CANYONS & CAVES

A Newsletter from the Resource Management Offices Carlsbad Caverns National Park

Issue No. 11 **Winter 1998**

Edited by Dale L. Pate
Special Thanks to Paula Bauer and Bill Bentley

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RESOURCE NEWS

LECHUGUILLA CAVE SURPASSES 100 MILES – A survey expedition led by Peter and Dave Jones and just completed (December 1998), added over 6,000 feet of new survey to the known length of Lechuguilla Cave. This brings the total length of surveyed passages to approximately 100.5 miles (161.7 kilometers). A more exact figure will be released as soon as possible.

OTHER LECHUGUILLA NEWS – The October 1998 LEARN survey and exploration expedition in Lechuguilla Cave netted 3,115 feet of survey bringing the total length of the cave to 99.32 miles (159.8 kilometers). Donald Davis continued his project of measuring significant speleothems on this expedition. In Tower Place, he measured a soda straw to be 18.77 feet long, a stalactite at 58.8 feet long, and a stalagmite to be 62.4 feet high.

SAR TECHNICAL RESCUE EXERCISE - A total of 13 park staff members participated in a 3-day SAR training exercise from November 18-20, 1998. The three goals for the exercise were (1) to work as a team to learn rescue techniques for vertical rescues, (2) assure safety for all participants as well as the patients, and (3) to protect natural resources while effecting the rescues. The first day consisted of classroom, hands-on work including knot-tying, anchors, rigging, patient assessment, and patient packaging. The second day was a field day where everything was practiced on a small cliff along the Desert Loop Drive, including the use of live patients. The third day saw the group lowering and raising a patient in a SKED on a drop of 60-feet inside Chimney Cave. All participants did an excellent job. Participants for the exercise were: Stan Allison, Paula Bauer, Tom Bemis, Richard Banuelos, Chris Burns, Lyn Carranza, Craig Digulio, Laura Denny, David Elkowitz, Lance Mattson, Dale Pate, Jason Richards, and Clarence Wadkins.

NEW PARK WATERLINE – Work is in progress on the new waterline for the park. Over 3 miles of trench has been excavated of the total 5-mile length below the escarpment. Progress has been slowed in places because of the lack of approval from the State Historic Preservation Office (SHPO) dealing with compliance issues and also because of contractor encroachment outside the existing water line right-of-way. Construction has started for the new water tank, building and evaporation pond to be located at the bottom of the escarpment. This new tank will replace the smaller of the two water tanks now located west of the Visitor Center.

RATTLESNAKE SPRINGS AQUIFER - Erika Bowen of New Mexico Tech. Univ. has completed her study on the aquifer that feeds Rattlesnake Springs. This spring is emanating from the conglomerate and alluvial fan from Slaughter Canyon. The study was initiated because of concern over the possible contamination of Rattlesnake Springs from oil and gas activities in the area. This alluvial aquifer is not hydraulically connected to the Capitan aquifer within the Capitan Reef because of geological constraints. Recharge to the springs occurs from high intensity, short duration rainstorms in Slaughter Canyon. Water flows through the gravel in the canyon and as it leaves the canyon, flows into "fingers" or different pathways within the gravel of the alluvial fan. The water tends to stay within these "fingers" of gravel because of the harder, less soluble Castile Formation found below it. Water chemistry data indicates that these "fingers" are separate pathways. The pathway to Rattlesnake Springs contains the best water quality while the pathways to the springs on the Black River contain dissolved sulfates of greater than 1,000 parts per million, which is over five times higher than the waters from Rattlesnake Springs. These pathways seem to maintain separate channels so there is an unlikely risk of contamination from a leak of hydrocarbons at the El Paso Natural Gas Facility. The average discharge at Rattlesnake Springs is 3.2 cubic feet per second (450 gallons per minute). The nearby agricultural groundwater pumping, which when active is 1,200 gallons per minute, draws down the level of the spring pond for short durations, but at current use levels does not seem to degrade longterm spring flow. Erika Bowen will give a presentation concerning her research to park staff at the Visitor Center Theater at 11 am on January 7, 1998.

The NATIONAL CAVE & KARST RESEARCH INSTITUTE ACT OF 1997 was signed into law by President Clinton on October 30, 1998. This bill establishes the Institute in the Carlsbad, New Mexico area and states that the Institute will be administered by the National Park Service in conjunction will another institution. The purposes of the act are as follows: to further the science of speleology, to centralize and standardize speleological information, to foster interdisciplinary cooperation in cave and karst research programs, to promote national and international cooperation in protecting the environment for the benefit of cave and karst landforms, and to promote and develop environmentally sound and sustainable resource management practices.

WELCOME to Scott Sievertsen. He will be working with the Cave Resources Office as a SCA. Scott has most recently worked as a seasonal in Interpretation at Jewel Cave.

A NEW ERA IN PEST MANAGEMENT

by Renee Beymer

This past summer the housing and visitor use areas at Carlsbad Caverns National Park saw a major influx of skunks. The dry conditions created a situation where the skunks became attracted to this area because of more readily available food and water. The skunks under natural conditions would not be in large numbers in such a small area. In this situation, the skunks have become pests. Webster's dictionary defines a pest as the following: *1. A nuisance. 2. An injurious animal or plant, especially one harmful to humans. 3. a pestilence.* Carlsbad Caverns National Park officially adopted its first Integrated Pest Management (IPM) Plan in May 1998. This plan--to be reviewed every four years--spells out methods by which the park can effectively and safely manage pests.

Integrated pest management coordinates all available biological, environmental and modern pest management technology. This is an attempt to prevent unacceptable levels of pest damage through the most economical means available and with the fewest possible pesticide hazards to people and the environment. This approach relies on cost-effective and site-specific pest controls, decision-making processes, and risk reduction systems. Unlike any given single method of pest control, the IPM approach is more effective than traditional methods because it combines tactics like sanitation, monitoring, exclusion, habitat modification, and (only when necessary) judicious use of specific pesticides.

Controlling destructive pests, such as termites, or rodents in buildings, is important to preserve the natural and cultural resources in the park and to protect the health, safety, and comfort of park staff, residents, and visitors. The best approach to resolving pest problems in the park makes use of a full array of IPM methods, including mechanical, physical, cultural, and chemical controls. [Cultural controls means changing our behaviors to avoid causing pest problems.] All actions to reduce pest threats at CAVE must begin by limiting *unnatural* sources of food, water, and shelter, and making the structures and cultural resources as pest-proof as possible while preserving the desired uses and historic contexts.

Pest management is a program crossing several disciplines and all park divisions. Most park staff, from managers to residents, are involved in pest management activities at some time or another. If the program is to be effective, it is important for the entire staff (as well as concessionaires and other non-NPS interests in the park) to participate as a problem-solving "team". Various roles and responsibilities outlined in the plan for the park IPM program are (briefly) described below.

The **Superintendent** has overall responsibility for the park IPM program, with program implementation delegated to a designated park **IPM Coordinator**. The **Chief of Resources Management and Visitor Protection** oversees the IPM program, and his division prepares Resource Management Plan project statements covering significant IPM operations (such as weed control) and seeks funding for them.

The **IPM Coordinator** (Renée Beymer, ext. 364) is the focal point of all activities directly or indirectly related to pest management, including: maintenance, resource management, interpretation, planning and design, management of concessions and special use permits. Information exchange among these groups is a major responsibility of the park IPM coordinator, who should provide continuing education to park staff about IPM techniques.

The **Maintenance Division** plays a vital role in park pest management. The maintenance staff must be alert to conditions and signs of pests and pest damage during routine maintenance activities (i.e., rodent feces on office or visitor center floors, termite damage, rodent burrows under structures, evidence of bird nests, etc.) and should report their observations. Good sanitation in the visitor center and office buildings is essential to control pests. By promptly scheduling repairs of all reported structural, utility, or vegetative deficiencies that support or encourage pest infestations and removing construction or other non-functional debris (rocks, lumber, etc.) lying in or around park structures, we can minimize pest problems.

The **I &VS and RM&VP Divisions and other employees** can help control pests and the problems they create by picking up any food trash found in visitor areas (or anywhere else) and by reporting any conditions that appear favorable for pests.

The **Museum Curator** is responsible for maintaining a pest-free environment for historical artifacts and other objects stored in the museum collection.

Park Residents (including non-NPS residents) are responsible for assuring their quarters and surrounding areas are kept clean and do not attract or harbor pests. The prompt reporting of structural deficiencies and other pest-related maintenance needs will help in our battle to control pests.

The **Safety Officer** (Aleta Knight) serves an influential role in park pest management. During all safety inspections, the safety officer will watch for and report evidence of pests and any destructive or hazardous conditions caused by pests.

The **Concessions Manager** (also Aleta Knight) is responsible for assuring concessions and other non-federal operations are regularly inspected and monitored for pests.

Any conditions found that encourages pests, such as poor trash and garbage practices or poor sanitation, will be brought to the attention of the IPM Coordinator and the concessionaires.

Pests in the park can cause serious problems. Employees are encouraged to do their part by following good pest management practices. The Integrated Pest Management Plan goes into much more detail and is available from all division chiefs. If anyone has questions, please contact Renée Beymer at ext. 364.

POCKET GOPHERS (Family Geomyidae)

by Ken Geluso

Two species of pocket gophers inhabit Carlsbad Caverns National Park, the Yellow-faced Pocket Gopher (*Cratogeomys castanops*) and Botta's Pocket Gopher (*Thomomys bottae*). Although pocket gophers are fossorial rodents (burrowing animals) and are seldom seen above ground, their presence is easily detected because gophers deposit characteristic mounds of dirt on the surface of the ground as they excavate their underground burrows.

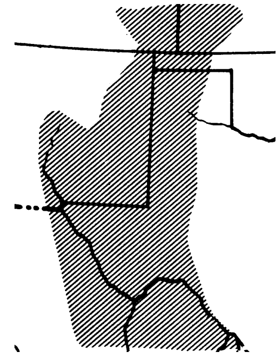
When fully grown, Yellow-faced pocket gophers from the park are three times larger than Botta's. Because of this substantial difference in body size, I found it fairly easy to identify burrow systems of these two species by measuring the diameter of their tunnels. The average diameter is 101 mm for *C. castanops* and 70 mm for *T. bottae.* By examining tunnel widths, I located one area in the park where these species live together.

YELLOW-FACED POCKET GOPHER (*Cratogeomys castanops*)

Yellow-faced pocket gophers are common only at Rattlesnake Springs. Earthen mounds made by this species were observed frequently on lawns of the picnic area and those around the ranger station, orchard, and pump house. Diggings also were numerous in fields adjacent to these lawns, although mounds are more difficult to spot in these situations of tall grass and weeds. Around the picnic area and in the fields, soils were well-developed, easy to dig with a shovel, and contained no rocks and only a few small stones. In contrast, the ground around the pump house was extremely difficult to dig because it contained numerous stones intermixed with the soil.

Because gopher activity at Rattlesnake Springs was always in habitats influenced by man, I was curious to determine if Yellow-faced pocket gophers also were responsible for diggings in a natural habitat adjacent to Rattlesnake Springs. This natural area lies just over the northern fence line across from the picnic area. Earthen mounds were in a small grassy area surrounded by littleleaf sumac, viscid acacia, javelina bush, tarbush, and creosote bush. Soil was friable, deep, easy to dig, and contained very few stones. At this location outside the park, I caught both Yellow-faced and Botta's pocket gophers in separate but nearby tunnel systems.

Range map of *Cratogeomys castanops* in North America north of Mexico. Illustration borrowed from the Peterson Field Guide Series titled "Mammals" by William Burt and Richard Grossenheider and published in 1980.



During midwinter, I noticed some large gopher mounds in the vicinity of the man-made earthen tank located by the Sewage Disposal Ponds. A flat, grassy wash with tall bushes intersects this earthen tank, and the surrounding habitat is desert scrubland. The gopher mounds were 12.8 meters from the edge of the tank in a disturbed area of bare ground. Soil at this local spot was compact, fairly easy to dig with a shovel, and contained some stones and small rocks. The top edge of the gopher's tunnel was 140 mm below the surface of the ground and it's opening was 100 mm in diameter. A very large male weighing 410 grams was captured in this tunnel system on February 14. This individual was the only Yellow-faced pocket gopher caught on park property outside of Rattlesnake Springs. This species was not present in other seabed habitats along the base of the escarpment nor was it present anywhere on the reef. Yellow-faced pocket gophers prefer the deeper soils of the park, and their altitudinal range extends only from 3,625 to 3,680 feet.

BOTTA'S POCKET GOPHER (*Thomomys bottae*)

Botta's pocket gophers are common and widely distributed in the park, being found from the lowest elevations of the seabed to the highest summits of the reef. Based on specimens from the park, the altitudinal range of this species extends from 3,625 to 6,450 feet. Botta's pocket gophers usually were found in shallow, rocky soils of the park. It was the only pocket gopher found on the reef. Some individuals, however, coexisted with Yellow-faced pocket gophers in the deep, rockless soils of Rattlesnake Springs

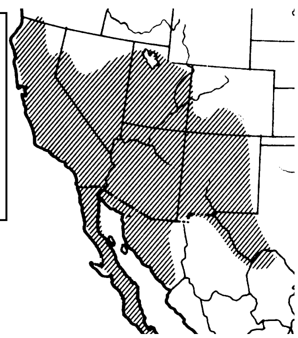
Botta's pocket gophers were found in all major habitats of the reef including its summits, the face of the escarpment, canyon floors, and canyon slopes. I observed workings of this species along tiers of narrow ledges located high on vertical cliff faces. On canyon floors, gophers lived on creek beds as well as on the higher grassy banks. In pine woodlands of the summit, mounds were noted at 6,470 feet. Excavations of Botta's pocket gopher were common around the residences near Carlsbad Cavern.

Botta's pocket gophers also were found in all major habitats of the seabed. In desert scrubland, most activity of this species occurred in rocky areas containing lechuguilla and grassy areas having tall bushes. Gophers also lived in the grasslands, alluvial fans, juniper plains, and wide draws.

As mentioned in the previous account, both Botta's and Yellow-faced pocket gophers were captured in close proximity to each other just outside Rattlesnake Springs. Knowing that Botta's pocket gophers were living so close to Rattlesnake Springs, I set additional traps in this area, but on park property. On February 9, traps were set in five separate burrows located along a three-foot wide strip of ground lying between a cement aqueduct and fence line. The soil along this strip was deep, friable, nearly stoneless, and very easy to dig.

After finding different burrow systems, it was readily apparent from the diameters of tunnels that both species were present at Rattlesnake Springs. After cutting into one horizontal tunnel and removing enough soil to set a pair of traps, I noticed that the tunnel opening was wide on one side and narrow on the other. Two gophers were captured together in this tunnel the following morning, a Yellow-faced pocket gopher from the larger opening and Botta's pocket gopher from the narrower one. On this same morning, two other gophers (one of each species in separate tunnel systems) were caught along this strip of ground at Rattlesnake Springs.

Range map of *Thomomys bottae* in North America north of Mexico. Illustration borrowed from the Peterson Field Guide Series titled "Mammals" by William Burt and Richard Grossenheider and published in 1980.



Botta's pocket gophers are known to eat the root of agaves. Some of the highest gopher activity on park property was in and around the large patches of lechuguilla growing in the desert scrubland. In pine woodlands of the summit, I captured two Botta's pocket gophers among patches of New Mexico agave that had been eaten by pocket gophers. Removing a dead or dying agave from the ground invariably reveals missing roots and a shallow gopher tunnel running beneath it.

This article was taken from a report titled "Rodents of Carlsbad Caverns National Park" by Ken Geluso which was completed in 1992.

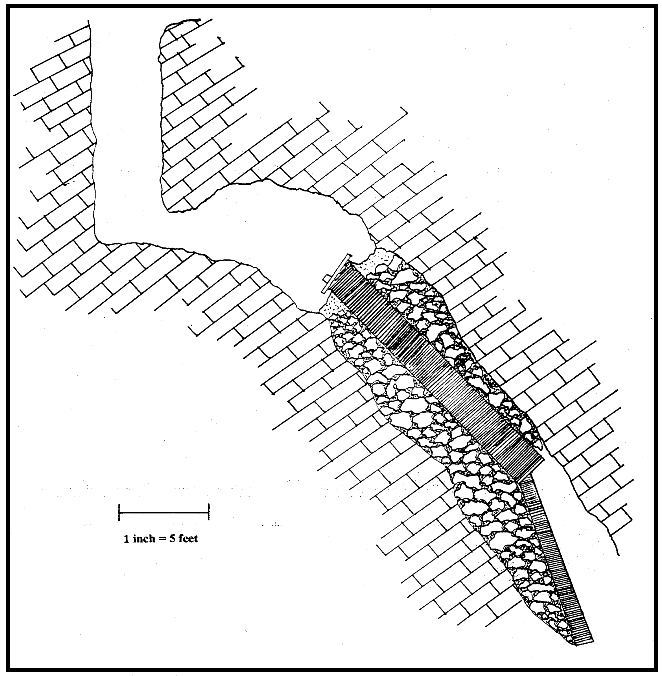
LECHUGUILLA CAVE CULVERT REPLACEMENT AN ENVIRONMENTAL ASSESSMENT

by Jason M. Richards

On May 26, 1986 a group of cavers from Colorado dug into the Lechuguilla Cave we know today. Four days later, a 16-foot long, 24-inch in diameter road culvert was installed through the alluvial backfill for safety reasons. Attached to the lower portion is a half-culvert 12-feet long for a total length of 28 feet. The Lechuguilla Cave culvert consists of three parts: a locking lid at the top, covering a 24-inch in diameter galvanized road culvert, and a braced half-culvert with a ladder and fencing at the bottom.

Lechuguilla Cave exchanges air at the culvert whenever barometric pressure changes. When barometric pressure drops, the cave exhales (blows out); on the other hand, when barometric pressure rises, the cave inhales (sucks in). During these barometric pressure changes, winds through the culvert have been clocked in excess of 60 miles per hour. Although an airlock lid has been installed, this harsh environment of humid air exchange has taken its toll on the culvert and its components throughout the years. Now, 12 years later, all the metals of the structure exhibit significant corrosion creating a safety concern.

Also of concern is the stability of the rubble pile that the culvert goes through. During and after rainstorms, rocks and debris roll down onto the lid of the culvert and also falls into the crawlspace found at the bottom of the culvert. Though this has not been a major problem, the culvert now in place needs to be extended to prevent further degradation of the rubble pile.



A Profile of the Present Culvert (Drawing by Jason Richards)

These safety and environmental concerns have spurred the need to replace the current culvert. A draft environmental assessment (EA) is in the finishing stages and should go out for comment in the near future. The draft EA will consist of three alternatives. **Alternative 1** will suggest the complete removal and replacement of the current culvert. A 42-inch-diameter PVC pipe with double airlocks and an interior stainless steel ladder will then be installed. **Alternative 2** will suggest the removal of all alluvial backfill, blocking the entrance above the current culvert with a rebar and concrete wall, and establishing an airlock in the 10-foot fissure currently accessed by a rope. **Alternative 3** will suggest no action. The current alternatives are subject to change as more research in the project continues.

Although the EA is a slow process, the results will hopefully make access to Lechuguilla Cave a safe experience and restore natural air exchange through the alluvial backfill. All interested parties are welcome to provide comments and suggestions for this project.

CAVE CORROSION RESIDUES: ANYBODY HOME?

by Paula Bauer

The caves of Carlsbad Caverns National Park will provide scientists with a unique environment in which to perform research in a cutting-edge field. Geomicrobiology, the study of the interactions of microbes and geologic features, is one of the latest areas to pique the interest of the scientific community in its examinations of life and the world. This fall the National Science Foundation (NSF) contributed nearly $300,000 in support of a three-year project which will examine the role microorganisms play in the dissolution process of cave walls of Lechuguilla and Spider Caves to create corrosion residues. In general these residues tend to be clays intermixed with iron and manganese oxides. An example of a corrosion residue would be rust which is a residue left over from the breakdown of an iron object.

This project goes by the heady title of "Geomicrobiological Interactions of Microbial Communities in Cave Deep Subsurface Environments: A Novel Extreme Environment". Earlier research on the corrosion residues from Lechuguilla Cave indicates the presence of microbial communities including fungi and bacteria. Thus, as the scientists study the interactions of cave and microbes they will also identify the organisms present and determine their characteristics, such as the methods they use to adapt to the extreme environment, their primary energy sources, and the amount of biological activity. And, results of the study will be the description of a currently unexplained natural community and to provide an analog for subsurface microbial communities on other planets (i.e. Mars). Although the original study focused on Lechuguilla Cave, Spider Cave, a cave through which visitor tours pass weekly, is also included because corrosion residues are extensively evident on the cave's ceilings and walls. Spider Cave's heavy use provides a great comparison and contrast to Lechuguilla's relatively pristine condition.

While trying to grasp the big picture, science is paying closer attention to the little things in life. Although the study of bacteria, fungi, and other microscopic creatures has been going on since the 17th Century, we now recognize that they play an inextricable part in our lives and our world, such as helping us digest, aiding plant growth, making us ill, and breaking down dead material. Microbes and their products are used in many household items, biologically improving contaminated areas and for developing medical treatments. We are just beginning to understand the role that living organisms play in geologic development. In fact, recent studies showing the role of micro-organisms in the breakdown of rock, or alternatively in the precipitation of minerals, will be applied as models for portions of this study.

This NSF funded project is a collaborative effort of numerous respected scientists. The principle investigators that will be visiting the park are Diana Northup and Dr. Penny Boston. Occasionally, electron microscope guru Mike Spilde of the Institute of Meteoritics at the University of New Mexico and Dr. Larry Mallory known for his research on Lechuguilla Cave microorganisms and anti-cancer substances will join them. Ms. Northup is well known at Carlsbad Caverns for previous scientific research including describing the natural history of the park's cave crickets. This project will provide her with a dissertation with which she hopes to earn her doctorate. Doctors Clifford Dahm, Northup's advisor, and Laura Crossey, both of UNM, will assist with the laboratory phases of the research as well as serve on Northup's thesis committee. Dr. Boston, a consultant for National Aeronautics and Space Administration (NASA) and now also on the faculty of UNM, seeks an analog for what subsurface life may be like on other planets, specifically Mars.

In October, the author accompanied Northup and Boston into Spider Cave. We took samples of some of the residues for laboratory study and measured their pH levels. The pH levels ranged from 6.6 to 9.1. For comparison, pure distilled water at neutrality is pH 7.0. Lower numbers indicate acidity, higher numbers indicate alkalinity. The pH levels of corrosion residue samples in Lechuguilla have revealed an extreme range from 1.3 to 12.8. Often these variations are noted in samples taken very near each other. This differentiation in such a small space may indicate distinct microbial influences. Northup and Boston hope to determine the significance of the differentiation and its cause. Initial scanning electron microscope examination of the residue in Spider has shown features present that are similar to those discovered in Lechuguilla Cave. The discovery of concentrations of rare earth elements in both caves also provokes novel ideas and theories. Rare earths are unusual elements that most of us outside of the scientific community would not normally hear about. Why are there such high concentrations in some of the cave materials? Are microbes 'gathering' them to create pockets of toxic material they want to avoid? Are they a nutrient source for the organisms? Are they products of consumption by organisms? Or is there no biologic involvement and simply a result of some affinity to the surrounding clays?

The more we explore, the more questions we ask. Lechuguilla Cave has excited scientists and cavers since the beginning of its explorations for its plethora of intriguing mysteries and its original wonders – geologic and biotic. Now, through the NSF grant, further study will pursue the answers to the questions of interactions between the geological and the biological features of the cave. Geomicrobiological research is not exclusive to caves. Currently, mines spark similar research because, like caves, they allow access to the depths of the earth's crust. Additionally, researchers often examine cave sediments for evidence with which to create snapshots of an area's ecology in a previous time or to better understand human development. Once again the natural wonders of Carlsbad Caverns National Park bring it to the forefront of science and to the brink of a host of new discoveries.

To read abstracts from research proposals concerning caves and subsurface environments, visit the National Science Foundation website at *www.NSF.gov.* To view scanning electron images of some of the organisms and minerals studied to date, visit Diana Northup's website at *www.i-pi.com/~diana*

AGE DATING THE TEXAS TOOTHPICK IN LOWER CAVE

by Dale Pate

In the summer of 1983, two cores were drilled and extracted from the large stalagmite known as the Texas Toothpick below the Jumping Off Place in Lower Cave. These cores were obtained by Brooks Ellwood, a graduate student from the University of Texas at Arlington, for measuring the remanent magnetic properties of the different calcite layers. The calcite itself does not exhibit magnetic properties, but as the formation grew, dust and other air-borne particles that did have magnetic properties would settle onto the formation. During wet periods when the formation was actively growing, very few particles became imbedded in the growth of the stalagmite. During drier periods when less growth was occurring, a more significant number of particles would settle on the formation. These particles became covered with layers of calcite when active growth started again due to a wetter period.

This project was not a success because of the lack of material that exhibited magnetic properties. Particularly during wet periods, there was not enough dust and particles in the air in that part of the cave. It was suggested that future studies of this type should be done with formations found closer to cave entrances. To understand more about this study, it is important to know that magnetic north is not stationary. Magnetic north slowly moves in reference to geographic north. As particles with magnetic properties become trapped, the direction of magnetic north at that time becomes locked into place making it possible to date layers of calcite and undisturbed sediments from measuring the direction particles are aligned to.

Even more interestingly, the earth has experienced reversals in its magnetic field, so that a compass would actually point to magnetic south, completely opposite of what everyone is used to. The last magnetic reversal occurred from 730,000 to 900,000 years ago. A paleomagnetic study of silts in Lower Cave show that these silts were deposited during this time when the magnetic reversal was in effect.

Dr. Derek Ford of McMaster University dated the cores from the Texas Toothpick with a technique known as Uranium-series dating. Using this dating method, he found that outer portions of the formation stopping growing about 167,000 years ago. The inner areas exceeded the limits for this type of dating at greater than 350,000 years old. Based on a number of factors including the fact that the Texas Toothpick has been formed on top of these silts that are more than 730,000 years old, Dr. Ford estimates the stalagmite to be about 600,000 years old.

An excellent source that discusses these studies is the "*Geology of Carlsbad Cavern and other caves in the Guadalupe Mountains, New Mexico and Texas*" by Carol Hill.

THE CAVE'S GROWING HAIR!

by Jason M. Richards

Angel hair, cave cotton, threads, beards, and ropes. You may have heard these terms, but do you know what they are? Carlsbad Caverns, Lechuguilla Cave and many other caves of the Guadalupe Mountains have beautiful displays of these "fibrous sulfate minerals". These unique speleothems are usually one of three minerals: gypsum, epsomite, or mirabilite. Mirabilite (Na2SO4.10H2O) and epsomite (MgSO4.7H2O) are considered soluble sulfates and grow seasonably in certain sections of Carlsbad Cavern. These minerals are so susceptible to relative humidity (RH) that even breathing on them, causes them to dissolve back into the soil or bedrock from which they came. The ideal conditions for these minerals to grow, is 88% RH and temperatures at 10° to 15°C. RH above 88% will cause these minerals to dissolve.

It is interesting to note that these minerals can change due to relative humidity. If, for example, the RH falls below 79% with a temperature of 12.2°C, epsomite dehydrates into hexahydrite. Mirabilite on the other hand, dehydrates into a mineral called thenardite when the RH is 54% and the temperature is 21°C.

The cave resource staff is presently studying an area in Lower Cave along the long loop where a soluble sulfate grows annually in the form of cave cotton, or angel hair. Presently, the RH is running between 98 and 100%, the temperature is 14°C, and the growth has not yet started. However, during the winter months the RH will drop and this elusive mineral will again perform its reappearing act. We have not positively identified the mineral, however, mirabilite is suspected.

CORNERING A LION!

© by Laurence Parent

Dale Pate, the cave resource manager at Carlsbad Caverns National Park, asked me to relate an interesting caving incident that occurred at Little Midnight Cave when I was about 17 years old. As this event happened about 20 years ago, my memory is a bit hazy on some details. At the time my father was a ranger, so we resided in the park. Becoming a caver at a young age came naturally. Bob Morelli, a teenage friend and the son of another park employee, and I often went out ridge-walking in search of undiscovered caves with the blessing of Charlie Peterson and later Ron Kerbo.

On the fateful day of the Little Midnight Cave incident, we were out hunting in the Slaughter Canyon area. We struggled up a ridge to near the canyon rim. Although we were hunting for new caves, we decided to stick our heads into a short, known cave named Little Midnight Cave. It was a small, hands-and-knees-type of tunnel leading into darkness at the base of a cliff near the canyon rim. We dug our hardhats, lights, and gloves out of our packs and crawled into the cave. Through some misfortune, I was leading with Bob right behind me. Most cavers will run into cave inhabitants sooner or later. Snakes, including rattlers, can liven up the entrance area on cave trips. I've encountered raccoons, ringtails, porcupines, and even a skunk in various caves near their entrances. Bats are another common creature often found deep within caves. But nothing prepared me for this little wildlife experience.

Neither Bob nor I were very familiar with Little Midnight Cave. Its size, length, and other features were largely a mystery to us. We had crawled in a short distance and were about to enter a small chamber when I heard what sounded like wind ahead. I turned my head back and started to tell Bob that there must be another entrance or a lot of air volume in this cave. Abruptly the sound changed. I jerked my head back forward.

There in front of me, maybe 20 feet away, was a very upset mountain lion, its eyes glowing in the beam of my headlamp as it snarled at me. Not surprisingly, it was not delighted to be trapped in a cave with two humans between it and the entrance. Also not surprisingly, I wasn't thrilled about being one of the humans cornering the lion. Mountain lions very rarely attack people, but I figured that cornering one in a cave probably greatly increased the odds. This was not a good place to be.

These thoughts flashed through my brain in maybe a second or two. Unfortunately Bob was between me and the exit. I started screaming, "Get out! Get out!" He started to ask me what was wrong. When I kept screaming "Get out!" and started to climb out over him, my panic sank in, the questions ended, and reverse movement started. My next memory is of us standing on the slope about 50 feet below the cave entrance gasping for air and shaking. His eyes widened as I told him of the lion. We hastily packed our gear back in our packs as we kept a careful eye on the cave entrance. To our relief, the cat didn't appear. We decided that we had had all the fun we could handle that day and began the steep descent through catclaw and lechuguilla back to the parking lot at the canyon entrance. Along the way we disturbed a rattlesnake, which made us a little jumpier. Normally the snake would have been reasonably exciting in its own right, but in this case it sure didn't compare to the mountain lion.

I've never been back to Little Midnight Cave. It's a long climb up to it and, besides, it might be inhabited by an animal with bigger claws and teeth than me.

LIVING IN LION COUNTRY

by David Roemer

If you live or work at Carlsbad Caverns, then you live and work in mountain lion country. Mountain lions have always been here, preying on mule deer and playing an important role in the ecosystem. Mountain lions are generally elusive animals, and are not often seen. Don't let that fool you into thinking that these powerful predators aren't there. If you've spent much time hiking in the Guadalupe Mountains, then chances are that they've seen you - perhaps at a closer distance than you may realize.

WHAT TO DO IF YOU LIVE IN LION COUNTRY

Like any wildlife, mountain lions can be dangerous. As more people move into new subdivisions and recreate in parks and open spaces, encounters with lions will probably increase. Although human/lion interactions are infrequent, they are potentially dangerous. Serious consequences, including injuries and death, have resulted from such interactions. We can live with these predators if we respect mountain lions and their habitat. At Carlsbad Caverns National Park mountain lions are a protected and valued part of our natural heritage. To reduce the risk of problems with mountain lions at the park, we urge you to follow these simple precautions:

- Make lots of noise if you come and go during the times that mountain lions are most active - dusk to dawn.
- Closely supervise children whenever they play outdoors. Make sure children are not playing outside after dusk or before dawn. Talk to children about lions and teach them what to do if they meet one.
- Eliminate hiding places for lions, especially around children's play areas. Make it difficult for lions to approach unseen.
- Do not encourage wildlife to come near to your house. Predators follow prey. Store all garbage securely and **don't feed any wildlife**.
- Keep your pet under control, preferably indoors. Roaming pets, including dogs, are easy prey and can attract mountain lions. Bring pets in at night. Don't feed pets outside; this can attract raccoons and other animals that are eaten by lions.
- Encourage your neighbors to follow these precautions. Prevention is far preferable to a lion problem in the housing area.

WHAT TO DO IF YOU MEET A MOUNTAIN LION

People rarely get more than a brief glimpse of a mountain lion in the wild. Lion attacks on people are rare, with fewer than a dozen fatalities in North America in more than 100 years. Most survivors of attacks never saw the lion before first contact. Generally speaking, whether you have just seen a lion, or have just been grabbed by one, do your best to not act like prey! Specifically, the following guidelines may be helpful:

- When you hike in mountain lion country, go in a group and make plenty of noise to reduce your chances of surprising a lion. A sturdy walking stick can be used to ward off a lion. Make sure children are close to you and within your sight at all times.
- Do not approach a lion, kittens, or a kill site (if you're not sure, just stay away from dead animals). Give lions a way to escape a confrontation.
- **STAY CALM** when you meet a lion. Talk calmly yet firmly to it. Move slowly.
- **DO NOT RUN AWAY.** Face the lion and stand upright. Back away slowly only if you can do so safely. Running will likely stimulate the lion's instinct to chase and attack, so don't do it.
- **DO ALL YOU CAN TO APPEAR LARGER.** Raise your arms and open your jacket if you are wearing one. If you have children with you, protect them by picking them up so they won't panic and run.
- If the lion behaves aggressively, throw stones, branches or whatever you can get your hands on without crouching down or turning your back. Wave your arms slowly and speak firmly. You must try to convince the lion that you are not prey, and that in fact, you may be a danger to the lion.
- **FIGHT BACK AGGRESSIVELY** if a lion attacks you. Do not play dead, or you will be. People, even children, have fought back successfully with rocks, sticks, caps,

garden tools, and bare hands. Remain standing or try to get back up. Always face the lion.

Human safety in mountain lion country is everyone's responsibility. Make sure that you and your family and guests take the proper precautions and know what to do in case of a lion encounter. Adopt an attitude of respect, not fear, and we can coexist with these magnificent animals.

MOUNTAIN LION MONITORING PROJECT BIANNUAL REPORT: FALL 1998

by David Roemer

The Fall monitoring transect for mountain lion (*Puma concolor*) sign took place from October 13 through November 12 this year. We had help from four first-time transect participants (Steven Bekedam, Craig DiGuilio, Liz Gray, and Guntram Werther) plus some usual suspects (Dave Roemer, Renée Beymer, and Chuck Hayes from NMG&F). There was a lot of lion sign to find, and by the time we were midway through, Steven was a professional scat-finder. We had a lot of help with people and pack shuttles from the RM&VP park rangers, who contributed approximately 32 hours of time to the project, usually on short notice. As logistics went haywire, we even called on Mark Maciha to drive up Red Hill twice.

Background and Methods

The transects were originally divided into four half-day transects in Walnut Canyon, one two-day transect in Rattlesnake Canyon, and one three-day transect in Slaughter Canyon. To improve the consistency of field methods, our intention was to have our three primary observers (DR, RB, and SB) conduct most of the transects. However, bad weather, scheduling conflicts and sickness led to numerous departures from both plans (Table 1). Methods followed the protocol in Smith et al. (1988), which was briefly reviewed for all new participants.

Daytime temperatures ranged from over 90° F to barely over 40° F during the transect period. Heavy rainfall and fog occurred during the three-day overnight, presenting serious difficulties for the team, and probably obliterating some lion sign. Rainfall for the period prior to the survey was below average (2.76 inches from May through August; the 51-year mean for this period is 7.71 inches)[1] which may have contributed to the abundance of sign found.

Table 1. -- Transect Segments and Participants for Fall 1998 Mountain Lion Transects.

Date	Kilometers	Participants
Oct. 13	Walnut Canyon km 0-6	D. Roemer, R. Beymer, S. Bekedam, C. Hayes
Oct. 14	Walnut Canyon km 6-13	D. Roemer, R. Beymer, S. Bekedam, L. Gray
Oct. 15	Walnut Canyon km 13-18	D. Roemer, R. Beymer, S. Bekedam
Oct. 16	Walnut Canyon km 18-20	D. Roemer, R. Beymer, S. Bekedam
Oct. 18	Slaughter Canyon km 45-58	D. Roemer, R. Beymer, S. Bekedam
Oct. 19	Slaughter Canyon km 58-68	D. Roemer, R. Beymer, S. Bekedam
Oct. 20	Slaughter Canyon km 68-70	D. Roemer, R. Beymer, S. Bekedam
Nov. 3	Slaughter Canyon km 70-76	R. Beymer, S. Bekedam, G. Werther
Nov. 5	Rattlesnake Canyon km 27-32	S. Bekedam, C. Hayes
Nov. 11	Walnut Canyon km 20-26	D. Roemer, R. Beymer, S. Bekedam
Nov. 12	Rattlesnake Canyon km 33-45	D. Roemer, S. Bekedam, C. DiGuilio

[1] Precipitation statistics after August 30, 1998 are unavailable. All weather data was collected from the Bat Cave Weather Station, and downloaded for this report from the Western Regional Climate Center *(http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?nmccav)*.

Results

All told, we found 41 standard units of sign (SUS) comprised of 34 scats, 5 tracks, and 2 scrape sites (Table 2, Fig. 1). Scats were especially numerous, and constituted a high percentage (82.9%) of sign found during this survey period. Sign was found in 29 different kilometers, including 3 segments where sign had not been previously found (km 14 in Walnut Canyon, km 42 in Rattlesnake Canyon, and km 68 in Slaughter Canyon). Both the Frequency of Encounter (FOE) and Dispersion of Sign (DISP) were the highest yet recorded, 0.539 and 0.382, respectively (Table 3).

Discussion

The use of track surveys for studying population trends in mountain lions has many advantages. They are non-intrusive, inexpensive, and safe (especially compared to flight tracking of radio-collared animals), and enable the participation of volunteers from all walks of life in looking for and discovering lion sign. In areas where the presence of lions is uncertain, track surveys can establish their presence. Finally, track survey data is always "better than nothing" and most resource managers would be thrilled to find 11 years of track data like ours in their files.

Having said that, there are significant limitations on what one can say about lion populations based solely on track survey data. There is a high degree of subjectivity due to differences in observer abilities, seasonal changes that affect the persistence and detectability of sign, and questions about the independence of sign (i.e., is all sign produced regularly and without discrimination, or do other factors determine the timing or placement of sign?). For example, the activity of a female lion with cubs would lead to a temporary concentration of sign in a small area. Scrapes are another example. Scrapes are usually made by males who often patrol large territories and leave scrapes frequently. Therefore, a high number of scrapes in any given survey might all be the handiwork of a single lion. When it comes to interpreting sign, not all signs are equal.

The amount of scat found this fall was somewhat staggering. The fact that we found sign in three areas where we had never found sign before is also a possible indication that there may be an increase in lion numbers. However, the lack of rainfall between our spring and fall transects may have influenced our results. Rain (and other environmental factors) causes the decay and eventual disappearance of lion sign, like scat. The near total absence of rainfall this summer may have preserved lion sign better than during average years.

So how many mountain lions do we have? The best available estimate so far comes from a ten-year analysis of our data by Harveson et al. (in press), who determined that no positive or negative trends were identifiable from fall 1987 to spring 1996. With no significant trends to consider, we can fall back on the final results from the Harvey and Stanley Associates project which estimated lion density in the Guadalupe Mountains at 2.3 adults/100 km^2 and 5.6 lions (all age classes)/100 km^2 (Smith et al. 1986). These numbers are the estimated maximum density during the study period (1982 - 1985) in a 400 km^2 area encompassing Carlsbad Caverns National Park, Guadalupe Mountains National Park, and parts of the Lincoln National Forest in between.[2] Considering the results of our just-completed transect, it seems safe to say that lions are not decreasing in the park, and may be at least temporarily on the rise. It will be interesting to see if the next few transects are like the one we just finished.

Future Directions

While most practitioners of track surveys are still in the "data tinkering" mode, our investment in 11-plus years of transects (over 5,000 person-kilometers hiked!) deserves a more thorough test. The data sets from Carlsbad and Guadalupe Mountains National Parks could really benefit from a good look by a qualified biostatistician. The spatial component of the data also requires careful consideration. Not only the amount of sign, but where you find it, has possible implications for analysis. For example, there are several "hot spots" along the transect route where we almost always find lion sign. Chances are that regardless of high lion density or low lion density, we will always find something at these places. However, the "not-so-hot spots" that are marginally successful, may show great fluctuations that may be more closely tied to actual fluctuations in lion populations.

Another technique that we are keeping a close eye on involves the use of microsatellite DNA analysis to identify individual mountain lions from scat samples. The Utah Division of Wildlife Resources will be using this technique this year on tissue samples from harvested lions. This technology may enable us to someday identify the total number of unique individuals responsible for all the scat we find during the surveys! At $150-300 per sample, this information doesn't come cheap, but costs are expected to fall as the technology grows. We will stay in touch with developments on this front, and with potential partners, in the hopes that we can someday improve our monitoring.

[2] Carlsbad Caverns National Park is approximately 189 km^2, so mathematically speaking, we might have in the neighborhood of 4 adult lions (11 including subadults and kittens). The greatest known population of lions using this park occurred in December 1982, when 4 adult females, 2 adult males, and at least 6 kittens were identified (Smith et al. 1986).

References

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Smith, T.E., R.R. Duke, M.J. Kutilek, and H.T. Stanley. 1986. Mountain lions (Felis concolor) in the vicinity of Carlsbad Caverns National Park, NM., and Guadalupe Mountains National Park, TX. Harvey Stanley and Assoc., Inc. Alviso, CA. 137pp.

Smith, T.E., R.R. Duke, and M.J. Kutilek. 1988. Mountain lion population trends monitoring in Carlsbad Caverns and Guadalupe Mountains National Parks. Harvey Stanley and Assoc., Inc. Alviso, CA. 41pp.

Table 2.-- Percent contribution of mountain lion sign for transects at Carlsbad Caverns National Park, NM.

Year	Season	Scat		Scrape		Track		Kill		Total
1998	**Fall**	**34**	**82.9%**	**2**	**4.9%**	**5**	**12.2%**	**0**	**0.0%**	**41**
1998	Spring	12	66.7%	3	16.7%	3	16.7%	0	0.0%	18
1997	Fall	3	16.7%	4	22.2%	11	61.1%	0	0.0%	18
1997	Spring	8	61.5%	0	0.0%	3	23.1%	2	15.4%	13
1996	Fall	7	50.0%	2	14.3%	4	28.6%	1	7.1%	14
1996	Spring	12	75.0%	1	6.3%	3	18.8%	0	0.0%	16
1995	Fall	9	81.8%	0	0.0%	2	18.2%	0	0.0%	11
1995	Spring	3	23.1%	5	38.5%	5	38.5%	0	0.0%	13
1994	Fall	11	57.9%	2	10.5%	6	31.6%	0	0.0%	19
1994	Spring	10	40.0%	12	48.0%	3	12.0%	0	0.0%	25
1993	Fall	15	68.2%	3	13.6%	3	13.6%	1	4.5%	22
1993	Spring	9	69.2%	2	15.4%	2	15.4%	0	0.0%	13
1992	Fall	9	75.0%	1	8.3%	2	16.7%	0	0.0%	12
1992	Spring	6	75.0%	0	0.0%	2	25.0%	0	0.0%	8
1991	Fall	3	75.0%	0	0.0%	1	25.0%	0	0.0%	4
1991	Spring	8	72.7%	2	18.2%	1	9.1%	0	0.0%	11
1990	Fall	5	41.7%	0	0.0%	7	58.3%	0	0.0%	12
1990	Spring	15	88.2%	2	11.8%	0	0.0%	0	0.0%	17
1989	Fall	8	100.0%	0	0.0%	0	0.0%	0	0.0%	8
1989	Spring	11	78.6%	3	21.4%	0	0.0%	0	0.0%	14
1988	Fall	6	75.0%	2	25.0%	0	0.0%	0	0.0%	8
1988	Spring	3	37.5%	3	37.5%	1	12.5%	1	12.5%	8
1987	Fall	7	53.8%	2	15.4%	3	23.1%	1	7.7%	13
Avg.	Fall	9.8	64.3%	1.5	9.9%	3.7	24.2%	0.3	1.6%	15.2
Avg.	Spring	8.8	62.4%	3.0	20.2%	2.1	15.6%	0.3	1.9%	14.2
Avg.	Both	9.3	63.3%	2.2	15.1%	2.9	19.8%	0.3	1.8%	14.7

Table 3.-- Frequency of Encounter (FOE) and Dispersion of Sign (DISP) for transects at Carlsbad Caverns National Park.*

Season	Year	SUS	FOE	KM W/SUS	DISP
Fall	**1998**	**41**	**0.539**	**29**	**0.382**
Spring	1998	18	0.237	12	0.158
Fall	1997	18	0.237	13	0.171
Spring	1997	13	0.171	13	0.171
Fall	1996	14	0.184	11	0.145
Spring	1996	16	0.239	13	0.194
Fall	1995	11	0.145	11	0.145
Spring	1995	13	0.171	9	0.118
Fall	1994	19	0.250	12	0.158
Spring	1994	25	0.329	19	0.250
Fall	1993	22	0.289	16	0.211
Spring	1993	13	0.171	7	0.092
Fall	1992	12	0.158	9	0.118
Spring	1992	8	0.105	7	0.092
Fall	1991	4	0.053	3	0.039
Spring	1991	11	0.145	9	0.118
Fall	1990	12	0.158	10	0.132
Spring	1990	17	0.224	12	0.158
Fall	1989	8	0.105	8	0.105
Spring	1989	14	0.184	8	0.105
Fall	1988	8	0.105	8	0.105
Spring	1988	8	0.105	7	0.092
Fall	1987	13	0.171	13	0.171
Avg. Spring		14.2	0.189	10.5	0.141
Avg. Fall		15.2	0.200	11.9	0.157
Avg. Both		14.7	0.195	11.3	0.149

FOE is calculated as Total SUS/Total km. This is basically an expression of how often sign is found. For example, in Fall 1998 there was 0.539 SUS per kilometer. DISP is calculated as Total km containing SUS/Total km. This is an expression of how many kilometers have sign. For example, in Fall 1998, 38.2% of all kilometers had sign.

Fig. 1. -- Mountain lion sign found on transects at Carlsbad Caverns National Park, NM.