 7 – Plant Activities

- **They Ate What?**
- **Where Did the Water Go?**
- **An Automatic Water System**
- **Giving Trees**

They Ate What?

Pre-Visit and Field-Trip Activities

Intermediate and Secondary Levels

Science (Life)**, Social Studies** (Cultures, Geography)

45 Minutes plus Field Trip

Objective(s). Students will list and identify plants used for food or medicinal purposes.

Related NM Content Standards with Benchmarks. SC10-M1, SC10-M2, SC10-H2, SS6-M2, SS11-M3

Method. Students will prepare identification records/cards for plants common to Carlsbad Caverns area. Students will hike the nature trail at the park, identifying plants used by early American Indians.

Materials. field plant guide and/or southwest desert plant field guide, large index cards, pens, coloring pencils

Key Vocabulary. flora, roots, medicinal, names of plants underscored below

Background. The early American Indian diet consisted mainly of wild plants. Although many early American Indians were hunters, they were also gathers. Eighty percent of what they ate was vegetation rather than meat. The *yucca* was quiet popular among the early American Indians. Its flower, stalk, buds, core and fruit were eaten. *Prickly pear* pads were roasted, then placed on wounds to heal cuts and infections. The pads of the cacti and fruit were eaten. Soaked *algerita* wood chips were used to relief sore eyes, and the plant's berries were eaten. The *Texas walnut* (Ephedra) was eaten raw or was grounded into flour. Mashed leaves and juice of *mesquite* were used to sooth irritated eyelids. A drink was made from its pods and seeds, and its fruits were eaten. *Juniper* berries were made into tea. Tea was also made from the *littleleaf sumac*. For more information about these and other useful plants, refer to a field guide.

Suggested Pre-Visit Procedure. Prior to the field trip, the teacher will instruct students to…

1. Research how early American Indians who inhabited the Chihuahuan Desert used plants, roots and flora.
2. Make identification records on large index cards for at least 10 plants found at Carlsbad Caverns National Park. Each record should include common name, scientific name, family, where found, description, food/medicinal/clothing purposes and an illustration in color.

Suggested Field-Trip Procedure. During the field trip, the teacher will instruct students to…

1. Walk the nature trail, looking for and identifying plants used by the early American Indians. (Students will need to take their identifications records to the park.)
2. Mark each plant found on their illustration records.

Cautions

- Some plants may be fatal if swallowed.
- The spines (needles/thorns) of many desert plants inflict pain.
- Collecting anything, without a special-use permit, is illegal in a national park.

Where Did the Water Go?

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Unifying Concept, Physical, Life)

Two 30-Minute Sessions plus Monitoring Over the Period of a Day

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Objective(s). Students will demonstrate and explain what evaporation is and how life in the desert adapts to it.

Related NM Content Standards with Benchmarks. SC2-E3, SC9-E1, SC10-E1, SC11-E1

Method. By demonstrating evaporation in action, students determine how animals and plants of the desert adapt to extremely high temperatures.

Materials. sponges, cut up pieces of sponge, 2 shallow pans, chalkboard, bucket of water, blackboard

Key Vocabulary. evaporation, transpiration, nocturnal

Background. Water is evaporating from surfaces all the time. This evaporation helps desert animals and plant survive hot, dry lands. Some animals sweat. As the sweat changes from a liquid to a vapor, it pulls heat away from the surface, thus cooling the animal. Some animals, like the roadrunner, pant to cool down. Other animals have big ears and long legs, such as jackrabbits. Their big ears give off body heat and their long legs keep their important body organs away from the hot desert ground. All desert animals have their own way of removing heat to cool their bodies.

Carlsbad Caverns National Park has 76 species of mammals, 44 species of reptiles and amphibians, and more than 800 species of plants. When you visit the park, there is a good chance that you may not see its abundant wildlife. That is because many of these animals are nocturnal, searching for food during the cooler night hours. Many of the park's plants have waxy coverings, small leaves that roll up in the hot day, small pores, hairs and spines. Without a protective waxy coating, small leaves that roll up and small pores, these desert plants would lose most of their water through the process of transpiration. Hairs and spines also reduce water loss by breaking the wind.

Suggested Procedure

1. Have students demonstrate how water evaporates by wiping damp sponges across a blackboard. When the dry patches appear, ask students, "Where did the water go?" Explain that the water evaporated—changed from a liquid to an invisible gas.

2. Have students demonstrate the affects of heat on evaporation. Take 2 shallow pans filled with equal amounts of water. Place one directly in the sunlight and the other in a shady place. Using a measuring cup, determine the amount of water left in each pan at the end of the day. Have students explain the results.

Alternative

A. Have students write their names on the sidewalk with a wet piece of sponge.

B. Instruct students to write their names twice—in a sunny location and in a shaded location.

C. Time how long it takes for the names to disappear.

D. Have students explain why the water evaporates more quickly in the sun.

3. To show how animals stay cool by sweating, have each student dip one arm into a bucket of water, leaving the other arm dry. Next have them wave both arms in the air. Which feels cooler? Why?

4. To demonstrate how plants retain moisture, make two wet spots on the sidewalk. Cover one with a clear plastic. Which one dries quicker? What part of the plant does the plastic represent?

An Automatic Watering System

Pre-Visit or Post-Visit Activity

Primary/Elementary and Intermediate Levels

Science (Life)

45 Minutes plus Monitoring for up to a Week

Objective(s). Students will describe ways cacti are adapted to the desert.

Students will demonstrate how temperature effects transpiration.

Related NM Content Standards with Benchmarks. SC10-E1, SC11-E1, SC11-M1, SC11-M2

Method. Students compare desert plants to woodland plants.

Materials. Each Group: a potted cactus, a potted woodland plant, flashlights, plastic bags, pieces of string (to close plastic bags), 2 sponges of equal size, petroleum jelly, 2 plastic margarine tubs, rubberband or string, transparent plastic bags, thermometer, paper, pencil

Key Vocabulary. transpiration, photosynthesis

Background. Carlsbad Caverns National Park is located in the northern part of the Chihuahuan Desert. Plants that grow in deserts look different than those that grow where there is much rainfall. Many of the plants at the park are cacti. Cacti are uniquely adapted to the desert. The spines on a cactus help shade the plant from the sun's rays and break the strong desert winds. The more barrel-shaped the cactus is, the less light shines on the plant, especially in the hottest part of the day when the sun is overhead. Water loss through the leaves of a plant is called transpiration. Cacti and other desert plants have a coating of a waxy substance that helps protect them from water loss. Cacti and other desert plants open their pores to receive carbon dioxide (which is necessary for photosynthesis) at night instead of during the day when temperatures are much higher.

See the background for "Where Did the Water Go?" activity.

Suggested Procedure for Part 1

1. To each group, hand out one cactus, one woodland plant and one flashlight.
2. Turn out the lights. Have students shine flashlights (from above) only on the woodland plant, then only on the cactus. Make sure the flashlight is held high enough to create shadows. What is the difference? The leaves on the woodland plant *catch* more light; the spines of the cactus shade the plant from direct sunlight.

Suggested Procedure for Part 2

1. Have each group completely cover a healthy potted cactus with a transparent plastic bag, using a rubber band or plastic bag to secure the bag around the top.
2. Have each group repeat #1 using a potted woodland plant, such as a fern.

3. Have each group place their pots in a sunny location and lean a thermometer against each pot, positioning thermometer so it will not receive direct sunlight.
4. Have students observe the plants and bags for a week. Daily, have groups record the temperature and any changes in appearance for both of their plants.

Suggested Procedure for Part 3

1. Give each group 2 small tubs, 2 equal-sized sponges and petroleum jelly.
2. Pour 1/4 cup of water into each tub.
3. Cover one side and all four edges of one sponge with petroleum jelly. Lay the sponge non-greased side down into the tub of water. Lay the other piece of sponge in the other tub of water.
4. Watch the sponges soak up the water. Over the next week, find out how long it takes for each sponge to dry out. The one with petroleum jelly will dry out last. Explain that the jelly, like the wax that covers many desert plants, prevents water loss through transpiration.

Giving Trees

Pre-Visit, Field-Trip and Post-Visit Activities

Primary/Elementary Level

Science (Life**),**

Language Arts (Unifying Concepts, Receptive Language, Expressive Language)

Two 50-Minute Sessions

Objective(s). Students will explain the benefits of trees in the natural environment.

Students will develop a biography of a chosen tree in a natural environment.

Related NM Content Standard with Benchmarks. SC10-E1, SC10-E2, SC11-E1, LA3-E1, LA4-E1, LA5-E1, LA5-E5

Method. During their field trip, each student *claims* a tree. As a post-visit activity, students research their trees and write tree biographies.

Materials. *The Giving Tree* by Shel Silverstein, copies of the student worksheet, crayons or colored pencils

Key Vocabulary. tree, bark, leaf, biography

Background. Living trees create shades and serve as homes for insects and small animals. Trees clean the air by removing carbon dioxide and releasing oxygen. They also return nutrients to the soil through their fallen leaves. Dead trees are hosts to fungi (which also decompose them), small animals and insects. Dead trees replenish the soil with nutrients for new growth. Healthy trees are essential for our environment.

Suggested Pre-Visit Procedure

1. The day before the field trip, read *The Giving Tree* to your students under a large shade tree.
2. Discuss how the tree in the story gave of itself. Ask students how trees are essential to a healthy natural environment.
3. Instruct students to *claim* a tree at the park during the course of their field trip.

Suggested Post-Visit Procedure

1. After returning from the field trip, distribute copies of the student worksheet. Review each section of the worksheet with your students.
2. Have students use their worksheets to write biographies about the trees they selected on their field trip. Give students time to research their trees with reference materials available in the school library. Encourage students to be accurate and creative.

3. Have students share their biographies with each other. Place special emphasis on the contributions each individual tree has made to its environment. Ask students why they choose the trees they did.

Biography of a Tree

Student Worksheet

Identification (name of your tree)

Birth Place (Walnut Canyon, Rattlesnake Springs or wherever)

Age (young, middle-aged, old, deceased)

Characteristics (List characteristics and draw pictures of the bark, leaf and seed of your tree.)

Bark	Leaf	Seed

Special Adaptations

Contributions to its Environment

Why I Chose this Tree

Illustration (Draw a picture of your tree on back.)

Section 8 – Stewardship Activities

- **The “LITTERary” Arts**
- **Don’t Touch**
- **A National Park: My Responsibility**
- **Who, Me, Make Lint?**
- **Lint Ecosystems**

The “LITTERary” Arts

Pre-Visit, Field-Trip and Post-Visit Activities

Primary/Elementary Level

Science (Life, Science in Society)**, Art** (Visual)

1 Hour

Objective(s). Students will predict the effects litter has on wildlife.

Students will propose ways to eliminate these dangers.

Related NM Content Standards with Benchmarks. SC11-E6, SC16-E4, AE2-E7

Method. Students collect litter, evaluate it and create a collage.

Materials.

- Each Student: plastic gloves, plastic trash bags for collecting litter
- Each Team: poster board, glue, different types of litter

Key Vocabulary. litter, stewardship

Background. There are countless beautiful, special places around the world. And all it takes is a little litter to make a place ugly and alter nature’s perfect balance. Litter causes injury, illness and even death to wildlife. Fishing lines can become tangled around a bird’s beck and prevent it from eating. When tangled around an animal’s legs, fishing line prevents the animal from running. Plastic six-pack rings can get caught around fish and other wildlife. As the animal grows, the non-expandable rings cause a slow, squeezing death. Cans and bottles can trap small animals and lead to their death. Cigarette butts, cellophane wrappers, styrofoam cups and other trash can be eaten by deer, causing internal problems and poisoning.

Suggested Pre-Visit Procedure

1. Divide the class into teams of 3 or 4. Have each team draw a picture of the way the park looks now.
2. Explain to students that Carlsbad Caverns National Park has more than half a million visitors every year. On a busy day, the park may have four thousand visitors or more. Imagine what the park would look like if each visitor littered just once on a busy day. How would the park look if every visitor littered over an entire week? A year?
3. If students have visited Carlsbad Caverns National Park, have each team draw a picture of the park as it looks now.
4. Have students pretend that 4,000 visitors littered the park on a single day. Instruct each team draw a picture of Carlsbad Caverns on that day.
5. Have each team present both their pictures and talk about the Carlsbad Caverns National Park that they would want to visit.

Suggested Field-Trip Procedure

1. Divide the class into teams of 3 or 4.
2. Distribute a pair of plastic gloves and a plastic trash bag to each student.
3. Have each team contribute bags of litter that they found on school grounds, parks or other areas. These items should be things found where wildlife could get to them, not from trash cans. CAUTION students not to pick up broken glass, syringe needles or sharp metal.

Suggested Post-Visit Procedure. Using the litter, have each team make a collage by gluing the litter to the poster board. Have students evaluate the litter and decide which is most harmful to wildlife. Ask students to propose ways people can eliminate litter pollution. What are some alternative ways to package six-packs? How can individuals be told about the dangers of litter? What can students do personally to reduce litter?

Don't Touch

Pre-Visit Activity

Primary/Elementary and Intermediate Levels

Science (Unifying Concepts**), Mathematics** (Unifying Concepts)

30 Minutes

Objective(s). Students will demonstrate that skin contains oil.

Students will theorize concerning the effects skin oils have on speleothems.

Students will calculate human impact on cave formations given a specific number or time.

Related NM Content Standards with Benchmarks. SC1-E1, SC2-E3, MA1-E1, MA1-E5, MA1-M4, MA1-M6, MA3-E2, MA4-E4, MA4-M4

Method. Students demonstrate how touching can damage a speleothem.

Materials. mirror, limestone rock, water

Key Vocabulary. speleothem

Background. Oil and dirt from hands can damage speleothems. By simply touching speleothems, oils are left behind. Touching can also dull the color of speleothems, sometimes staining them. Touching can also stop the growth of speleothems. Since speleothems are formed with water, oil creates a barrier that does not allow dissolved minerals to continue to deposit.

Suggested Procedure for Mirror Activity

1. Have each student touch the mirror. This works best after lunch or recess when their hands are likely to be dirty and sweaty.

2. Show the class the mirror covered with finger prints. Explain that they have changed the appearance of the mirror. A mirror can be cleaned with cleaner, speleothems in a cave cannot. Why would you not want to use cleaners such as Windex, to clean cave speleothems?

3. Facilitate class discussion.

   What happens to rain water when it falls on an oily spot on your driveway? What comparison can be made with oil-coated speleothems?

   Students use a calculator to determine the following. Carlsbad Caverns National Park has more than a half-million visitors a year. If five percent of were to touch speleothems, how many people would that be? Do you think that many people touching speleothems damages the cave? Do you think the park's "No-Touch Rule" is a good one? Have students justify their answers and discuss.

Suggested Procedure for Limestone Rock Activity

1. At the start of the school day, give students the following instructions with no background information.

   "I have two limestone rocks. Do not touch the rock on my desk. At all times, someone in the class must be touching the rock in my hand. Pass it around so everyone will have an opportunity to handle the rock. Before school is out for the day, we will compare the two rocks."

2. An hour before school is dismissed, ask students to form an hypothesis. Which rock will be *water-resistant?*

3. Test the hypothesis by having one student drop water on the rock on the desk. Have students observe and record their observations.

4. Have another student drop water on the handled rock. Have students observe and record their observations.

5. Facilitate a class discussion. What happened? Why?

A National Park: My Responsibility

Post-Visit Activity

Intermediate and Secondary Levels

Social Science (History),

Science (Unifying Concepts, Life)**, Language Arts** (Research & Synthesis)

Five 45-Minute Sessions

Objective(s). Students will describe at least two types of decisions involving managing a park.

Students will define their roles in building the park and describe at least four jobs needed to manage parks.

Related NM Content Standards with Benchmarks. SC2-M3, SC2-H3, SC11-M6, SC11-H6, LA10-M3, LA10-H3, LA10-H4, SS4-M4

Method. Students create their own model of a national park to demonstrate what they have learned about the National Park System and managing natural resources.

Materials. slide program or video about national parks, maps and brochures of national parks, various other materials according to the model chosen—markers, modeling clay, construction paper, paper for a mural, masking tape, scissors, sandpaper, grass carpeting, bricks, canvas, various containers, paint, water, artificial plants, toy animals, plaster of paris, rocks, miniatures of natural/historic objects, etc.

Key Vocabulary. Park Service Organic Act, bureau, interpretation

Background. On August 25, 1916, forty-four years after Yellowstone National Park was established, President Woodrow Wilson signed legislation creating a new federal bureau, the National Park Service, in the Department of the Interior. The act created the National Park Service to *conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.* This mission statement (the Park Service Organic Act) continues to guide the management of the parks. Today, there are 376 units in the National Park System, covering more than 83 million acres in every state (except Delaware), the District of Columbia, American Samoa, Guam, Puerto Rico and the Virgin Islands.

Units of the National Park System have been created in two principle ways—Acts of Congress and presidential proclamations. Congress determines the name and designation for each unit. Units include national parks, monuments, battlefields, military parks, historical parks, historic sites, lakeshores, seashores, recreation areas, scenic rivers and trails, parkways and the White House. Collectively, these units represent America—its beauty, its history and its culture.

The National Park Service is composed of several thousand employees. All employees are public servants who have been entrusted to protect, interpret and administer the parks for the benefit of the people. However, park rangers cannot adequately care for 83 million acres alone. Without the support and assistance of the American people, parks will not survive past our present generation.

Suggested Procedure for Session One – Preparing the *Soil*

1. Explain to students that they will collectively create one national park for their own community based on the natural resources in their neighborhood that they want to protect. Students will decide how they will represent the park. They can make a mural, a three-dimensional model, a video, a photo display or choose another method.

2. Inform students that when the park is completed, they will make a presentation that addresses the following: the park's mission, how visitors use the park, how natural resources are protected and the issues involved in managing the park.

3. Show students a video that introduces the National Park Service such as *The National Park Service: An American Legacy.* (Carlsbad Municipal Library carries over seventy National Park videos. Check your school or public library.) As an alternative, you may wish to invite a park ranger into your classroom for a special program to introduce the mission of the National Park Service.

4. Facilitate a class discussion about the National Park Service video. If you invite a park ranger into your class, set aside time at the end for a question and answer period.

Suggested Procedure for Session Two – Building the *Foundation*

1. Discuss with students the different jobs and skills/knowledge involved in managing a park: biologist, planner, maintenance engineer, administrator, interpreter, teacher, safety specialist, manager, historian, botanist, recreation specialist, etc.

2. Divide students into groups of four, giving each group maps and brochures from a variety of national parks. Instruct them to look for information on the following: trails, restrooms, recreational activities (boating, fishing, swimming, camping) transportation, education, interpretation, orientation, lodging, food service, souvenirs, safety of visitors, waste disposal, protection of resources, parking, staff housing, historic structures, new buildings/development, boundaries, hours of operation, scenic overlooks, boardwalks, utilities (telephone, power), fees, park regulations, etc.

3. Have students collectively select the methods and materials they will use to create a model of their park.

4. Have students identify the threats/dilemmas facing the park—environmental degradation, vandalism, relic hunters, acid rain, adjacent development, visitor safety, transportation, public use, etc.

5. Assign each work group of four a specific task—trails, transportation, interpretation/education, safety, administration, etc.

Suggested Procedure for Session Three – Building *Walls* and *a Roof.* Have students work within their work groups to build the model.

Suggested Procedure for Session Four – Adding the *Décor.* Have students use the class period to complete their model and plan for a formal presentation.

Suggested Procedure for Session Five – Ribbon Cutting Ceremony. Have students make their presentations, keeping in mind what they were told in *Session One* about their park's mission, how visitors use the park, how natural resources are protected and the issues involved in managing the park.

Who, Me, Make Lint?

Pre-Visit and Field-Trip Activities

Primary/Elementary Level

Science (Science in Society)**, Social Studies** (Geography)

45 Minutes in Classroom plus Field Trip

Objective(s). Students will examine lint and explore its origins.

Students will discuss the detrimental effects of lint upon cave environment.

Related NM Content Standards with Benchmarks. SC16-E3, SS12-E5

Method. Students examine several readily available sources of lint and relate the knowledge to lint's effect upon caves.

Materials. dryer lint, magnifiers, hairbrushes (student-supplied)

Key Vocabulary. lint, fibers, synthetic

Background. People shed about 107 pounds of skin in a 70-year lifetime, and lose 200 to 300 hairs daily! Fibers are shed by clothing. In five years, 100 pounds of lint were collected from Carlsbad Cavern. Effects of lint on a cave environment are not entirely known, but lint likely changes the biological balance by introducing a new food source, which may lure *foreign* species into the cave. Bacterial action, due to skin/hair build up and decomposing natural clothing fibers, corrodes speleothems.

Suggested Pre-Visit Procedure

1. Have students brush their hair with a clean hairbrush brought from home. Two or more students work together, but only one should brush his/her hair. Have students remove and count the hairs from the brush.

2. Distribute a clump of dryer lint and a magnifier to each group of students. Have students examine the lint through the magnifier to identify the various substances that compose the clump. The clump may contain hairs, dirt, skin flakes, fabric fibers, etc.

3. If the weather is dry, have students lightly scratch their arm to see skin flakes. The skin flakes are especially evident in a beam of sunlight.

4. Have students check uncarpeted low-traffic areas of their homes for dust bunnies as further evidence of lint.

5. After students have completed the exploration activities, facilitate a class discussion on the possible effects of lint on a cave environment. Lint is a foreign element in the cave; as such, it will result in changes to the environment. Skin, hair and natural fibers from clothing are all possible food sources for bacterial crickets, mites and other organisms. The bacteria can cause corrosion of the cave speleothems and provide a food source for larger species.

Suggested Field-Trip Procedure. Remind students of their lint exploration before you enter Carlsbad Caverns. Challenge students to find lint accumulation in the cave, without touching. Be especially aware of lint as you climb Appetite Hill, as this area is a prime lint collector.

Lint Ecosystems

Pre-Visit Activity

Primary/Elementary Level

Science (Unifying Concepts, Inquiry, Science in Society),

Social Studies (Geography)

10 Minutes per Day for 6 Weeks

Objective(s). Students will demonstrate how lint enters a cave.

Students will theorize about the effect lint has on a cave environment.

Related NM Content Standards with Benchmarks. SC2-E1, SC2-E3, SC6-E2, SC16-E3, SS12-E5

Method. Students place rocks in different areas of the classroom or school to experiment with lint build up.

Materials. water misting bottles, 6 rocks (Sandstone or limestone are recommended because they are porous and will collect and hold water.)

Key Vocabulary. lint

Background. Review background for "Who, Me, Make Lint?" activity.

Suggested Procedure

1. Designate 3 rocks as wet rocks and 3 rocks as dry rocks. Wet the designated wet rocks with the mister.
2. Have students pick 3 different places to put the rocks. Ask the custodian not to dust or sweep these areas.
3. Place 2 rocks—one wet and one dry—in each area. (Place the wet rock on the right and the dry rock on the left so they will not be confused.)
4. Each day dampen the designated wet rock. Be sure not to get the dry rock wet.
5. Have students record their observations each week. Does the wet rock have more dust than the dry rock? Does one group of rocks have more dust than another group of rocks? Why? What effect could lint have on the cave environment?

Section 9 – Fire Activities

- **Fire!**
- **Fire on the Run**
- **Firefighting**
- **Spark!**

Fire!

Pre-Visit, Field Trip and Post-Visit Activities

Intermediate and Secondary Levels

Science (Inquiry, Life)

Language Arts (Expressive Language, Research and Synthesis)

Four 45-Minute Sessions plus Field Trip

Objective(s). Student will identify positive and negative effects of fires.

Students will communicate their investigations to others.

Related NM Content Standards with Benchmarks. SC6-M1, SC6-M-6, SC6-H6, LA5-M3, LA5-H3, LA10-H4

Method. Students conduct field investigations and present their conclusions.

Material. plant and animal identification guides, notebook and pencil for each student, various materials depending upon the presentations

Key Vocabulary. wild fire, controlled fire, prescribed burn, management ignited fires

Background. Management ignited fires have been evident recently in government agencies, since more benefits of fire are known. These planned burns reduce fuel loads, thus preventing fires from getting too hot and burning all life from an area.

When Smokey Bear says, “Only you can prevent forest fires,” he is talking about people causing fires through carelessness such as not attending their campfires. Fires can be so hot that they kill most of the plant life. Some fires move so fast that animals do not have enough time to escape. However, there are benefits. Fires increase soil productivity by recycling nutrients, opening up habitat, generating new growth and creating more diversity.

See “Fires in Carlsbad Caverns National Park“ in Section 2 – Just the Facts.

Suggested Pre-Visit Procedure

1. Divide the class into groups of five.
2. Instruct students to brainstorm about the negative and positive aspects of fires on an ecosystem. (Each group should have one facilitator, one recorder and one presenter.)
3. Allow each group to make a presentation to the class about their brainstorming session.

Suggested Field Trip Procedure

1. Take students on a field trip to several burned areas and some unburned areas of Carlsbad Caverns National Park. (Call the park to find out where these areas are and when they were burned.)
2. Have students make and record their observations of each area. They should record plant species, wildlife observed and evidences of wildlife. Evidences might include some,

or all, of the following: paw prints, animal waste materials, animal remains and/or habitats.

Suggested Post-Visit Procedure

1. Have students gather in their previously assigned groups.
2. Instruct students to collectively evaluate the positive and negative effects of fires on both the plants and the animals. Have students identify both short and long-term benefits and harms.
3. Instruct groups to prepare formal programs to present their findings to science classes. Students are to use a variety of technologies/visual aids/media to interpret their investigations.
4. Arrange scheduling with other teachers for students to make presentations in their classrooms.

Fire on the Run

Pre-Visit or Post-Visit Activity

Primary/Elementary Levels

Science (Unifying Concepts, Physical, Science in Society)

45 Minute

Objective(s)

- Students will describe fire lines and back-burns
- Students will list ways fires can start
- Students will explain how fire lines and back-burns can be useful in fighting fires

Related NM Content Standards with Benchmarks. SC2-E3, SC9-E1, SC16-E3

Method. Students play a modified version of "Red Rover, Red Rover."

Material. large blank adhesive labels, markers

Key Vocabulary. fire line, back-burn

Background. See Fires in Carlsbad Caverns National Park fact sheet.

Suggested Procedure

1. Explain what a fire line and back-burn are and how they can be useful in managing fire. A good fire line can hold back the approaching fire. Brainstorm things that can *jump* a fire line or even start a new fire. (Example: sparks jumping the line, burning logs rolling across the line, burning limb overhanging the line, lightning, convection heat, conduction heat, radiated heat, matches, cigarette butt, campfire, arsonist, backfire, etc.)

2. With a bold marker, write the names of each of the *fire starters* that were brainstormed onto separate adhesive stickers. Divide the class into two groups, the fire line and the fire starters. Give each fire starter a sticker to wear. Tell them they will represent what is written on their stickers. Have the fire starters line up on one side of the playing field facing the other end of the field. Tell the second group that they will represent the fire line. Their job is to keep the fire starters from crossing the fire line. The members of the fire line stand in a line at the opposite end of the playing field and link hands.

3. To begin, the fire line asks in unison, "Fire Mass! Fire Mass! Let (name of a fire starter, such as "matches") try to pass!" When a fire starter's name is called, the student representing that name runs and tries to break the link of hands in the fire line. If the fire starter is successful, he/she gets to take one person from the fire line back with him/her. The new fire starter is given a sticker to represent a fire starter. If the fire starter is not successful breaking through the fire line, he/she must stay and become part of the fire line. Repeat this several times.

4. As an extension, add a back-fire. Divide the fire line into two groups. Have the first half of the group stand in a line. Place the second half of the group in a line just behind the

first group, linking hands. The first line is the fire line. The second line is the back-fire. Repeat the game, except the fire starters not only have to break the fire line, but also the back-fire.

Firefighting

Pre-Visit or Post-Visit Activity

Primary, Intermediate and Secondary Levels

Science (Science in Society), Language Arts (Receptive Language)

2 Hours

Objective(s)

- Students will discuss firefighting equipment used at Carlsbad Caverns National Park.
- Students will explain how fires start in this area of the Chihuahuan Desert using as their visual the three legs of the fire triangle.

Related NM Content Standards with Benchmarks. SC16-E1, SC16-E2, SC16-M2, SC16-H2, LA3-E3, LA3-M3, LA3-H3, LA4-E7

Method. Through slides, demonstrations and activities, students learn about fire.

Materials. video entitled "Introduction to Fire Behavior," VCR, fire truck, fire equipment

Key Vocabulary. prescribed burn, management ignited fire, wildland fire, wildfire, Pulaski, Nomex

Background. Read Fire at Carlsbad Caverns National Park fact sheet.

Suggested Procedure

1. Conduct a KWL (what I KNOW, what I WANT to know, what I've LEARNED). Ask students what they know about fire behavior. Have students discuss in partners and record on the KWL chart. Introduce a fire triangle and fire related vocabulary. Tell students to focus on recreation hazards, occupation hazards, and weather-related hazards.
2. Show students "Introduction to Fire Behavior." (For a copy of the video, contact Fire Management Officers at your area United States Forest Service or a park ranger at a nearby National Park. The video explains the fire triangle, types of equipment and the visible changes to the ecosystem after a fire.)
3. Invite a wildland firefighter to your class to demonstrate proper use of fire tools and equipment and to show students his/her wildland fire truck.
4. Teacher probes students with questions.
   - What is a healthy force of nature?
   - What types of fires are there?
   - What is meant by fire behavior?
   - What are the forces of nature?
   - What could you do as a visitor in regards to fire?

5. Have students individually think about the KWL. Pair students to compare their thoughts. Square students by combining two pairs and continue discussion. Have students record thoughts on KWL chart.

Spark!

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Unifying Concepts, Science in Society), Art (Theatre)

Two 45-Minute Sessions

Objective(s). Students will model how fires grow and how they are controlled by fire fighters.

Related NM Content Standards with Benchmarks. SC2-E3, SC16-E3

Method. Students will play the role of trees, fire fighters, animals and sparks in the face of advancing fire.

Materials. Nomex shirts or yellow arm bands, blue bandannas or nerf balls (enough for 1/4 of the group)

Key Vocabulary. spot fires, fire line, Nomex, direct attack, containment, fuel, creeping fire, crown fire

Background. Forest fires start small. They only grow and spread if favorable fuels, heat and oxygen are available. In windy conditions, embers blown from the main fire can start new fires or spot fires. By removing fuels from an advancing fire's path, fire fighters can slow its growth. Effective fuel removal can be achieved by cutting and removing trees most likely to burn. Fire growth can also be slowed by using water. Water robs fire of much of its heat. Water or chemical drops on a large forest fire rarely put flames out entirely, but may slow the fire enough to contain and surround it through the construction of a fire line.

Suggested Procedure

1. Designate one child as the *spark* (or lightning) that starts the fire. One quarter of the group will be fire fighters, dressed in *Nomex* shirts (special protective clothing of a flame-resistant fabric) or yellow arm bands. Each is equipped with a blue bandana or nerf balls in the shirt pocket to symbolize *water*. Remaining students will be trees (fuel) which allow fire to grow and animals.

2. Explain to the players what each of their roles will be. Have the *spark* go to one end of the playing area, and align the fire fighters at the other end.

3. Have *trees* take root and grow anywhere they wish on the playing field. They should stand with their arms held up to mimic tree branches.

4. Instruct the *spark* to start the game by tagging a *tree*. *Trees* may not run from the fire—they have roots! Tagged *trees* become part of the fire and must join hands with the *spark*. The fire must now continue its pursuit of *trees* as a unit, attempting to capture *trees* with their free hands. Captured *trees* must join the chain of fire. Fire can move either as a long chain or may break into several smaller groups and travel as *spot fires*. But they may not travel as individuals.

5. Instruct fire fighters to stay on the sidelines until the fire has had a chance to grow to at least three or four players. Ask fire fighters, “Do you smell smoke?” When they say, “Yes,” let them go.

6. Fire fighters must avoid the *fire*, while attempting to slow the fire’s growth. They, too, can become the *fire* and must join the *fire* if caught. They can do this in following three ways:

   A. **Removal of fuels** - Fire fighters may tag *trees* and escort them out of the game to the sidelines. Fire fighters and *trees* may not be captured by *fire* en route to the sidelines.

   B. **Direct Attack** - Fire fighters may tag *fire* with their blue bandannas (water). Fire that gets hit with *water* must walk from that point on.

   C. **Containment** - Fire fighters may join hands to encircle or contain a *spot fire*. (Wet fires are easiest to contain because they walk slowly.) Contained *spot fires* must go to the sidelines.

7. Summary of Goals of Players
   - **Tree**
     - Stand still.
     - May be captured by either *fire* or removed to the sidelines by firefighters.
   - **Fire**
     - Tag *trees* and firefighters so they can grow!
     - Avoid water wielding fire fighters.
   - **Fire Fighter**
     - Remove trees to the sidelines before they are captured by fire.
     - Tag fire with water to slow its advance.
     - Join hands with other firefighters to encircle spot fires and remove them to the sidelines.

8. End of Game. The game is over when no trees remain. Compare the number of fire players left at the end of the game with the number of tree players on the sidelines. Who won? Fire fighters or the fire? Point out similarities in real life.

9. Interview a fire fighter. Have a group of students be reporters. Find out what caused the fire. How could it have been prevented? Was it a low creeping fire or a crown fire? How many acres burned? What direction did the fire come from? What direction did the fire go?

10. Interview the trees, plants and animals. Did the animals lose their home? Where did they live and what will happen now?

11. Have students write an article based on the above findings. Draw pictures and make this a supplement to a school newspaper or have the class produce its own newspaper.

Section 10 – Bus Activities

- **Bumpy Bus Coloring**
- **Road Kill Cafe**
- **When I Went to Carlsbad Caverns**
- **Colors in the Desert**
- **What am I?**

Bumpy Bus Coloring

Pre-Visit and Post-Visit Bus & Classroom Activities

Primary/Elementary Level

Science (Physical, Life)**, Language Arts** (Expressive Language, Aesthetics), **Art** (Visual)

20-Minute Pre-Visit Session, Two 30-Minute Post-Visit Sessions

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Objective(s). Through awareness and the safe use of coloring pencils, students will demonstrate their abilities to describe and/or categorize the things they perceive using their senses.

Related NM Content Standards with Benchmarks. SC7-E1, SC10-E1, LA9-E1, AE1-E15

Method. Students color worksheets to describe what they see and experience. Students participate in a *show and tell*.

Materials. Each Student: copy of bat coloring sheet, copy of turtle coloring sheet, 9" X 12" piece of cardboard, rubberband, coloring pencils (Do not use crayons as they will melt on a hot bus.)

CAUTION: This activity should not be attempted with students who may not use coloring pencils in a safe manner. Sharp pencil points and a bumpy bus don't mix!

Suggested Pre-Visit Procedure

1. Give each student a bat coloring sheet, a poster board, a rubber band and a small box of coloring pencils. Have the student put the rubber band around the cardboard on the narrowest side. He/She can then put the coloring sheet onto the board under the rubberband. Now each student has his/her own clipboard.

2. Ask students to color the bat. On the back of the sheet, have students predict what sites, sounds, smells and sensations they might expect to experience during their field trip.

Suggested Post-Visit Activities

1. On the return trip, give each student a copy of the turtle coloring sheet. Have students reflect upon all the things they saw throughout the day. Instruct students to color only the sections of the turtle that describes what they saw or experienced.

2. Upon their return to the classroom, allow students to use their coloring sheets as visuals for a field trip show and tell. Encourage students to talk about the things they learned during the field trip—what they smelled, what they saw, what they felt, what they heard and/or what they tasted.

Road Kill Cafe

Pre-Visit Bus Activity

Primary/Elementary Level

Science (Life)

Length of Bus Trip

Objective(s). Students will identify animals and the reasons animals come near the roads.

Related NM Content Standards with Benchmarks. SC10-E1, SC11-E2

Method. By observing living and dead animals near the road, students will draw conclusions as to why animals are found alive and dead near the road.

Materials. paper and pencil for each student

Background. Animals come to the roads and highways for many reasons. The land a few feet from the highway has often been disturbed, so there may be new, young plants for animals to eat. Some animals have large home ranges, and the highways go through that range. For these reasons, many animals are killed while trying to cross the road. These roadkills are not all bad, however. Many scavenger animals such as, turkey, vultures, coyotes and ravens, feed off the dead animal carcasses.

Suggested Procedure

1. On your trip to Carlsbad Caverns National Park, ask students to watch for animals—dead or alive, it does not matter. Instruct them to write the names of the animals they see along the highway.

2. When close to the park, ask students to share with the class what animals they saw. What might be some reasons these animals were near the road? Why would these animals like to eat the plants on the side of the road rather than the ones in a safer location? What is a positive result from roadkills?

3. Facilitate a class discussion comparing and contrasting the amount and type of plant life near the road versus away from the road. Is there a difference? Why or why not? What effect does the amount of vegetation have on the animals that are killed along the road?

When I Went to Carlsbad Caverns

Post-Visit Bus Activity

Primary/Elementary and Intermediate Levels

Language Arts (Unifying Concepts, Receptive Language)

20 Minutes

Objective(s). Students will recall things they observed while visiting the park.

Related NM Content Standards with Benchmarks. LA2-E1, LA3-E3, LA3-M3, LA4-E1, LA4-M1

Method. Students play a memory game.

Suggested Procedure

1. Explain the game to students.
2. Student #1 will start off the game by saying, When I went to Carlsbad Caverns National Park, I observed . . . He/She will fill in a word that starts with “A” (example: agave).
3. Next, Student #2 repeats the sentence and then add his/her own observation, starting with a “B” (example: bat). Student #2 sentence would be—When I went to Carlsbad Caverns National Park, I observed an agave and a bat.
4. Then, Student #3 says the sentence and adds another observation that begins with “C.”
5. Continue until all letters have been used.

Colors in the Desert

Bus Activity

Primary/Elementary Level

Science (Physical)

15 Minutes

Objective(s). Student will describe the desert in terms of color.

Related NM Content Standard with Benchmark. SC7-E1

Method. Students play a game of “I Spy.”

Background. Many colors can be seen in the desert. The green from the chlorophyll in the plants, the red/orange from the iron oxide in rocks, and the black from the magnesium dioxide in the rocks.

Suggested Procedure

1. Explain that there are lots of different colors, not just brown and green. As you drive down the highway, when you see an interesting color say, “I spy something (state the color.)”
2. Have students guess the object.

What am I?

Post-Visit Bus Activity

Primary/Elementary and Intermediate Levels

Science (Physical, Life)**, Language Arts** (Receptive Language)

20 Minutes

Objective(s). Students will list facts about a variety of objects found at Carlsbad Caverns National Park.

Related NM Content Standards with Benchmarks. SC7-E1, SC10-M2, LA3-E3, LA3-M3

Method. Using clues they have been given, students recall things they learned during the field trip.

Materials. list of clues

Suggested Procedure. Read these clues (and others you may have prepared), allowing your students to guess what object you are describing.

Clues

1. I hang around in cool dark places. I must have water to grow. Some people think I look like an icicle, but I'm made of rock. (Stalactite)
2. Green and grey are the colors I wear. I keep a lot of information under my hat. (A National Park Ranger)
3. Some people say I look good enough to eat. But don't take me to the movies, I'd probably break your teeth. (Cave Popcorn)
4. Although my tail looks like a raccoon, my face looks like a cat. (Ringtail)
5. I build my nest of mud and straw high on rock walls away from danger. Visit me in the summer; I'm gone in the winter. (Cave Swallow)
6. I am a part of the past, now I'm part of the rock. (Fossil)
7. Look in the sky and you may see me soar. Sometimes I go to the cave entrance in evening to catch a free meal of bats as they exit the cave. Watch for my red tail as I fly by. (Red-tailed hawk)
8. Without me there would be no cave. Drop by drop I made the speleothems to grow. (Water)
9. Water takes too much credit! Without me, the water would have nothing to dissolve. (Limestone)
10. Don't use me to sip your drink! I'd rather stay on the ceiling of the cave. (Soda straw)

11. I prefer the cave, but sometimes I will venture out to the surface, never making a sound. I use my long antennae to find my way around in the dark. (Cave cricket)
12. Some people say I'm rare in the desert, but lots of times I'm there, you just have to look. Animals come from far away just to get a drink from me. (Spring)
13. I am very versatile. My roots, flower stalk, buds, core and fruit are all edible. My roots can be mashed to use for soap. Some people use my leaf fibers to make ropes, mats and sandals. (Yucca)
14. In the early morning or at evening time, be careful driving because I am often near the road. I'm one of the largest animals in the park. I may be cute, but remember, I'm still a wild animal. (Mule deer)
15. We grow at weird angles and look like spaghetti when we bunch together. Some say we are formed when water under great pressure is forced through small holes. (Helictites)

Section 11 – Miscellaneous Activities

- **What to Take**
- **Night Owls**
- **Make a Solar Hot Water Heater**
- **Moon Over the Classroom**

What to Take

Pre-Visit Activity

Primary/Elementary, Intermediate and Secondary Levels

Science (Life)

45 Minutes

Objective(s)

- Students will identify things they need to survive in the desert.
- Students will appraise one another's choices.

Related NM Content Standards with Benchmarks. SC11-E9, SC11-E10, SC11-M9, SC11-M10, SC11-H9

Method. Students brainstorm things they need to bring when they visit the desert.

Materials

- Older Students: desert survival guide or scout manual for reference, paper, pencils
- Younger Students: a wide variety of clothing, a variety of food, sack lunch, medication, bandages, backpack, water bottle with water, camera, caving gear, toys, flashlight, tent, blankets, sunglasses, hats, proper shoes, etc.

Background. Carlsbad Caverns National Park is located in the Chihuahuan Desert. Deserts are lands that are very dry and receive little rain. Strong winds often blow. The weather can be either hot or cold in the desert.

Some deserts sizzle with temperatures as high as 130°F. Desert plants and animals have special features that help them thrive in hot temperatures. What precautions do people need to take in the desert? What do you need to wear and take with you on your field trip to Carlsbad Caverns National Park? If you and your family were planning a backcountry hike at the park, what would you pack?

See The Backcountry of Carlsbad Caverns National Park.

Suggested Procedure for Young Students

1. Teach a desert unit.
2. One or two days before your field trip to Carlsbad Caverns National Park, place desks along the walls of the classroom, leaving a large space in the middle of the room. Place all kinds of things that students might need and/or want to take along on the field trip or on a backcountry hiking adventure.
3. When students enter the classroom, hand one student the backpack. Instruct him/her to put in the backpack only those things that would be useful for the field trip.
4. Allow the student to explain why he/she selected those items placed in the backpack.

5. Allow classmates to question the student about his/her selection.
6. Empty the backpack and hand it to a second student. Instruct the student to pretend like he/she is going on a two-day backcountry adventure with his/her family at the park, and pack his/her backpack accordingly.
7. Allow the student to explain his/her thought processes during the packing.
8. Allow classmates to question the student about his/her selection.
9. Repeat this process using all students who would like to be packers.
10. Discuss safety rules for the desert—stay calm if lost, find shade and stay put.

Suggested Procedure for Older Students

1. Have students brainstorm what they know about the desert.
2. Have students brainstorm about appropriate behavior and dress in the desert.
3. Have students make a supply list for their trip to the desert.
4. Discuss safety rules for the desert.

Night Owls

Pre-Visit and Post-Visit Activities

Primary/Elementary and Intermediate Levels

Science (Inquiry, Life)

2-Hour Pre-Visit Hike, 40-Minute Post-Visit Presentation

Objective(s). Students will use their senses to investigate the outdoors after sunset.

Related NM Content Standards with Benchmarks. SC5-E2, SC5-M1, SC5-M2 SC6-E2, SC6-M2, SC10-E1

Method. Students hike after sunset, stopping every 10 - 15 minutes to participate in mini-science activities.

Materials

- Night Vision: candles and matches
- Colored Paper: a 3" X 2" square of different colored paper for each student
- Wintergreen Lifesavers: wintergreen -flavored lifesavers
- Scents: 4 jars or film containers, 4 cotton balls with different scents (cinnamon, vanilla, vinegar, rubbing alcohol, etc.)
- Moth-Bat Game: blindfold

Key Vocabulary. diurnal, nocturnal, adaptation, echolocation, rods, cones

Background. People are often less comfortable and familiar with the world of dark than with the light of day. People are diurnal—awake in the day. Some animals are nocturnal—awake in the night. They have special adaptations that people do not. A visit to the *dark side* is coming!

Suggested Pre-Hike Procedure

1. The purpose of the night hike is to give students a greater appreciation of the outdoors after the sun sets. Before going outside, facilitate a discussion about night life—nocturnal animals, night vision, etc.

2. Establish guidelines for the hike.

Suggested Hike Procedure. Begin the hike. Stop every 10 minutes to do one of the following mini-science activities.

- *Night Vision.* Have students cover one eye with one hand. Light the candle and have students look at it for about one minute using the uncovered eye. Blow the candle out and have students look around alternating opening and closing each eye. (Students will see and feel the difference between night and day vision simultaneously.)

- *Solo Walk.* Discuss how it feels to be in the desert at night. Ask students if it would feel different to be in the desert by themselves. Have one leader walk approximately fifty feet

ahead. Then, have students walk one at a time towards the leader that has walked ahead. Follow-up with a discussion about how it felt.

- *Colored Paper.* Pass out a different color square of paper to each student. Ask them to look at it and guess what color they think it is. Have the students put the square in a pocket. When the class returns to light, have them check and see if they were right.

- *Wintergreen Lifesavers.* Have your students form a circle. Pass out the Lifesavers. Tell them that they are to chew with their mouths open. Count to three and have everyone chew at same time, watching each other. (They should see sparks caused by an ingredient in the Lifesaver.) Ask students to explain what caused the sparks.

- *Scent.* (Before your outing, place variously scented cotton balls in film containers.) Have students form a circle. Explain that you will be passing around something to smell. Pass around one container at a time. When the container has gone all the way around the circle, let students guess the scent they smelled.

- *Moth-Bat Game.* Have your students form a circle. Explain echolocation. Have someone volunteer to be the bat. The bat is blindfolded and placed in the center of the circle. Have someone volunteer to be the moth. The bat says "bat" and the moth must answer immediately with "moth." They move around the circle until the bat catches the moth. (You may wish to repeat this exercise until all have had a turn.)

- *Animal Ears.* Ask students to find a spot to sit quietly alone. Using hands cupped around their ears, listen for animal sounds. Have students stand in a circle. Have them cup their ears while one student talks to them. Then try listening normally. Once they realize the difference, have them cup their ears and listen for as many sounds as possible during a 45-second period. Talk about what they heard.

- *Disappearing Heads.* Have students stand in two rows facing each other about eight feet apart. Instruct them to stand completely still and stare at the face of the person across from them. (Their head should disappear.) Explain why their heads seem to disappear. Rods in the eyes see light and cones see color. When you stare straight ahead, you use the cones and ignore the rods. But at night, light is more important than color. In a sense, your eyes are turning off the light, making the object seem to disappear.

Suggested Post-Hike Activities

1. Have students brainstorm various occupations that require people to work during the night hours. Do their occupations require them to work inside a building with good lighting? Do they work outdoors at night? Why is it necessary for some people to work at night? Do people have special adaptations like nocturnal animals?

2. Ask students if they know of any occupation that requires people to work day hours in an environment where there is no sunshine? Tell students to close their eyes and pretend.

   Your alarm clock goes off at six o'clock in the morning. You bathe, dress and start on your way. The sun is beginning to rise. You drive for forty-five minutes, meeting only a few cars along the highway. You are in a very rural area—the Chihuahuan Desert. You arrive at your job site and the sun You arrive at your job site and the sun is now shining brightly. You step onto an elevator to begin your work day. The elevator's first stop, and only stop, is 750 feet below the surface of the earth. There is absolute no natural lighting at your work site. You turn on your flashlight to find a switch. Who are you?

3. Introduce the park ranger you have invited to your school. The park ranger will share his/her total darkness stories with your students.

Make a Solar Hot Water Heater

Pre-Visit or Post-Visit Activity

Intermediate Level

Science (Unifying Concepts, Inquiry, Physical)

45-Minutes for Construction

Objective(s). Student will construct and operate a solar hot water heater and explain how it operates.

Related NM Content Standards with Benchmarks. SC2-E3, SC6-M1, SC9-M1

Method. Students design and construct a hot water heater.

Materials. 10 feet of flexible black tubing, shallow cardboard or wooden box (about 12" X 18"), a piece of glass to cover the box, flat black paint, black paper or black cloth for inside the box, spring-type wooden clothes pins, tape, 2 empty cans or buckets, thermometer, pencil, paper

Key Vocabulary. solar

Background. If you spend all your time underground while visiting Carlsbad Caverns National Park, you may not notice one of the park's most valuable and abundant resources—the sunshine which illuminates the surface of the park's almost 47,000 acres. In fact, the whole State of New Mexico has so much sunshine that in 1925, its citizens selected a flag design with the ancient Zia sun symbol against a yellow background.

Scientists estimate that the sunlight falling on the United States during a single summer day contains twice as much energy as our nation uses in an entire year. But how can we collect it? Solar energy is clean and available. In remote areas, sunlight is more practical and less costly than transmission lines. However, there are a few disadvantages connected with solar energy. First, it is only there on sunny days. Secondly, it is at its weakest in the winter when we need it the most. And lastly, collectors and storage devices are expensive. Nevertheless, the potential benefits outweigh the shortcomings.

Every park ranger at Carlsbad Caverns carries three sources of light into the cave. If you are worried about the taxpayers footing the bill for large quantities of batteries, worry no more! Park rangers use energy from the sun to recharge their batteries.

Suggested Procedure

1. Cover the inside of the box with black paint, black paper or black cloth. Cut two holes on one side of the box. Loop the tubing back and forth inside the box. Both ends of the tubing should stick out of the sides of the box several feet.

2. Place the glass cover on the box. Secure it with tape.

3. Fill one bucket with water. Place the box and the bucket in full sunlight. Put one end of the tubing into the bucket of water. Place the other bucket under the opposite end of the tubing at a lower level. Suck gently on the end of the tubing to establish siphon action.

When the water starts to flow through the tubing, pinch the tubing with a clothespin to limit the water flow to a small trickle.

4. Note the temperature of the water. After a while, take the water temperature again. Is it warmer than the water before it goes through the water heater? Why? What would happen to the water temperature if it were slightly overcast? What would happen to the water if it moved faster through the water heater?

Moon Over the Classroom

Pre-Visit or Post-Visit Activity

Primary/Elementary Level

Science (Space)

45 Minutes

Objective(s). Students will identify the different moon phases and will describe an eclipse.

Related NM Content Standards with Benchmark. SC13-E1, SC13-M1

Method. Phases of the moon are demonstrated using a lamp (sun), a ball (moon) and student (earth).

Materials

- The Class: lamp with a 40-70 watt clear bulb (no lamp shade), extension cord
- Each Student: pencil, ball

Key Vocabulary. eclipse, moon phases

Background. There are five phases of the moon: new, crescent, half, gibbous and full. When the moon is in new or crescent phase, it is close to the sun. It takes about one month (29.53 days) for the moon to go from full to new and back to full again. Only during a new moon can an eclipse of the sun happen (solar eclipse). Only during a full moon can there be an eclipse of the moon (lunar eclipse). A solar eclipse occurs when the moon passes directly between the Earth and the sun and only lasts a few minutes. A lunar eclipse occurs when the earth casts a shadow on the moon. It can last a few hours.

During warm months, up to a thousand park visitors at Carlsbad Caverns National Park attend Bat Flight Programs each evening at sunset. Many visitors remain in the amphitheater after the bats disappear into the skies. They stay to enjoy brilliant stars, planets and the moon. Why does Carlsbad Caverns have such a magnificent night sky?

Suggested Procedure

1. Using the extension cord (taped securely to the floor to prevent tripping), set the lamp in the center of the room. Give each student a pencil and a ball. Have them poke the ball on the end of the pencil.
2. Explain to students that the lamp bulb represents the sun, the ball represents the moon and their head represents the Earth.
3. Turn on the lamp and arrange students in a circle around it. Have students hold the *moon* at arms length in front of them.
4. Ask students to move the ball a little to the left until they see a thin crescent light. Is the crescent facing the *sun* or away from it? (Make sure students are looking at the ball, not the light.)

5. Move the *moon* around the *earth* until exactly half of the *moon* is lit. Does the *moon* have to move away from or toward the *sun* to make it fuller?

6. Keep moving the *moon* until it is fully lit. (Students need to move the *moon* out of their head's shadow.) When the *moon* is full, is it between the *Earth* and the *sun*, or is the *Earth* between the *moon* and the *sun*?

7. Continue moving the *moon* in the circle until it is a quarter again and then a crescent. When the *new moon* appears, explain that the *moon* cannot be seen because it is so close to the *sun*. Also explain that from new moon to new moon is about one month. Repeat this exercise until students fully understand.

8. Create an eclipse by having students move their *moon* directly in front of the *sun* to create a shadow. Have students hold the *moon* in this position, but look around the room to see the shadows on other faces. Your head is the *Earth*, so only the people living where your eyes are, can see the eclipse. People on your chin do not see it. What phase is the moon just before or after a solar eclipse?

9. Create a lunar eclipse by moving the *moon* into the shadow of the *Earth*. What phase is the *moon* in just before or after an eclipse of the *moon*? Unlike the eclipse of the *sun*, everyone facing the *moon* can see the *moon* in an eclipse.

Section 12 – ParKids Productions and Video Activities

- **ParKids Productions**
- **A Short Story About a Deep Subject**
- **Stewardship**
- **It's All About Caving Safety and Caving Rules**
- **Bats! Bats! Bats!**

ParKids Productions

Project Background and Purpose

The title of the "series" is Parkids Productions. This scope of work pertains only to one video, *ParKids Productions Presents Carlsbad Caverns National Park*. Using *Parks As Classrooms* funding, Carlsbad Caverns National Park produced the first in what is hoped to become a series of educational videos that feature the resources of America's national parks. Schools that routinely visit the park may request a free copy of the video for their library. Teachers are encouraged to use the video to prepare their students for field trips to the Caverns.

Carlsbad's video has four major parts. Part 1 covers the history of the caverns, and is itself divided into four segments—geological history, American Indian influence, guano mining period, and National Park Service management. Part 2 is about park stewardship. Part 3 explains cave safety rules. Part 4 concludes the video with a bat skit and rap—dispelling many bat myths and presenting bats as beneficial to our environment.

The purposes of *ParKids Productions Presents Carlsbad Caverns National Park* are as follows:

- To prepare and excite elementary students about their upcoming field trips to Carlsbad Caverns National Park through a curriculum-based video.
- To introduce or reinforce the significance of Carlsbad Caverns to families visiting the park.
- To create a curiosity among young children so that they will wish to learn more about park resources.
- To allow students who are unable to visit the park to have a long-distance "park experience."

ParKids Productions Presents Carlsbad Caverns National Park's four video segments collectively will aid the students in obtaining the following:

- An insight into the mission of the National Park Service.
- An understanding of and appreciation for the reasons behind park rules.
- The realization that cave exploration is exciting and educational, but is dangerous if rules are not followed.
- A desire to help take care of Carlsbad Caverns because it has a monumental past and holds the key to many stories yet untold.

A Short Story About a Deep Subject

Part 1: The History and Geology of Carlsbad Caverns National Park

Pre-Visit, Field Trip and Post-Visit Activities

Primary/Elementary and Intermediate Levels

Science (Unifying Concepts, Inquiry, Life, Personal) **Language Arts** (Unifying Concepts, Listen and Read, Speak and Write**), Social Studies** (Environment)**, Math** (Geometry and Measurement Concepts)

60 minutes Pre-Visit, Field Trip, Two 60 minute sessions plus more if needed for perfection of brochure and evaluation

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Objective(s)

- Students will identify Carlsbad Caverns National Park as part of the Permian sea by listing its characteristics.
- Students will explain the history as recorded through rocks and various artifacts.
- Students will define a fossil by describing how one is formed.
- Students will identify and depict the three mountain ranges as part of the Capitan Reef.
- Students will describe the process of Carlsbad Caverns' cave formations.
- Students will identify the impact of the internal and external climate of Carlsbad Caverns on the dress preparation.

Related NM Content Standards with Benchmarks. SC1-E1, SC1-E1, SC2-E3, SC2-M3, SC4-E1, SC4-E2, SC4-E3, SC5-E2, SC5-M2, SC6-M6, SC9-ME, SC12-E3, SC12-E5, SC12-E3, SC12-E6, LA1-E1, LA1-E2, LA1-M2, LA1-H2, LA2-E4, LA2-M4, LA2-H4, LA3-E3, LA3-M3, LA3-H3, LA4-E1, LA4-M1, LA4-E7, LA5-E1, LA5-M1, LA5-H1, LA6-E1, LA6-E3, LA6-M3, SS12-E6, MA9-E1

Method

- View the video Part 1 on the geology and history of Carlsbad National Parks.
- Read Geology of Carlsbad Caverns and About Types of Caves.

Materials. Video "ParKids Productions," New Mexico map, The Geology of Carlsbad Caverns, Jim White, Carlsbad Caverns National Park Area History, 1848-1998, fact cards at bottom of page, drawing paper, pencil, color pencils, pocket journals

Key Vocabulary. reef, fossil, desert, marine organisms, calcite, limestone, sulfuric acid, carbonic acid

Background. Carlsbad Caverns, located in the Chihuahuan Desert, is an ancient marine fossil reef called Capitan Reef. It has a radius of 400 miles and includes 3 mountain ranges—the

Apache, Glass and Guadalupe. Many scientists believe that 250 million years ago this reef was covered by the Permian Sea. The history is recorded in the stone fossil as observed in the fossilized marine organisms.

The combinations of dirt, sand and calcite hardened the remains of marine organisms. Compacted and under pressure these organisms became cemented into limestone. Carlsbad Caverns was formed when water mixed with sulfuric acid seeped through the cracks in the rocks. The seeping water dissolved the rocks—making the cracks larger and larger. The cracks became water-filled underground rooms. Eventually the reef rose above ground and air replaced groundwater. Without the water to support the ceiling, large pieces of the ceiling collapsed. Large rooms and hallways resulted from the process.

Pictographs are prehistoric records of human existence. These are usually found in areas protected from sun and weather. Human preservation efforts ensure these to be enjoyed and studied in the future.

Although he was not the first man to discover the cave, Jim White made Carlsbad Caverns famous through his exploration efforts. During the twenty years bat guano was mined in the cave, White worked for all but one of the mining companies. In his spare time he continued exploring the cave. Guano mining stopped in 1923 when Carlsbad Caverns became part of the National Park System. As the park's first ranger, White made the cave more accessible to the public.

Suggested Pre-visit Procedure for Carlsbad Caverns National Park Brochure

1. Provide students with vocabulary before viewing video.
2. Introduce the brochure and its use as an accurate source of information for tourist. (see the brochure rubric)
3. View Part 1 of the video, *ParKids Productions*, for the brochure information. Have students take notes in notebooks.
4. Stop the video after the geology section and discuss cave formation and fossils.
5. Locate Carlsbad Caverns and the three mountain ranges on a New Mexico map.
6. Continue viewing part one of the video on history. Provide students with information from fact sheets. Provide time for students to create a timeline to be included in their brochure.
7. Review the brochure criteria and expectations for quality using the rubric. Provide a rubric for each student.
8. Break into groups and have students glean information from fact sheets.
9. While still in the groups provide the students with fact cards found at bottom of page. Students will read the information to determine the cave type of Carlsbad Caverns.
10. Have students independently create a rough draft of their brochure.

Suggested Field Trip Procedure for Carlsbad Caverns National Park Brochure. The students will pick up various brochures related to Carlsbad Caverns and surrounding areas. Students will observe the various cave formations within the cave. They will also observe the landscape surrounding the visitor center. Be sure students take note of the external and internal

climate. Ask them what they can observe in visitors that demonstrates the impact of the two climates.

Suggested Post-Visit Procedure for Carlsbad Caverns National Park Brochure

1. Compare and contrast the student-made brochure with the brochures gathered from the field trip. Students will make recommendations and provide positive feedback for their brochures and the brochures of classmates.
2. Revise rough draft based on feedback. Students will create the final draft of their brochure.
3. Students evaluate their brochure and exchange for a peer evaluation.
4. Students will present their brochure to the group. Students will make recommendations and provide positive feedback for their brochures and the brochures of classmates.

Suggested Expansion. *Use as a multimedia activity.*

- Assign students to create a multimedia brochure using PowerPoint or HyperStudio

  OR

- Create a computer generated 3-fold brochure. Brochure could be created in small groups.

Types of Caves – Fact Cards	
Solution Caves Formed by weak, natural acid dissolving soluble rocks such as limestone, dolomite, gypsum and marble.	**Lava Tubes** Formed during the cooling of lava flows. First, a crust forms on the lava as it begins to cool. A break in this crust allows some of the molten lava to flow through the break leaving long, tunnel-like passages.
Sea Caves Formed from wave action. The waves force water into the cracks in rock, breaking off the rock.	**Wind Caves** Formed from wind erosion or cliffs or hills. They are almost always small caves that seldom penetrate into total darkness.
Talus Caves Formed from huge rocks that have fallen from cliffs.	**Glacier Caves** Formed by melting waters moving through glaciers.
Soil Caves Formed when flash floods move through the soils and transport earth with them. They are found in desert areas.	**Tectonic Caves** Formed by the action of earthquakes.

Brochure Advertising Carlsbad Caverns National Park

Name: _____

Grades: (4) Very Few Errors, (3) Few Errors, (2) Several Errors, (1) Incomplete, (0) Not Evident

Visual____ Content and Written_____ Presentation_____ Overall_____

	Self	Peer	Teacher	Comments
Brochure – Quality of Visual			/44	
Brochure is neat and free of wrinkles and extra marks			/4	
Lettering is neat, evenly spaced, and legible			/4	
Illustrations: ____colorful ____ neat ____ focused ____ fills area ____ detailed			/20	
The brochure is an accurate source of information for the tourist.			/4	
Descriptions are clear, concise, and use a variety of vocabulary			/4	
Correct spelling and usage of vocabulary			/4	
Complete sentences with capitals, punctuation, and complete thought.			/4	
Content and Written			/28	
Brochure is interesting and follows a central theme.			/4	
Brochure includes: __Location __Timeline __Mountain Ranges __Cave Type and Formation __Formation of Fossils __Internal and External Climate and its Impact on Dress			/24	
Presentation of Brochure			/20	
Sequenced and uses the brochure as part of the presentation			/4	
Variety of voice			/4	
Eye contact with audience			/4	
Interesting and informative			/4	
Prepared with appropriate materials and evidence of rehearsal			/4	

Stewardship

Part 2: Stewardship of Carlsbad Caverns National Park

Pre-Visit, Field Trip and Post-Visit Activity

Primary/Elementary and Intermediate Levels

Science (Inquiry, Life, Technology)**, Language Arts** (Unifying Concepts, Listen and Read, Speak and Write)**, Art** (Theater and Visual)

60 minutes Pre-Visit, Field Trip, Two 60 minute sessions plus more if needed for perfection of script, performance and evaluation.

Objective(s)

- Students will define stewardship and identify daily applications.
- Students will illustrate the basic rules of stewardship as it applies to Carlsbad Caverns National Park.

Related NM Content Standards with Benchmarks. SC5-E2, SC5-M2, SC6-M6, SC11-E8, SC11-E6, SC15-E2, AE1-E1, AE1-M1, AE1-E2, AE2-E3, AE4-E7, AE8-E9, LA1-E1, LA1-E2, LA1-M2, LA1-H2, LA2-E4, LA2-M4, LA2-H4, LA3-E3, LA3-M3, LA3-H3, LA4-E1, LA4-M1, LA4-E7, LA5-E1, LA5-M1, LA5-H1, LA5-E5, LA6-E1, LA6-E3, LA6-M3

Method. Students review rules through discussion and viewing Part 2 of ParKids Production/Stewardship.

Materials. Video *"ParKids Productions,"* drawing paper, pencil, color pencils, pocket journals

Key Vocabulary. stewardship

Background. Stewardship on the National Park System involves a staggering 83 million acres. Many experienced volunteers donate thousands of hours to restore and conserve the caves. Stewards view caves as a precious nonrenewable resource.

Suggested Pre-visit Procedure for Carlsbad Caverns National Park

1. To introduce the lesson on stewardship, the teacher will conduct a brief discussion on rules which students view to be related to safety and preservation of Carlsbad Caverns National Park. Explain to students that they will be creating a four-fold books depicting stewardship and the basic rules of stewardship.
2. Ask the students what rules they think will be included in the video. First, have students record their ideas in their pocket journal. Then discuss in pairs. Have students form groups of four by combining two pairs and discuss their answers. Students should make revisions and additions here.
3. View Part 2 of *ParKids Productions*. The teacher will stop and start the video to reinforce definition and rules.
4. Discuss correlation between student and video suggestions. Ask students why the rules of stewardship apply and how each of them could contribute to the park.

Suggested Field Trip Procedure for Carlsbad Caverns National Park

1. Review the rules of stewardship. Have students silently observe another person and note how they were stewards of the park.

2. As the fieldtrip progresses have the park ranger identify ways students could contribute in a positive way to the needs of the park presently and in the future.

Suggested Post-Visit Procedure for Carlsbad Caverns National Park

1. Have students share how each of them observed the rules of stewardship, what they observed in another person and a suggestion for their wish for the future of the park.

2. Explain the procedure for making the four-fold book using the directions provided.

3. Have students design a cover depicting the definition of stewardship and the concepts presented in video and the field trip. They are to use a page to identify one basic rule with possible elaboration. The page facing the written is to illustrate the rule. Students should fill the book with the rules of stewardship. Refer to rubric as a guide for students and grading.

Suggested Expansion

- Assign students to create a multimedia presentation on stewardship using PowerPoint or HyperStudio

  OR

- The book could be created in small groups. ABCD has suggested other stewardship activities. These may be incorporated to fill the needs of your students.

Four-Fold Book

Materials: Any size paper. Large sheets of newsprint work well. Scissors are optional.

Steps:

1. Fold paper in half lengthwise. Fold in half again. Fold in half again.

2. Open and re-fold width-wise. Cut from center of fold edge to center of paper.

3. Open the slit.

4. Pull points D and B out while pushing A and C to the middle forming a plus sign.

5. Bring points D and B toward you. Bring remaining point toward to make the book.

6. Crease the main folds well.

7. To increase the number of pages, glue two or more books together.

*The slit for this book may be torn rather than cut if scissors are not available. The initial folds must be creased very well.

Four-Fold Book on Stewardship

Name: _____

Grades: (4) Very Few Errors, (3) Few Errors, (2) Several Errors, (1) Incomplete, (0) Not Evident

Visual _____ Content and Written _____ Presentation _____ Overall _____

	Self	Peer	Teacher	Comments
Four-Fold Book Quality Visual			/44	
Book is neat and free of wrinkles and extra marks.			/4	
Lettering is neat, evenly spaced, and legible			/4	
Illustrations: __ colorful __ neat __ focused __ fills area __ detailed			/20	
The book is an accurate source of information on stewardship.			/4	
Descriptions are clear, concise, and use a variety of vocabulary.			/4	
Correct spelling and usage of vocabulary.			/4	
Complete sentences with capitals, punctuation, and complete thought.			/4	
Book - Content and Written			/20	
Book is interesting and follows a central theme of stewardship.			/4	
Book includes: __Definition of stewardship __Rules of Stewardship __Illustrations of Each Rule __Elaboration included for each rule and/or additional rules may be referred to and explained.			/16	
Presentation of Book			/20	
Sequenced			/4	
Variety of voice			/4	
Eye contact with audience			/4	
Interesting and informative			/4	
Prepared with appropriate materials and evidence of rehearsal.			/4	

It's All About Caving Safety and Caving Rules

Part 3: Caving Safety

Pre-Visit, Field Trip and Post-Visit Activity

Primary/Elementary and Intermediate Levels

Science (Inquiry, Life), **Language Arts** (Unifying Concepts, Listen and Read, Write and Speak), **Social Studies** (Environment)

60 minutes Pre-Visit, Field Trip, Two 60 minute sessions plus more if needed for perfection of book and evaluation.

Objective(s)

- Students will identify rules of safe caving.
- Students will effectively communicate the message of cave preservation.
- Students will elaborate on the three rules of safe caving.

Related NM Content Standards with Benchmarks. SC-5E3, SC-5M2, SC11-E1, SC11-E9, SS11-E3, LA1-E1, LA1-E2, LA1-M2, LA1-H2, LA2-E4, LA2-M4, LA2-H4, LA3-E3, LA3-M3, LA3-H3, LA4-E1, LA4-M1, LA4-E7, LA5-E1, LA5-M1, LA5-H1, LA6-E1, LA6, E3, LA6-M3

Method

- View the video, Part 3 of the *ParKids Production* Video.
- Read "Safe Cave Exploration" in Section 2 – just the Facts.

Materials. Video "*ParKids Productions,*" Safe Cave Exploration, fact cards, pencil, pocket journals. Art supplies will vary according to what the students use in their skits.

Background. Cave safety involves responsible planning.

Suggested Pre-visit Procedure for Carlsbad Caverns National Park Skit

1. Introduce the skit. (See the brochure rubric.)
2. View Part 3 of the video, *ParKids Productions*, for skit information. Have students take notes in notebooks.
3. Stop the video after the caving section and discuss cavers' rules of three.
4. Break students into groups of five and have them plan, write and create props for their skit depicting cave safety and preservation of the cave environment. (See rubric for the skit.)
5. Have students exchange their skit with another group for feedback. Tell students to list the materials needed.

Suggested Field Trip Procedure for Carlsbad Caverns National Park. The students will take notes on park ranger presentation on cave safety and cave preservation. They will also want to note observation of self and others as it relates to cave safety and cave preservation. Have

students look for cave formations that have obviously been touched and compare them to formations that have not. Have students look for cave hazards and elaborate on the rules of three. Students should note evidence of human impact on the natural cave environment.

Suggested Post-Visit Procedure for Carlsbad Caverns National Park

1. Compare and contrast the information gained through the video with the information provided by the park ranger and student observations.
2. Revise rough draft of the skit script based on feedback from peer students and observations. Students will create the final draft of their script.
3. Provide time for students to practice skits.
4. Have students perform their skit and have students provide peer evaluation based on the rubric requirement.

Suggested Expansion

- Use as a multimedia activity. Assign students to create a multimedia presentation using PowerPoint or HyperStudio.

  OR

- Create a computer-generated slideshow.

Skits may be performed for other classes.

Skit and Props on Caving Safety

Name:_____

Grades: (4) Very Few Errors (3) Few Errors (2) Several Errors (1) Incomplete (0) Not Evident

Visual_____ Content and Written_____ Presentation_____ Overall_____

	Self	Peer	Teacher	Comments
Skit Props - Quality of Visual			/36	
Props are neat and free of wrinkles and extra marks.			/4	
Lettering is neat, evenly spaced, and legible.			/4	
Illustrations: __ colorful __ neat __ focused __ fills area __ detailed			/20	
The prop(s) accurately relate to, and communicate the message of the skit.			/4	
Props are appropriate to the skit.			/4	
Script – Content and Written			/36	
Descriptions are clear, concise, and use a variety of vocabulary.			/4	
Complete sentences with capitals, punctuation, and complete thought.			/4	
The script and props are interesting and follows the central theme of caving safety.			/4	
The script includes correct spelling and usage of vocabulary.			/4	
Script: __ Communicates Rules of Three __ Costume is appropriate to script __ Props are appropriate to the message __ Defines Cave Safety __ Elaboration is included for each rule and/or additional rules may be referred to and explained			/20	
Presentation of Skit			/20	
Sequenced with use of props			/4	
Variety of voice			/4	
Eye contact with audience			/4	
Interesting and informative			/4	
Prepared with appropriate materials and evidence of rehearsal			/4	

Bats, Bats, Bats!!!

Part 4: Respecting and Understanding Bats

Pre-Visit, Field Trip and Post-Visit Activities

Primary/Elementary and Intermediate Levels

Science (Unifying Concepts, Inquiry, Life, Technology, Personal)**, Language Arts** (Unifying Concepts, Listen and Read, Write and Speak)**, Social Studies (**Technology)

60 minutes Pre-Visit, Field Trip, Two 60 minute sessions plus more if needed for perfection of game, gameboard, and evaluation

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Objective(s)

- Students will identify common myths about bats.
- Students will effectively communicate the message of bat preservation.
- Students will elaborate on bats and their benefit to the environment and to humans.
- Students will identify the role of bats in their ecosystem.
- Students will identify the common bats found at Carlsbad Caverns National Park.
- Students will classify and identify the characteristics unique to each classification relating to bats.

Related NM Content Standards with Benchmarks. SC2-E3, SC5-E2, SC5-M2, SC6-M6, SC10-E1, SC11-E6, SC15-E2, SC16-E2, SS14-E3, LA1-E1, LA1-E2, LA1-M2, LA1-H2, LA2-E4, LA2-M4, LA2-H4, LA3-E3, LA3-M3, LA3-H3, LA3-E4, LA4-E1, LA4-M1, LA4-E7, LA5-E1, LA5-M1, LA5-H1, LA6-E1, LA6-E3, LA6-M3

Method. View the video Part 4 Bats of Carlsbad National Park.

Read “The Bats of Carlsbad Caverns and Elsewhere“ in Section 2 – Just the Facts.

Students will create a game of knowledge and chance

Materials. Video *“ParKids Productions,”* The Bats of Carlsbad Caverns and Elsewhere in Section 2 – Just the Facts, game card template, pencil, markers, paper, glue, spinner or dice, pocket journals

Vocabulary. scat

Background. At Carlsbad Caverns there is a large, active colony of roosting bats with a long-term occupancy record dating back 5,000 years. The population of bats has been steadily decreasing over the years. This decrease can be linked to a lack of knowledge and awareness of the beneficial contributions of their existence.

Suggested Pre-visit Procedure for Carlsbad Caverns National Park Skit

1. Introduce the game concept. (see the game board and game cards rubric) Explain to students that they will need a variety of resources. Students will need to gather bat facts

from books, the video, presentations, Just the Facts and interviews to provide a large range of questions relating to the objectives. Review the objective with the students so they will know what types of questions to create.

2. View Part 4 of the video, *"ParKids Productions,"* for game information. Have students take notes in notebooks.

3. Stop the video after the bat section and discuss myths and facts relating to bats. Ask students how they felt for the bats in question.

4. Break students into groups of two and have them plan, write, and create game boards, cards, playing strategy, and the rules of the game. See rubric. The design of the game must be related to the bat theme, must provide a variety of accurate information and include chance.

5. Have students share their rules, game ideas and bat facts with another group. They should review the rubric to provide feedback for each other. Students should provide a list of materials needed.

Suggested Field Trip Procedure for Carlsbad Caverns National Park Game

1. The students will take notes on the park ranger presentation on as it relates to bats. They will also want to note any observation and evidence of bat life within Carlsbad Caverns National Park.

2. While at the park students will interview park visitors about their bat knowledge. Record information to share during the post visit activities. Extend the interviews at home with parents and neighbors.

Suggested Post-Visit Procedure for Carlsbad Caverns National Park Game

1. Compare and contrast the information gained through the video with the information provided by the park ranger, student observations and student interviews. Create a t-chart (myth and or inaccurate information vs. factual) and share their information with the class. The teacher may want to display these charts.

2. Revise rough draft of the game cards and board based on feedback from peers and observations. Students will create the final version of their game.

3. Provide time for students to polish the games.

4. Have students share their game. Provide time for students to play games created by others. Have students provide peer evaluation based on the rubric requirement.

Suggested Expansion

- Games may be shared as part of an open house or conference where students may share their games with their parents and allow others to play their game.

- You may have a game day where students rotate around the room playing the games of others.

- You may want to display the games in centers where students can play as they have time.

- Games could be shared with other classes by inviting another class to partner with your class to play.

- Students could create a digital game based on a multimedia program such as HyperStudio.

Bat Game Card

To be copied for student's use.

Bat Game and Game Board

Name:_____

Grades: (4) Very Few Errors (3) Few Errors (2) Several Errors (1) Incomplete (0) Not Evident

Visual_____ Content and Written_____ Presentation_____ Overall_____

	Self	Peer	Teacher	Comments
Game and Board - Quality			/44	
The board and cards are neat and free of wrinkles and extra marks.			/4	
Lettering is neat, evenly spaced, and legible.			/4	
Illustrations: __colorful __neat __ focused __ fills area __ detailed			/20	
The game is accurate in its information to provide a game of knowledge.			/4	
Directions are clear, concise, and use a variety of vocabulary.			/4	
Correct spelling and usage of vocabulary.			/4	
Complete sentence with capitals, punctuation, and complete thought.			/4	
Game and Board - Content and Written			/24	
The game is interesting and follows a central theme.			/4	
Game includes: __ Board __ Cards __ Directions __ Spinner or Dice __ Markers			/20	
Presentation of the Game			/20	
Sequenced			/4	
Variety of voice			/4	
Eye contact with audience			/4	
Interesting and informative in describing the skill of knowledge and chance as it relates to bats.			/4	
Prepared with appropriate materials and evidence of rehearsal.			/4	

Section 13 – Student Glossary

adapt: change to fit the environment

adaptation: a behavior, physical feature or other characteristic that helps an animal survive and make the most of its habitat; the way any living thing is fitted to the life it leads

algae: group of plants found in water or damp places that have chlorophyll, but lack tree stems, roots and leaves; a one-celled or many-celled, colonial plant

amphibian: a smooth-skinned, cold-blooded vertebrate that starts its life in water then lives on land in moist areas as an adult

anatomy: the science of the structure of animals; the structure of an animal or plant

aquatic: growing or living in water; done in water

bark: the outer covering of branches, roots and trunks of trees

biography: an account of a person's life written by another

bird: an animal that lays eggs and has wings and a body covered with feathers

brachiopod: a marine shellfish that began extinct

Brunton Compass: a special compass used by geologists to help them make maps of rock formations

bureau: a division of a government department

calcite: a mineral composed of calcium carbonate; the mineral found in limestone that serves as a cement in sandstone. Most cave formations are made of calcite.

calcium carbonate: a chemical compound that is found in seashells and in limestone and in other sedimentary rocks; a mineral important in the development of coral reefs, mollusk shells and other aspects of the marine environment

camouflage: an organism's ability to blend in with its surroundings by changing its color and/or shape to conceal itself from predators

carbon dioxide: a gas formed during organic decomposition and respiration; a gas that is naturally found in the air and combines with water to form carbonic acid; a gas in the air

carbonic acid: a weak acid that forms when carbon dioxide mixes with water; the solution of water and carbon dioxide that dissolves limestone to make caves. This acid can dissolve calcite and redeposit it in the form of a speleothem.

cave: a naturally formed underground passageway or room, often formed by the dissolving action of acidic groundwater

cave pearl: a small, round ball of calcite formed under water

caver: a person who explores caves in a safe manner while showing respect for the cave, its contents and the land above it

cavern: another word for cave; commonly defined as a large cave

chamber: a large room in a cave

chemical reaction: the action of substances undergoing chemical changes

chemical weathering: the breaking down of rocks by chemicals found in water, air and plants

climate: average of weather conditions over a long period of time in a large geographical area, as determined by air pressure, heat, wind and moisture

cold-blooded: ectothermic; not able to maintain a constant body temperature independent of the outside temperature. Insects, reptiles, fish and amphibians are cold-blooded.

colony: a group of living things of one kind living together

column: a speleothem that is formed by the joining of a stalactite and a stalagmite, or when a stalactite grows down connecting with the cave floor or a stalagmite grows up to the cave ceiling

cones: Specialized cells in the retina of the eye that makes it possible to see color.

conservation: the wise and careful use of our natural resources

controlled fire: a fire that is confined to a particular area

coral reef: a ridge or mass of limestone built up of materials deposited around a framework of skeletal remains of mollusks, colonial coral and massive calcareous algae

core: the center portion of the Earth; the metallic center of the Earth. It consists of the inner core and the outer core. The outer core lies 3,100 miles below the Earth's surface.

crust: the outer layer of the earth

crystal: a rock that is formed when minerals cool from the liquid state and become solid

culture: the ideas, skills, arts and customs of a people from a particular period of civilization

deposit: material laid down over time

desert: an area that receives less than 10 inches (25 cm) of rainfall a year and has a very high rate of evaporation

dichotomous key: a tool that uses a series of yes/no questions to classify animals, plants or minerals.

dissolve: to become a part of a liquid

dissolution: the act of breaking down a soluble component of a material, such as the dissolving of calcium carbonate from limestone

diurnal: active during the day

diversity: a term referring to variety or differences in the natural world. Biological diversity refers to variety in living things; species diversity refers to variety among different species;

genetic diversity refers to the variety within a single species; ecosystem diversity refers to differences in living communities

drapery: a speleothem formed when water deposits calcite in thin sheets that hang in delicate folds; a hanging curtain formed by seeping water

echolocation: the use of reflected sound from an emitter such as a bat, to locate objects; a special hearing system in which an animal navigates or locates food by producing short, high-pitched sounds and then listens for the echoes the sounds make when they bounce off objects

eclipse: the partial or total apparent darkening of the sun when the moon comes between it and the earth (solar eclipse); or, of the moon when the earth's shadow is cast upon it (lunar eclipse)

ecology: the study of how plants and animals interact with each other and with their environments

ecosystem: a major interacting system that involves both living organisms and their physical environment

endangered species: a category of animal or plant that is in danger of becoming extinct

energy: the power or ability to make things move or happen

environment: the sum of all the surroundings affecting something's development and survival

estivation: a deep "sleep" some animals enter during droughts

evaporation: the process of converting a solid or liquid state into a vapor or gas

exploration: an investigation for either recreation, research or some other reason

extinct: a type of living organism that no longer exists

fauna: animal life

feldspar: the most common rock forming mineral (contains aluminum and silica)

fibers: any threadlike substance. Fibers often accumulate in show caves from people's clothing.

flora: plant life

flowstone: formed when water flows down walls, over floors and older speleothems over a period of time, building up sheets of calcite and looking like a rock waterfall; a cave formation made by flowing water

formation (cave): common term for a cave feature formed by minerals being deposited into a cave; sometimes called a cave decoration; a body of rock with defined characteristics that is different from other bodies of rock; speleothem

fossil: the hardened remains of a plant or animal from some previous time period, preserved in rock formations in the earth's crust

fuel: a substance that can be burned

geology: the study of the structure of the earth's crust, its formation and development of its layers; the scientific study of the earth and the rocks that make it up. It includes the study of

individual rock types (petrography) and early forms of life found as fossils in rocks (paleontology).

global positioning system: (GPS) the 24 satellites which orbit around the Earth launched and maintained by the US Dept. of Defense

groundwater: water that infiltrates the soil and is stored in slowly flowing reservoirs (aquifers); used loosely to refer to water which flows beneath the surface of the earth

guano: the waste and excrement from bats or birds; bat or bird droppings

gypsum: a soft form of calcite byproduct

habitat: an animal's home; the type of environment in which an animal or plant lives; the locality in which a plant or animal lives; the native environment of an animal that contains food, water, shelter and living space

heat: thermal energy in transit

helictites: twisted speleothems projecting at all angles from ceiling walls and the floor of caves that seem to defy the laws of gravity

herp: a collective name given to reptiles and amphibians

hibernation: a state of greatly reduced activity and metabolism produced by lowering of body temperature

humidity: the amount of moisture in the air

hydrochloric acid: a strong, highly corrosive acid; a solution of the gas hydrogen chloride in water

hygrometer: an instrument used to measure humidity

hypothesis: a tentative, unproven explanation that seeks to describe or explain a process in nature

indicator species: an animal or plant that is only found in a certain area. Lechuguilla, sotol and tarbush are indicator species of the Chihuahuan Desert.

inorganic: anything that is nonliving, was never alive and is not the product of a living organism

insect: any of many small invertebrate animals having a segmented body and three pairs of legs

insectivorous: the habit of eating insects; feeds on insects

instinct: an inborn ability to do something

interpretation: the act of explaining or giving meaning to an event

intersect: to cross each other

invertebrate: an animal without a backbone

Jacobson's organ: a sensory organ, usually in a herp's mouth, that helps a herp smells its environment

karst: a terrain underlain by solutional rocks such as limestone; a terrain where the topography is formed by the dissolving rock, usually limestone and is generally characterized by sinkholes, underground streams and caves; a limestone formation pitted with caves, craves, cracks, potholes and sinkholes

larva: the immature stage of an insect

lava tunnel: horizontal cave-like tube formed when the surface of a large lava flow hardens, but the lava beneath remains molten and continues to flow

leaf: any of the flat, thin parts, usually green, growing from the stem of a plant

limestone: a sedimentary rock consisting primarily of calcite carbonate, commonly from shells and dead sea animals; a rock composed mostly of the remains of living things, such as shells or coral. Most solutional caves form in limestone.

lint: clinging bits of thread or fluff from clothing

litter: trash, rubbish or garbage

management ignited fires: prescribed fire; a fire started by fire officials to meet specific objectives. When planning a fire, officials consider safety, economics, public health, and environmental, social and legal issues.

mantle: the layer between the crust and the outer core of the earth; the layer beneath the earth's crust. Scientists think it is about 1,800 feet deep.

maternity colony: a group of pregnant or nursing bats that gather into a single large colony, sometimes hundreds or even millions, for the purposed of rearing young. The shared body heat is essential to survival and growth of the young.

mammal: a vertebrate which is warm blooded, has hair or fur, produces milk, and usually gives live birth to its young

marine organisms: animal or plant life found in the sea/ocean

medicinal: having the properties of medicine

megabats: nickname for fruit bats and flying foxes

metamorphosis: a process that changes the young of certain animals (such as amphibians) into their adult forms

microbats: nickname for all bats that can echolocate with ultrasonic sound

migration: the periodic movement of organisms into or out of an area

mineral: an inorganic substance occurring naturally in the earth and having definite physical and chemical properties; basic components that rocks are made of

mole: a small burrowing animal with very soft fur and very tiny eyes

molt: to shed the exoskeleton or outer skin

moon: a natural satellite of a planet. The Earth has one moon.

moon phases: the stages of the moon (quarter, full, new, etc.) as it moves around the Earth during a month's time

myth: a traditional story serving to explain some phenomenon, custom, etc.

national park system: all lands (376 units) under the management of the National Park Service,US Department of the Interior

native species: a species that occurs naturally in an area

national park unit: an area set aside by Congress and owned by the people of the United States for the purpose of preserving some of the best of America's scenery, history, nature and wilderness for future generation

natural resource: resources found in our natural environment

nocturnal: active at night

nomex: a type of flame-retardant clothing

non-native species: an organism that has been brought accidentally or intentionally into an area where it does not naturally occur. These species often compete with and cause problems for native species. Non-native species are also called exotic, invasive and alien species.

organic: of, like or derived from living organisms

organism: any living thing

oxygen: a gas in the air that almost all-living things need to survive

Park Service Organic Act: With the signing of this legislation on August 25, 1916, President Woodrow Wilson created a new federal bureau—the National Park Service.

pesticide: a chemical used to destroy insects or other pests

petrograph: proper term for any type of rock art

petroglyph: a relief carving cut into the face of cliff or rock representing an image or an idea

photosynthesis: the process by which plants use the sun's energy to convert carbon dioxide and water into sugar

pictograph: a painting made on a rock surface representing an image or an idea

pollination: the transfer of pollen from the anther of a flowering plant to the stigma prior to fertilization

pollution: a human-caused change in the physical, chemical or biological conditions of the environment that creates an undesirable effect on living things

popcorn: small, round formations on cave walls and ceilings

population: the organisms, collectively, inhabiting an area or region

precipitation: any or all forms of liquid or solid water particles that fall from the atmosphere and reach the Earth's surface

predator: an animal that lives by hunting and killing other animals for food

preen: to smooth with the bill, to make one's appearance neat and tidy

pre-historic: being in existence in the period before written history began

prescribed burn: a fire that is planned; management-ignited fire. These fires are often set to reduce the potential or a hot, uncontrolled fire in the area, or to restore a more natural balance in an area that burned more frequently naturally, but has experienced extensive fire suspension.

preservation: action taken by humans to help protect wilderness lands, historic buildings or other places for the enjoyment of future generations

prey: an animal that is hunted or caught by another animal for food

pulaski: Named for a famous firefighter, the Pulaski is a tool used as an ax or a hoe to cut and remove fuels.

pup: a baby bat

rabies: an infectious viral disease of mammals, usually transmitted through a bite

regurgitate: to bring back up to the mouth, partly digested food

raptor: a bird, which hunts at night for rodents and small birds

reef: a ridge of rock, coral or sand at, or near, the surface of the water

renewable resource: a resource that can be replaced through natural processes if it is not overused or contaminated

reptile: a cold-blood vertebrate, dry-skinned vertebrate that usually has scaly skin and typically lays shelled eggs on land. Most reptiles do not go through metamorphosis. Lizards, snakes and turtles are examples of reptiles.

respiration: exchange of gases (oxygen in; carbon dioxide out) between living cells (plants and animal) and the environment, including oxidation and the release of energy

rimstone dam: calcium carbonate deposits located on cave floors that usually impound small pools of water

riparian: of, pertaining to, or living on the bank of a river, lake or tidewater

rocks: composed of single mineral or mixture of mineral and are called igneous, sedimentary or metamorphic, according to how they were formed

rods: The eye's rods allow people and animals to see light.

rodent: a mammal that has one pair of continuously growing incisors in each jaw

roost: resting place, usually for bats and birds; also, to rest in such a place

roots: the part of a plant that is usually underground

sedimentary rock: rock made of particles of rock, minerals, plants and animals matter that have been squeezed and cemented together by heat, pressure and chemical actions

sediments: deposits of sand, mineral fragments or sometimes-organic matter usually laid down by water but sometimes deposited by wind or glaciers

seed dispersal: the act of transporting seeds from the parent plant to new locations where seeds are more likely to survive. When forests are cleared, they cannot regenerate without seed dispersal.

shelf stone: a flat shelf or stone formed in a cave pool

show cave: a cave which has been made available for safe public exploration and tours

shrew: a small mouse-like animal with a long pointed snout and tiny eyes that lives on insects and worms

skeleton: the hard framework of an animal body that supports the tissues and protects the organs

soda straw: thin-walled hollow tube speleothems about ¼-inch diameter. They grow from ceiling of caves as water runs down inside them and deposit rings of calcite at their tips.

solar: having to do with the sun

solutional cave: a cave that is formed in rock that can be dissolved by acidic groundwater. Most solutional caves form in limestone, dolomite, gypsum and marble.

sonar: SONAR is an acronym for “sound navigation ranging”—a system developed by scientists to locate objects under water by sending out signals and listening to the echo; echolocation

sound waves: waves of energy in the atmosphere that are generated by sound

species: a genetically and adaptively unique plant or animal, which is able to reproduce itself

specimen: a part or individual used as a sample of a whole or group

speleology: the science of the cave environment, including both the physical and the biological aspects

speleothem: cave formation; cave decoration; a secondary mineral deposit formed in caves, such as stalactites and stalagmites. It is derived from two Greek words “spelaion” meaning cave and “thema” meaning deposit.

spelunker: an outdated term for a person who explores caves; caver

spot fires: new fires started from embers blowing from the main fire

stalactite: a speleothem that hangs down from cave ceilings and can form as layers of calcite are deposited by water flowing over the outside of soda straws. They form after the centers of the hollow soda straws become plugged or partially plugged. They can also form by water leaving deposits on the cave ceiling.

stalagmite: a speleothem that rises upward from the floor of a cave passage. They are often, but not always, formed by dripping water from stalactites above. They are usually larger in diameter than stalactites and more rounded at the top.

stewardship: responsible service

sulfuric acid: a highly corrosive acid created by the combination of hydrogen sulfide gas and water. It readily dissolves limestone and leaves gypsum as one of the residues of the chemical reaction.

symmetrical: something that has corresponding form, size and/or arrangement of parts in its two opposite halves

synthetic: something artificial or man-made, not of natural origin

temperature: the degree of hotness or coldness of anything

thermometer: a device for measuring temperature

threatened species: a species that is not yet endangered, but whose populations are heading in that direction

topography: the physical features of a district or region, such as the relief and contour of the land

topographical map: a map of the surface features of an area that uses contour lines

transpiration: loss of water from plants into the surrounding atmosphere; the giving off of moisture through the pores on the surface of leaves and other parts of plants

tree: a large, woody perennial plant with one main trunk and many branches

trigonometry: a form of mathematics used in surveying

trilobite: a crab-like invertebrate that became extinct

tropical rain forest: an evergreen forest located at low elevations in regions between the Tropics of Cancer and Capricorn

troglobite: an animal which spends its entire life in a cave's total darkness and uniform environment; nickname – cave dweller

troglophile: an animal that lives above ground, but can live above-ground; nickname – cave lover

trogloxene: an animal that lives above ground, but visits caves occasionally; nickname – cave guest

twilight zone: the area of a cave that has very little natural light

ultrasonic: having a frequency above the human ear's audibility limit of about 20,000 cycles per second; sound often too high a pitch for humans to hear

uplift: the process by which tectonic forces (forces that cause sea floors to spread and continents to move apart as new crust is created at mid-ocean ridge) push rocks upward

vandalism: the willful or malicious destruction or damage of any public or private property

velocity: quickness of motion; speed

Venn diagram: a diagram that uses overlapping circles to show relationships between sets

vertebrate: an animal with a backbone, skull and skeleton of cartilage or bone

vibration: a rapid rhythmic, back and forth motion

warm-blooded: endothermic; being able to maintain a constant body temperature independent of the outside temperature. Mammals and birds are warm-blooded.

water table: the boundary between underground areas that are saturated by water and unsaturated; the level of standing groundwater beneath the earth's surface

weather: condition of atmosphere, determined by air pressure, heat, wind and water

wild cave: a cave that does not have improvements, such as lights, stairs and railings for visitor safety

wildfire: an unwanted wildland fire

wildland fire: any non-structure fire, other than a prescribed fire (management ignited fire), that occurs in the wildland

Section 14 – Content Standards with Benchmarks

Science

Unifying Concepts

CONTENT STANDARD #1 – Students will understand science concepts of order and organization.

SC1-E1 – Students will demonstrate knowledge and understanding that science is based on the assumption that the environment is understandable and predictable.

CONTENT STANDARD #2 – Students will use evidence, models and explanations to explore the physical world.

SC2-E1 – Students will use evidence to understand interactions that allow prediction of changes in natural and artificial systems.

SC2-E2 – Students will describe different terms such as hypothesis, model, law, theory, principle and paradigm.

SC2-E3 – Students will recognize models as representations of real objects and events, and explain how the models work.

SC2-M3 – Students will design and develop models.

SC2-H3 – Students will analyze models for limitations, strengths and basic assumptions.

CONTENT STANDARD #3 – Students will use form and function to organize and understand the physical world.

SC3-E1 – Students will describe form and function as complementary aspects of units of matter, objects, organisms and systems.

CONTENT STANDARD #4 – Students will understand the physical world through the concepts of change, equilibrium and measurement.

SC4-M3 – Students will use elementary scientific devices to measure objects and simple phenomena.

Science as Inquiry

CONTENT STANDARD #5 – Students will acquire the abilities to do scientific inquiry.

SC5-E1 – Students will describe the scientific method.

- identification of a problem
- research literature review

- development of an hypothesis or research question
- design of an experiment or research
- use of cooperative teams composed of individuals with different kinds of expertise to conduct research
- collection of data
- evaluation of data in relation to the hypothesis
- communication of the problems, the evidence and the conclusions

SC5-E2 – Students will describe and use simple equipment, tools, techniques and a variety of information sources to gather data and extend the senses.

SC5-M2 – Students will employ equipment, tools, a variety of techniques and information sources to gather, analyze and interpret data.

CONTENT STANDARD #6 – Students will understand the process of scientific inquiry.

SC6-E1 – Students will describe the different methods used in the process of scientific investigation for—asking questions (formulating hypotheses), answering questions, comparing the answers to what scientists already know.

SC6-E2 – Students will explain that scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).

SC6-E4 – Students will explain that scientists use different kinds of investigations depending upon the questions they are trying to answer.

SC6-M1 – Students will use different kinds of methods, including observation, experiments, and theoretical and mathematical models to answer a variety of scientific questions.

SC6-M2 – Students will use their own understanding of science to guide their scientific investigations.

SC6-M4 – Students will choose appropriate methods and analytic techniques for specific science problems and investigations.

SC6-M5 – Students will use technology and scientific methods to gather evidence to enhance the accuracy of their findings.

SC6-M6 – Students will describe the result of investigations with teachers, peers, parents and others.

SC6-H1 – Students will develop causal functional questions to guide investigations.

SC6-H4 – Students will use evidence to understand data and to develop consistent arguments to logically explain data.

SC6-H6 – Students will explain and interpret the results of investigations to teachers, peers, parents and others.

Physical Science

CONTENT STANDARD #7 – Students will describe the observable properties of objects and materials.

SC7-E1 – Students will describe the observable properties of objects and materials.

CONTENT STANDARD #9 – Students will know and understand the concepts of energy and the transformation of energy.

SC9-E1 – Students will describe the basic characteristics of light, heat, sound and electromagnetism, and explain that energy exists in many forms and can be transformed.

SC9-E2 – Students will describe the process of chemical reactions and how time is a factor in chemical reactions.

SC9-M1 – Students will apply knowledge about energy and energy transformation to science problems.

SC9-M2 – Students will explain how chemical reactions can take place in time periods ranging from less than a second to million of years.

SC9-M3 – Students will explain how chemical reactions involve concentration, pressure, temperature and catalysts.

Life Science

CONTENT STANDARD #10 – Students will know and understand the characteristics that are the basis for classifying organisms.

SC10-E1 – Students will demonstrate awareness of living things

- as single or multicellular with basic needs
- as surviving in environments that meet their needs with different structures that serve different functions in growth, survival and reproduction
- as part of systems such as food chains as capable of gathering information about themselves and their environment through senses
- as similar within species but unique as individuals

SC10-E2 – Students will describe life cycles of plants and animals.

SC10-M1 – Students will use information about living things.

- the roles of structure and function as complementary in the organization of living systems
- cells as the fundamental unit of life
- the functions of cells which sustain life
  cell division
- the use of nutrients by cells
- the role of heredity and environment in the characteristics of individual organisms

- that small differences between offspring and parents may accumulate in succeeding generations and may or may not be advantageous for the species

SC10-M2
Students will categorize organisms according to reproductive and other characteristics.

SC10-H2
Students will use biological classifications to sort organisms and understand how they are related.

CONTENT STANDARD #11 – Students will know and understand the synergy among organisms and the environments of organisms.

SC11-E1 – Students will explain how an organism's patterns of behavior are related to its environment.

SC11-E2 – Students will describe how all animals depend on plants for food, either directly or indirectly.

SC11-E3 – Students will describe how organisms cause changes in their environments.

SC11-E6 – Students will describe the impact humans have on other species.

SC11-E7 – Students will describe various kinds of resources, such as food, fuel and building materials.

SC11-E9 – Students will describe basic human needs including air, food, water, safety and security.

SC11-E10 – Students will identify issues of responsibility for health.

SC11-M1 – Students will distinguish among organisms based on the way an organism regulates its internal environment in relation to changes in its external environment.

SC11-M2 – Students will describe how organisms obtain and use resources, grow, reproduce and maintain a stable internal environment while living in a constantly changing external environment.

SC11-M3 – Students will predict behavior in relation to changes in an organism's internal and external environments.

SC11-M6 – Students will examine the impact humans have had on other species and natural systems over time.

SC11-M9 – Students will illustrate the role of personal control of basic needs on health outcomes.

SC11-H10 – Students will model responsible health behaviors for peers and others.

SC11-H3 – Students will predict an organism's behavioral responses to external stimuli as a function of inherited and acquired characteristics.

SC11-H6 – Students will predict the impact humans might have on species and environmental systems.

SC11-H9 – Students will evaluate the interaction of multiple factors such as risk, environment and desire on choices for meeting basic human needs.

Earth and Space Science

CONTENT STANDARD #12 – Students will know and understand properties of Earth Science.

SC12-E1 – Students will describe the physical and chemical properties of Earth's materials and the states of matter.

SC12-E2 – Students will describe the uses of Earth's materials as resources and the sun as the major source of external energy for the Earth.

SC12-E3 – Students will describe changes in Earth's surface.

SC12-E5 – Students will use fossil and other evidence to investigate how the Earth has changed or remained constant.

SC12-M3 – Students will model natural processes that shape the Earth's surface.

SC12-M4 – Students will observe, measure and record weather changes daily.

SC12-M5 – Students will explain how fossils are formed and how fossils provide evidence of the complexity and diversity of life over time.

SC12-M6 – Students will use a rectilinear coordinate system such as latitude and longitude to locate points on the surface of Earth.

CONTENT STANDARD #13 – Students will know and understand basic concepts of cosmology.

SC13-E1 – Students will describe the pattern of movement of objects in the sky.

Technology and Science in Society

CONTENT STANDARD #16 – Students will know and understand the relationship between natural hazards and environmental risks for organisms.

SC16-E1 – Students will identify environmental risks including natural hazards related to internal and external processes of Earth's systems (weather, geochemical) and social hazards (occupational, recreational and personal).

SC16-E2 – Students will describe methods to reduce environmental risks.

SC16-E3 – Students will identify factors that change environments rapidly and slowly.

SC16-E4 – Students will describe factors such as drugs, disease and environmental hazards that can have negative health consequences.

SC16-M2 – Students will determine options for reducing and eliminating environmental risks and for coping with natural catastrophic events.

SC16-H2 – Students will evaluate human activities for the potential they have for increasing or decreasing environmental risks.

Language Arts

Unifying Concepts

CONTENT STANDARD #1 – Students will understand and use language arts for communication.

LA1-E2 – Students will acquire, develop and use vocabulary and linguistic skills to communicate effectively.

LA1-M2 – Students will use expanded vocabulary and linguistic skills to communicate effectively.

CONTENT STANDARD #2 – Students will understand and use language as a learning tool.

LA2-E1 – Students will use language arts skills and knowledge in all curriculum areas.

LA2-E4 – Students will acquire critical thinking skills in listening, speaking, reading and writing.

LA2-M1 – Students will apply language arts knowledge and skills to solve problems that arise in other curriculum areas.

LA2-M2 – Students will use language to understand various sources of information, local traditions and cultural as resources for learning.

LA2-H1 – Students will analyze, understand and use the connections between language arts and other disciplines.

LA2-H2 – Students analyze and effectively understand and use the applications of language in the daily life of many cultures.

Receptive Language

CONTENT STANDARD #3 – Students will listen and read for a variety of purposes.

LA3-E3 – Students will acquire vocabulary through listening, reading, observing and interacting with others.

LA3-M3 – Students will increase and use vocabulary through listening, reading, observing and interacting with others.

LA3-H3 – Students will increase and refine the use of vocabulary appropriate to specific purposes.

CONTENT STANDARD #4 – Students will use a variety of listening and reading strategies appropriately.

LA4-E1 – Students will acquire basic listening skills.

LA4-E7 – Students will refine the use of social skills of audience behavior in a variety of settings.

LA4-M1 – Students will use active listening skills to acquire information.

LA4-M4 – Students will demonstrate comprehension of written and spoken language.

Expressive Language

CONTENT STANDARD #5 – Students will speak clearly and write effectively for a variety of audiences and purposes.

LA5-E1 – Students will develop and use a range of skills for speaking.

LA5-E2 – Students will develop a range of writing skills by writing on a regular basis.

LA5-E3 – Students will express facts, ideas and opinions in a variety of settings.

LA5-E5 – Students will participate in drama, music, poems and stories.

LA5-M3 – Students will express facts, ideas and opinions in a variety of settings in oral and written form.

LA5-H3 – Students will express facts, ideas and opinions clearly, articulately and appropriately for a specific purpose or audience.

Aesthetics

CONTENT STANDARD #8 – Students will appreciate and respect their own language, culture and literature, and will learn about the languages, cultures and literature of others.

LA8-E5 – Students will share responses with peers to oral and written materials.

CONTENT STANDARD #9 – Students will use language and literature to gain insight into their own and others' lives, and to build understanding of moral and aesthetic dimensions of human experience.

LA9-E1 – Students will use language to share experiences.

CONTENT STANDARD #10 – Students will use state-of-the-art computer and other technology to gather, use and synthesize information, and to create and communicate knowledge.

LA10-M3 – Students will use available technology to locate, organize and present information.

LA10-H3 – Students will use available technology to locate information and create quality products.

LA10-H4 – Students will develop documents and presentations for a variety of purposes using multiple types of technology.

Mathematics

Unifying Concepts

CONTENT STANDARD #1 – Students will understand and use mathematics in problem solving.

MA1-E1 – Students will use problem-solving approaches to investigate and understand mathematical content.

MA1-E4 – Students will verify and interpret results with respect to the original problem situation.

MA1-E5 – Students will use manipulatives, calculators, computers and other tools (as appropriate) in order to strengthen mathematical thinking, understanding and power to build upon foundational concepts.

MA1-M1 – Students will differentiate among problem-solving approaches to investigate and understand mathematical content.

MA1-M2 – Students will formulate problems from community mathematical situations.

MA1-M4 – Students will verify and interpret results with respect to the original problem situation.

MA1-M6 – Students will use manipulatives, calculators, computers and other tools (as appropriate) in order to strengthen mathematical thinking, understanding and power to build upon foundational concepts.

CONTENT STANDARD #2 – Students will understand and use mathematics in communication.

MA2-E2 – Students will use drawings, discussion, reading, writing and listening to access, learn and communicate mathematical ideas.

MA2-E3 – Students will use a variety of media and methods to communicate mathematical concepts, thoughts and problem solutions including charts, slides, graphs, maps, drawings, pictures, sound recordings, video, e-mail and others.

MA2-M2 – Students will use drawings, discussion, reading, writing and listening to access, learn and communicate mathematical ideas.

MA2-M3 – Students will create and use a variety of media and methods to communicate mathematical concepts, thoughts and problem solutions including charts, slides, graphs, maps, drawings, pictures, sound recordings, video, e-mail and others.

CONTENT STANDARD #3 – Students will understand and use mathematics in reasoning.

MA3-E1 – Students will describe logical conclusions in mathematics.

MA3-E2 – Students will use information sources, models, known facts, properties and relationships to explain mathematical thinking.

CONTENT STANDARD #4 – Students will understand and use mathematical connections.

MA4-E4 – Students will use mathematics in other curriculum areas.

MA4-M2 – Students will describe how mathematics is integrated throughout the school and surrounding environment.

MA4-M4 – Students will apply mathematical thinking and modeling to solve problems in other curriculum areas such as employability, health education, social studies, visual and performing arts, physical education, language arts and science.

Numbers and Operations

CONTENT STANDARD #7 – Students will understand and use computation and estimation.

MA7-E1 – Students will model, explain and develop proficiency with basic number facts and algorithms (be competent in addition, subtraction, multiplication and division of whole numbers).

MA7-M4 – Students will use computation, estimation and proportions to solve problems.

Geometry and Measurement

CONTENT STANDARD #9 – Students will understand and use measurement.

MA9-E3 – Students will make and use estimates of measurements.

MA9-M3 – Students will estimate, make and use measurements to describe and compare.

Statistics and Probability

CONTENT STANDARD #10 – Students will understand and use statistics.

MA10-M3 – Students will make inferences and convincing arguments based on data analysis.

Social Studies

Unifying Concepts

CONTENT STANDARD #3 – Students will know, understand and apply the language, tools and skills of social studies.

SS3-M2 – Students will interpret and report social studies information from diverse sources (people, media, technology, computers and libraries).

History

CONTENT STANDARD #4 – Students will know and understand the ways in which human beings view themselves and others over time.

SS4-E1 – Students will recognize that people may describe the same event or situation in different ways.

SS4-E2 – Students will describe how past events, people and places are recounted in stories, pictures and historical accounts.

SS4-E3 – Students will use various sources such as documents, letters, diaries, maps, textbooks, photos, petroglyphs and oral histories to understand the past.

SS4-E4 – Students will develop good questioning skills and techniques.

SS4-M4 – Students will investigate the past using a variety of sources in order to understand the present and prepare for the future.

CONTENT STANDARD #5 – Students will know and understand relationships and patterns in history in order to understand the past and present and to prepare for the future.

SS5-E2 – Students will identify the people, events, places and ideas that created the prehistory and history of New Mexico.

SS5-E3 – Students will identify the people, events, places and ideas that created the history and prehistory of the United States and the Americas.

SS5-M2 – Students will explain how the people, events, problems and ideas created the prehistory and history of New Mexico.

SS5-M3 – Students will explain how the people, events, places, problems and ideas created the prehistory and history of the United States and the Western Hemisphere.

SS5-H2 – Students will investigate and analyze the people, events, problems and ideas that created the prehistory and history of New Mexico and the Southwest.

SS5-H3 – Students will investigate and analyze the people, events, problems and ideas that created the prehistory and history of the United States and Western Hemisphere.

Cultures

CONTENT STANDARD #6 – Students will know and understand how personal and group identities are shaped by culture, physical environment, individuals, groups and institutions.

SS6-M2 – Students will evaluate ways regional, ethnic and national cultures influence individual's daily lives.

Geography

CONTENT STANDARD #11 – Students will know and understand the diverse, dynamic and ever-changing nature of culture.

SS11-E1 – Students will compare ways in which groups, societies and cultures address similar human needs.

SS11-E2 – Students will demonstrate how languages, stories, folktales, music, media, food and other artistic creations and performances serve as expressions of culture and influence the behavior of people.

SS11-E3 – Students will explore how people and their physical environments interact.

SS11-M2 – Students will demonstrate and explore how language, literature, the arts, media, architecture, other artifacts, traditions, beliefs, values and behaviors contribute to the development and transmission of culture.

SS11-M3 – Students will examine how people and cultures respond to, interact with and/or influence their physical environment.

CONTENT STANDARD #12 – Students will know and understand physical environments and their relationships to ecosystems and human activities.

SS12-E1 – Students will use geographic tools to find direction, size and shape, and show relative location.

SS12-E2 – Students will use basic spatial concepts such as location, distance, direction and scale as tools for mapping.

SS12-E3 – Students will identify varying land forms and geographic features such as mountains, plateaus, islands and oceans as components of Earth's physical systems.

SS12-E5 – Students will demonstrate how human interactions with the physical environment is reflected in the use of land, building of towns/cities and ecosystem changes in selected locales and regions.

SS12-E8 – Students will explain how people create uses for land and other resources.

SS12-M1 – Students will construct and interpret physical and mental maps of locales, regions of the world to show relative location, direction, size and shapes.

SS12-M2 – Students will use geographic tools and resources such as aerial photographs, satellite images, geographic information systems, map projections, atlases, gazetteers and other forms of cartography to generate and interpret information.

SS12-M5 – Students will understand the interrelated physical and cultural patterns reflected in land use, settlement patterns, cultural transmissions of customs and ideas and changes to the ecosystem.

SS12-M8 – Students will examine and debate uses of land and resources.

SS12-H7 – Students will evaluate information from different theories using a range of philosophies to explore diverse uses of land and resources.

SS12-H9 – Students will evaluate information from different theories using a range of philosophies to explore diverse uses of land and resources.

Arts Education

Unifying Concepts

CONTENT STANDARD #1 – Students will learn and develop the essential skills and technical demands unique to dance, music, theatre/drama and visual arts.

THEATRE

AE1-E10 – Students will imagine and construct technical elements for classroom dramatizations (e.g. simple sets, props, costumes, make up and/or sound effects).

AE1-M10 – Students will practice acting skills to develop characterizations that suggest or illustrate artistic choice.

VISUAL ARTS

AE1-E13 – Students will participate in the process of making art to understand the elements of art (line, shape, form, color and texture).

AE1-E14 – Students will explore and become familiar with art materials and their related techniques.

AE1-E15 – Students will use are materials and tools in a safe and responsible manner.

AE1-M14 – Students will explore are materials, techniques, qualities, characteristics and processes; understand what makes them effective in solving specific art problems and how they are used to enhance life experiences and ideas.

CONTENT STANDARD #2 – Students will use dance, music, theatre/drama and visual arts to express ideas.

VISUAL ARTS

AE2-E7 – Students will know and use art to interpret personal ideas, feelings and experiences through visual form.

CONTENT STANDARD #3 – Students will integrate understanding of visual and performing arts by seeking connections and parallels among arts disciplines as well as all other content areas.

THEATRE

AE3-E9 – Students will describe visual, aural and kinetic elements in theatre, dramatic media, dance, music and visual arts.

VISUAL ARTS

AE3-E11 – Students will identify and apply connections between the visual arts and other disciplines in the local curriculum.

CONTENT STANDARD #6 – Students will show increased awareness of diverse peoples and cultures through visual and performing arts.

VISUAL ARTS

AE6-E7 – Students will identify specific works of arts as belonging to particular cultures, times and places.

THEATRE

AE6-M6 – Students will explore similarities between life and theatre.

CONTENT STANDARD #8 – Students will contribute to communities by sharing expertise in dance, music, theatre/drama and visual arts and by participating in the activities of cultural institutions.

VISUAL ARTS

AE8-M9 – Students will create an exhibition showing artistic expertise of students.

Section 15 – References

AIMS Education Foundation. *Bats Incredible.* Fresno CA 1993.

American Cave Conservation Association, Inc. *Learning to Live with Caves and Karst*. *A Cave and Karst Curriculum and Resource Guide.* American Cave Conservation Association, Inc., Horse Cave KY, 1994.

American Forest Foundation. *Environmental Education Activity Guide*. Washington, DC, 1993.

American Geological Institute. *Dictionary of Geologic Terms*. Anchor/Doubleday, Garden City NY, 1976.

Bat Conservation International. *Educator's Activity Book about Bats*. Austin TX, 1991.

Bowden, Marica. *Nature for the Very Young*. John Wiley and Sons, 1989.

Caduto, Michael J. and Bruchau, Joseph. *Keepers of the Earth*. Fulcrum, Inc., Golden CO, 1988.

Collins, Jr., Henry Hill. *Complete Field Guide to American Wildlife*. Murray Printing, Forge Village MA, 1959.

Cornell, Joseph. *Sharing Nature with Children.* Dawn Publications, Nevada City CA 1979.

Cornell, Joseph. *Sharing the Joy of Nature*. Dawn Publications, Nevada City CA, 1989.

Cottrell, Jr., William H. *The Book of Fire*. Mountain Press Publishing Company, 1989.

de Golia, Jack. *Fire, A Force of Nature*. KC Publications, Las Vegas NV, 1989.

Densmore, Frances. *How Indians Used Wild Plants for Food, Medicine and Crafts*. Dover NY, 1974.

Educational Service, Inc. *Inquire*. Educational Service, Stevensville MI, 1976.

Everglades National Park. *An Activity Guide for Teachers: Everglades National Park*. FL

Hill, Carol, "Geological Walking Tour of Carlsbad Cavern." *New Mexico Geological Society Guidebook*. 44th Field Conference, Carlsbad Region, New Mexico and West Texas. 1993.

Lawrence Hall of Science. *Earth, Moon and Stars*. University of California, Berkeley CA, 1986.

Richmond Area Speleological Society. *Project Underground: A Natural Resource Education Guide*. Project Underground Inc., Richmond VA, 1993.

Moore, George W. and Sullivan, G. Nicholas. *Speleology: The Study of Caves*. Cave Books, St. Louis MO, 1978.

National Wildlife Federation. *Nature Scope*. National Wildlife Federation, 1989.

Riverside Publishing Company. *Webster's II. New Riverside University Dictionary*. Houghton Mifflin, Boston MA, 1988.

Seabury, Debra L. and Peeples, Susan L. *Ready-to-Use Science Activities for the Elementary Classroom*. The Center for Applied Research in Education, Inc. West Nyack NY, 1987.

Silverstein, Shel. *The Giving Tree*. Harper & Row Publishers, NY.

Stebbins, Robert C. *A Field Guide to Western Reptiles and Amphibians*. Houghton Mifflin, Boston MA, 1966.

South Central Mountains RC&D and the New Mexico Forestry and Resources Conservation Division. *A Southwest Fire Ecology: A Teacher's Guide to Fire Ecology in New Mexico and the Southwest*. South Central Mountains RC & D and the New Mexico Forestry and Resources Conservation Division, 1990.

United States Department of the Interior. *Meet the Wildfire Prevention Team*. The Firehouse, Clovis CA.

United States Department of the Interior, National Park Service. *Carlsbad Caverns General Management Plan*. 1996.

Vequist, Gary. *Research in Carlsbad Caverns National Park: Scientific Exploration and Discovery*. Caverns Guadalupe Mountains Association and the National Park Service, 1997.

Western Regional Environmental Education Council. *Project Wild*. Western Regional Environmental Education Council, 1986.

Section 16 – Evaluation Forms

Evaluation Form

About Bats, Caves and Deserts:
Carlsbad Caverns National Park's Book for Teachers

Name of School_____

City or County, State_____

Grade Level of Students _____ Date(s) _____

List all the activities you used.

CIRCLE the ones you liked. DRAW A LINE THROUGH any that you did not like.

1.

2.

3.

4.

I recommend the following changes, additions or deletions to this book.

_____

_____

_____

_____

_____

Were the activities developmentally and academically appropriate?

Did the activities reinforce your curriculum?

Did the activities stimulate your students' interests?

Were the information sheets in Section 2 helpful?

Evaluation Form

Carlsbad Caverns National Park's Report Card
Grades Assigned by Students Who Went on a Field Trip to the Park

Date you visited the park with your school group:_____

Your School:_____

Your Grade:_____

What did you do during your visit? _____
Please assign a grade – A, B, C, D, F

Park Rangers' Friendliness

Park Rangers' Knowledge

Exhibits in the Visitor Center

Informational Signs and Brochures

What did you like the most about your field trip?

What did you like the least about your field trip?

List three things you learned during your park visit.

1.

2.

3.

Evaluation Form

Carlsbad Caverns National Park's Report Card
Grades Assigned by Teacher Whose Students Participated in the Field Trip

Date of Field Trip: _____

School: _____

Grade Level(s): _____

Please rank your park experience on a scale of 1 to 7/ (1 represents the worse score possible experience and 7 represents the best possible experience)

Friendliness and Helpfulness of Park Rangers

Knowledge of Park Rangers

Fee Waiver Process

Reservation System

Self-Guided Tour of Big Room

Ranger-Led Program or Tour, if applicable

CD Audio Guide, if applicable

Comments:
_____
_____
_____