Canyons & Caves

A Newsletter from the Resource Management Offices
Carlsbad Caverns National Park

Issue No. 16 **Spring 2000**

Rattlesnake Springs on a cold, winter afternoon. (Photo © Dave Roemer)

Edited by Dale L. Pate
Special Thanks to Paula Bauer, Bill Bentley, Kelly Thomas

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Look for Issues of *Canyons & Caves* at the following websites: **http://www.caver.net/** Once there, go to the Caves & Canyons icon. Bill Bentley has placed all issues on his personal website. **http://www.nps.gov/cave/** Kelly Thomas is in the process of placing these newsletters on the park website.

RESOURCE NEWS

CARLSBAD CAVERN RESOURCE PROTECTION PLAN – With a new name, the Pre-design Plan for evaluating the effects of the park infrastructure built over Carlsbad Cavern is not ready for release to the public yet. More detail is being added to the plan and will hopefully be released as a draft Environmental Assessment in the next three to four months. This will give the new superintendent the opportunity to participate in this important decision making process.

BLM LAND WITHDRAWAL – To protect cave resources north of Carlsbad Cavern National Park, the Bureau of Land Management (BLM) withdrew 8,470.59 acres of Federal surface and minerals and 480 acres of federal minerals underlying private surface property. A Finding of No Significant Impact (FONSI) was issued on January 7, 2000. This action withdraws this property from mining and mineral leasing, subject to valid existing rights. In addition, this withdrawal will apply to 8,198.72 acres of state lands and mineral estate if acquired by the BLM.

LINCOLN NATIONAL FOREST LAND WITHDRAWAL The U. S. Forest Service recently held a 2nd public meeting and has asked for written comments concerning their proposal to withdraw 27,299 acres from mining activities and oil and gas leasing. This proposed withdrawal is to protect cave resources found in the Guadalupe District of Lincoln National Forest.

NATIONAL GEOGRAPHIC MAGAZINE – In the January 2000 issue, **Diana Northup** and **Penny Boston** (two scientists that are studying microbes in caves of the park) are featured in an article by Joel Achenbach titled "Life Beyond Earth". The two are pictured in a full-page photo in Cueva de la Villa Luz in Tabasco, Mexico wearing respirators and tyvek suits.

In the April 2000 issue, our own **Stan Allison** and **Gosia Allsion-Kosior** are pictured in an article on the Chiquibul Cave System in Belize. Check them out on page 69.

NEW FACES IN SURFACE RESOURCES – Welcome to two new SCA volunteers: Ben Laws and Gavin Emmons. **Ben** has a biology degree from the College of Charleston (South Carolina). He's from Georgia and is here as a 12-week Resource Associate. Among many other interests, Ben is a SCUBA diver and has worked in the Coastal Resources Division of the Georgia Department of Natural Resources. **Gavin** majored in sociology and anthropology for his degree from Lewis and Clark College (Portland). He's from Oregon, and has traveled and worked in parks in east Africa, Australia, and states on both coasts of our country. Gavin is our long-term Conservation Associate. **Welcome to the Hill!**

GOODBYE TO THE DECKERTS – Thanks to Frank Deckert for all the support he gave the Resource Management Division while Superintendent. Frank recently accepted the role of superintendent at Big Bend National Park. Good luck to both Frank and Gloria in their new home.

BIG ROOM BAT GUANO – Preliminary findings for the age of the bat guano in the Big Room of Carlsbad Cavern indicate that the deposit is 44,680 years old (+/- 1200 years). Pat Jablonsky collected samples of the guano in 1999 and had it radiocarbon dated at a lab in Florida. Pat has been back this year to collect two more samples that will be used to verify this first finding.

LOWER CAVE BAT SKELETON – A bat skeleton from Lower Cave was also collected this past year by Pat Jablonsky and dated at 2,060 years old (+/-40 years).

GREEN LAKE – The color of Green Lake in the Green Lake Room is **not** caused by microbes as some may believe, but is caused by light as it shines through the water. The deeper the water, the more blue the water will appear.

PINK BLOSSOMS - Every year there are lots of questions concerning the tree with the pink blossoms in Bat Cave Draw. At this time it is thought to be from the plum family, but identification will have to wait until the fruits are more developed. The tree is probably a non-native.

DOWN THE DRAIN AND INTO THE CAVE

by Paul Burger

We often ignore what happens to the chemicals we use in our houses. We scrub our toilets with Comet, pour Drano into our drains, and use detergent in our washing machines. This sends hazardous chemicals with exotic names like paradichlorobenzene, calcium hypochlorite, and muriatic acid into the pipes. It is important to understand what happens to these chemicals, especially those of us who live in the park. The sewage lines in the park are old with some sections made of clay tile. This collection system leaks and any chemical we send down the drain will eventually get into the cave.

A missing section of sewer line outside Building 7.
(NPS Photo taken in March 1995 by Dale Pate)

There are alternatives to these products. I have braved the traffic on the information superhighway and battled the big waves surfing the net to the EPA's webpage to find alternatives we can use to keep the cave clean and happy. These are not just for those of us who live on the hill, but for anyone who cares about what we are doing to our water.

Toilet/Bathroom Cleaner
Toilet brush and baking soda. Vinegar soak for tub and sink fixtures to remove calcium buildup; Avoid direct skin contact and breathing of fumes.

Drain Cleaner
Plunger; Flush drain with 1/4 cup baking soda and vinegar; Avoid direct skin contact and breathing of fumes.

Oven Cleaner
Baking soda and water; Avoid direct skin contact and breathing of fumes.

Bleach Cleaner
1/2 cup white vinegar or baking soda; Avoid direct skin contact and breathing of fumes.

Dishwashing detergent
1 part borax to 1 part baking soda; Handle all cleaning solutions with care.

Ammonia-based cleaner (all-purpose cleaner)
Vinegar and salt water mix for surfaces; Baking soda and water.

Glass cleaner
Wash windows with 1/4 to 1/2 cup white vinegar to 1 quart warm water, rub dry with newspaper.

Fabric softener
1 cup white vinegar or 1/4 cup baking soda in final rinse water.

Air freshener
Open box of baking soda or dish of vanilla; Simmer cloves; Open windows or use exhaust fans.
Rug and upholstery cleaner
Baking soda on rug, then vacuum.

RESTORATION OF CAVE WATERS USING "LIVING MACHINES â "

by Mark Bremer

We as a nation, as well as the remaining world, are struggling with the monumental task of restoring the clean water we use so as not to pollute our natural surroundings. The current and historical practices of wastewater collection and treatment have contributed to the contamination of the pristine cave waters at Carlsbad Caverns National Park. The recent infiltration study by the Colorado School of Mines (van der Heijde et al, 1997) found that wastewater reached the cave drips and pools. Elevated levels of nitrate and total organic carbon, both strong elements in domestic wastewater, indicate that the wastewater collection system is leaking and causing perceptible contamination of the cave waters.

Suspected sewer leak in the Main Corridor. The large white objects are shelf fungi and the red discoloration appears to be iron that has been deposited from ceiling drips. High fecal bacteria counts were found in the dripping waters. (NPS Photo by Dale Pate)

As a response to the contamination, the Carlsbad Cavern Resource Protection Plan and Environmental Assessment proposes the use of a pioneering technology - "Living Machines®" - to help protect the cave waters. With the continued presence of the 23,000 square foot Visitor Center located directly above the resource, the park proposes to treat the waste *at the point of use to* minimize the transmission of raw sewage over the cave. Instead of collecting the raw wastewater and transporting it several thousand feet through buried lines located directly over the cave, Living Machines® treat the waste at its source and restore the water to a level clean enough to reuse. This significantly reduces the threat of leaking raw sewage lines over cave resources. But before the secrets of this technology are fully revealed, an understanding of the history of wastewater collection and treatment at Carlsbad Caverns is useful in understanding how cave contamination occurred.

History of Conveyance

The first wastewater conveyance systems were most likely shallow pit toilets, commonly referred to as outhouses or privies, established with the first bat guano mining operations. At first crude in design and construction, they gradually yielded to more sophisticated accommodations with the advent of public visitation. Multiple unlined pit toilets with separate rooms for women and men were blasted into the limestone. Human waste in the cave was carried out by hand for disposal in the trenches. In 1924, the year that visitation statistics first appear in the record, 1,876 visitors made the long and arduous journey to Carlsbad Cavern.

The first National Park Service (NPS) structure, the powerhouse, appeared in 1926 (11,741 visitors). The first National Park Service offices and official quarters constructed in 1928 (46,222 visitors), resulted in a sewer collection and outfall system constructed of clay tile, the premium choice for such conveyance devices. Some of this clay tile pipe exists today as a part of the present conveyance system. According to the engineering record, the collection system was expanded in 1932, with the development of additional residences and a bunkhouse, to a single termination point that was not far enough beyond the sight and smell of tourists. The raw sewer discharged on the surface of the ground directly into Bat Cave Draw, approximately 100 feet southeast from the natural entrance. With increased visitation the park expanded surface development adding several ranger apartments in 1942 (124,809 visitors). The piped system was extended and the outfall moved out of Bat Cave Draw to drain off the escarpment to the south. The system also included state of the art cast iron pipe, a septic tank and spray disposal system. The septic tank near the end of the system was a significant improvement as it removed much of the pollution from the wastewater. The remaining effluent was sprayed with diffusers onto the surface to permit evaporation and would allow for plants to consume the remaining water. This system remained in use for over thirty years.

A 1951 NPS photo of spraying effluent on the ground to the east of the Visitor Center.

With the passage of the Clean Water Act in 1972 (856,086 visitors), the National Park Service embraced the principles for protecting surface and ground water resources and eliminated the surface disposal for a system with no discharge. The system was significantly extended and also included four lined evaporation ponds (340,000 S.F.) constructed at the base of the escarpment. Unfortunately, later that year one of the ponds, which was poorly constructed, broke while full of raw sewage. With subsequent additional developments, the 13,360 feet of transmission sewer pipe and four ponds remain as the current system in use today (469,218 visitors in 1999 excluding counts for Nov. and Dec.). Breaks in the system have been recently discovered and repaired and sewage overflows at the manholes occur approximately four times per year, requiring frequent cleaning.

Main sewer line leak discovered in early June, 1998. Sewage is flowing from left of photo. Note sewage lagoons in the background.
(NPS Photo by Dale Pate)

State of the Art Today

Living Machines® - originated by John Todd and commercially developed by Living Technologies of Burlington, Vermont, treats sewage and high-strength organic wastes. A Living Machine® is an array of biological communities housed in an environmental envelope, like a greenhouse. The system effectively transforms sewage into clean reusable water using a variety of life forms and solar energy and uses no chemicals whatsoever. Many existing systems have in excess of a thousand species of plants and animals. The systems operate in two parallel trains to permit portions of the treatment process to be removed from service to permit maintenance while continuing to treat wastes. If an innovative technology is to be employed for waste treatment, it should have a conventional treatment backup system, or be sufficiently redundant that multiple failures are unlikely (NPS, 1993).

The footprint of the proposed system is 2,100 square feet (seventy by thirty feet) and will be placed on an existing paved surface next to the visitor center. 4,327 feet of existing outsell sewer pipe, much over Carlsbad Cavern, shall be abandoned in the proposal. Once treated to reuse standards, the water may be depressurized and separately piped for reuse. Properly treated wastewater can be used for toilet flushing (after approved disaffection) and irrigation. (NPS, 1993) The visitor center, offices, maintenance yard, single family and apartment residences, and offices use over ten million gallons of water per year with a maximum use of 40,000 gallons per day. Visitors can safely reuse approximately forty percent of the total. Other reuse needs may include underground lunchroom restroom facilities and subsurface holding tank washdown. The remaining unused treated water may be returned for groundwater recharge. Planted composting of the undigested sewer sludge is proposed for beneficial use at one of the four existing sewer lagoons, the remaining of which are removed (along with the offensive olfactory assault during summer months). This system represents a complete sustainable practice from the standpoint of water use and is in concert with NPS sustainability goals.

A Living Machine in use today.

Living Machines® also provide an opportunity to teach students, young and old, about environmental education. These systems are aesthetically pleasing and beautiful to visit. Flowering plants, snails and fish invite people to understand how wastes are assimilated in complex biological communities. Given the high volume of visitation at the park, this technology provides for a unique opportunity to put valuable information into the hands of many park visitors, interestingly from diverse sections of the national and international communities. The environment created in a greenhouse enclosure provides a unique classroom to present a new knowledge base upon which park staff may expand. Plant communities in the system will include representatives from the local native diversity. Programs on aquatic studies, ecosystem management, environmental study and research, and ecological design may be presented with direct relation to the desert environment and its riparian and wetland communities. Environmental engineering, technology transfer, site pollution remediation and sustainable agriculture are other related learning opportunities for the public.

Forever changed is the classification of wastewater treatment systems. These new "machines" not only make it possible to protect the cave from further contamination from sewer systems, but exchange one thing for another - namely waste to reusable water. They are also desirable from a standpoint of visitor enlightenment and education. The external benefits to humans -- cave and groundwater protection; water conservation and reuse; visitor education and sustainability -- are possible with Living Machines®. The inner benefits, that of the renewal we breathe in the presence of water and plant environments can also be

realized. The restoration of water offers a source of replenishment, regeneration and intangible recognition of the slow-paced rhythm of water. The protection of cave waters and return to their pristine condition with the use of Living Machines® offers a unique opportunity to answer one of the most pressing issues facing our generation - the restoration of water.

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GRAY-BANDED KINGSNAKE LISTED AS ENDANGERED BY THE STATE OF NEW MEXICO

by David Roemer

Recently, the New Mexico State Game Commission ruled to list the Gray-banded kingsnake (*Lampropeltis alterna*) as endangered, under the provisions of the New Mexico Wildlife Conservation Act. The ruling, which follows the recommendations of biologists with the New Mexico Department of Game and Fish, becomes effective on March 31, 2000. Endangered status is the only way under New Mexico law that the state can prohibit the collecting of a non-game species. The Gray-banded kingsnake is highly sought after by reptile enthusiasts, and collecting is believed to pose a serious threat to the New Mexico population. It is, of course, already illegal to collect gray-banded kingsnakes (or any wildlife) in the park, except by scientific permits issued to qualified researchers.

The status and protection of the Gray-banded kingsnake is of significant interest to Carlsbad Caverns National Park. Much of the park has been identified as potential habitat for this rare and much sought-after species. The only scientific specimen collected in New Mexico comes from the park (Museum of Southwestern Biology 52000), although several unverified records and rumors attest to further sightings and possible illegal collecting that has occurred within the park boundary.

Gray-banded kingsnakes are highly variable in color. They have a grayish base color with black or dark gray crossbands that may be edged with white, or sometimes with orange or red. A photograph of a New Mexico animal may be found in Amphibians and Reptiles of New Mexico, by Degenhardt et al. (1996). Their striking color patterns make them highly-regarded by collectors and breeders, who sell kingsnakes at reptile shows and over the Internet. Collectors also use Internet forums to share news about good collecting sites, weather conditions, and current prices. In the Internet age, there is a greatly facilitated global market for rare animals like this kingsnake.

Gray-banded kingsnakes are a Chihuahuan Desert species, ranging from the northern Mexican states of Durango and Nuevo León, to west Texas and southeastern New Mexico. They are highly secretive, spending much of their lives underground. Much of their habitat is rough, broken terrain that offers little in the way of accommodation for would-be collectors. These conditions also make it difficult to study the animal, and nearly impossible to accurately gauge population health. Additionally, little is known about their food habits, reproduction, home range, and movements. The lack of good information about Gray-banded kingsnake ecology, their apparent rarity in New Mexico, plus the existence of a strong market for the animal, more than justifies their status as endangered.

Carlsbad Caverns National Park actively enforces regulations against collecting or disturbing Gray-banded kingsnakes and other wildlife. As such, the park constitutes protected habitat for the species. However, the park road from White's City traverses 7 miles of kingsnake habitat, and is a potential magnet for illegal reptile collectors. Mortality from vehicle traffic at night is also a risk. Park employees should remind visitors to drive carefully at night, and should always immediately report suspicious activity along the road to law enforcement personnel, any time of day or night.

Hopefully, endangered status for the Gray-banded kingsnake will promote increased awareness among amateur herpetologists and the general public regarding the fragility of the species and its habitat. Carlsbad Caverns National Park has an important role to play in the protection and scientific investigation of the species.

RESTORATION OF RATTLESNAKE SPRINGS RIPARIAN AREA GETS BIG FUNDING BOOST

by Renée Beymer

As we prepare to get rid of the Russian-olive (*Elaeagnus angustifolia)* and Johnson grass (*Sorghum halepense*) that are spreading in the Rattlesnake Springs area (RSS), we have received a shot in the arm from the new National Park Service (NPS) Exotic Plant Management Team program. The Chihuahuan Desert/Southern Shortgrass Prairie (CDSP) Exotic Plant Management Team has been funded for a five-year, 11-park project to remove invasive exotic plants. Carlsbad Caverns National Park will act as the host park (home base) for a team of weed-killing experts—a "weed swat team".

Mike Soukup, NPS Associate Director for Natural Resource Stewardship and Science announced the awards this week, saying,

> *"As part of the FY2000 Natural Resource Challenge (NRC) funding, we have established a new nationwide, exotic plant management program to battle a major, immediate threat to park natural resources, exotic (also known as alien, invasive, or non-native) vegetation. These plants invade native ecosystems, disrupt ecological balances, disrupt natural fire regimes, reduce diversity, and destroy natural succession. Exotic vegetation drastically changes habitat composition; consequently, parks are losing native plant species and the associated animal species that are dependent upon them. As*

called for in the NRC, a major component of the National Park Service's strategy to begin to control exotic vegetation in units of the National Park System is the establishment of Exotic Plant Management Teams (EPMTs). I am very pleased to announce the approval of $1 million to support the following four EPMTs in FY2000: (1) Hawaiian Islands, (2) Florida Partnership, (3) Chihuahuan Desert and Short-grass Prairie, and (4) National Capital Region.

"These EPMTs were selected from eight very competitive proposals that were submitted Servicewide. The proposed EPMTs were reviewed and ranked by a highly qualified and diverse panel of National Park Service and Bureau of Land Management experts. Criteria for reviewing the proposals included: significance of resources at risk; severity of threats to resources; readiness and available knowledge of the problem; program design and realistic factors for implementation; suitability of team approach for proposed area; and cost effectiveness."

The CDSP proposal was written primarily by Denise Louie (Big Bend NP) and presented to an NPS Washington Office panel by Renée Beymer (CCNP). The Chihuahuan Desert/Shortgrass Prairie EPMT will provide a team of five weed-killing experts based in Carlsbad for five years. They will work on invasive exotics at RSS, as well as travel to 10 other nearby parks that are listed below for similar work:

In Texas: Guadalupe Mountains National Park, Big Bend National Park, Fort Davis National Historic Site, Amistad National Recreation Area, Lake Meredith NRA, Alibates Flint Quarries National Monument

In New Mexico: White Sands National Monument, Capulin Volcano National Monument

In Colorado: Bent's Old Fort National Historic Site

In Oklahoma: Washita Battlefield National Historic Site

The highest priority exotic plant for many parks in the CDSP is saltcedar (or tamarisk), with Russian-olive as a priority for CCNP. The method of working with both species is essentially the same and that will simplify treatments. The park is working on compliance for the 'Invasive Weed Management and Riparian Habitat Restoration of Rattlesnake Springs' plan that will form the basis for most of the park's weed work. The Nature Conservancy, a neighbor at RSS that owns a portion of the riparian area, is also supporting the effort. This plan calls for a phased removal of Russian-olive and replacement with native Goodding's willow, desert hackberry, and soapberry trees, as well as killing Johnson grass and other exotics.

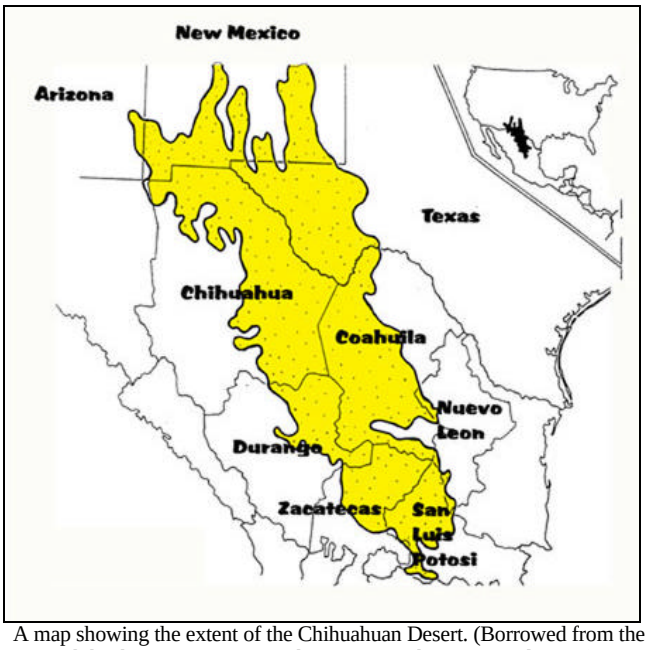
The local non-profit Chihuahuan Desert Conservation Alliance has agreed to provide volunteer assistance for the revegetation portion of the project, and this kind of community support really strengthened our proposal. Revegetation will be important to the overall success: providing good habitat for wildlife and native plants and reducing areas where exotics can invade.

GLOBAL RECOGNITION OF CHIHUAHUAN DESERT BIODIVERSITY

by Diane Dobos-Bubno

In February, the Chihuahuan Desert Conservation Alliance (CDCA), a local group concerned with the welfare of the Chihuahuan desert, hosted a speaker from the World Wildlife Fund (WWF). I don't often attend these meetings (call it getting too comfortable at home on a Tuesday evening), but two things about this presentation intrigued me. One, I knew the speaker. Back in 1997, Jennifer Atchley, then with The Nature Conservancy (TNC), spend one week in the park with a group of 25 other botanists surveying for our threatened Lee pincushion cactus. That Jennifer is now with the WWF led me to my second interest. What connection does the WWF, with its logo of the Giant panda of China, have with Chihuahuan desert conservation? After all, those familiar with the WWF associate the organization with its protection of large land mammals such as black rhinos in Africa or tigers in Siberia and not with protection of the mesquite bush or the prickly pear cactus.

Ms. Atchley's presentation explained this connection. She came to speak about the global importance of Chihuahuan Desert diversity and the WWF's role in maintaining that diversity. Having left TNC, Ms. Atchley, an ecologist, is the Program Officer for the newly formed Chihuahuan Desert Program, which focuses on promoting and funding conservation of habitat in this bioregion. The office's role will be to mobilize action to protect key habitats through strengthening local partnerships, training, education, policy shaping, and promoting sustainable industries.



A map showing the extent of the Chihuahuan Desert. (Borrowed from the Chihuahuan Desert Research Institute Website: www.dcri.org)

To lay out the background: a few years ago, scientists at the WWF began a process to define and identify ecoregions (large regional collections of natural communities that share a large majority of species, dynamics and ecological processes) with the highest biodiversity. Based on a comparative global analysis and synthesis of five extensive regional studies, the scientists identified more than

"*200 outstanding terrestrial, freshwater and marine habitat areas that are outstanding examples of the world's diverse ecosystems and priority targets for conservation action.*" From these top 200 ecoregions, 25 were selected for immediate protective action. The Chihuahuan Desert made both of these lists, which is why Jennifer has an office in Las Cruces.

What I found most rewarding about Jennifer's presentation was her focus on the incredible biological richness of the Chihuahuan Desert. Excitingly, the Chihuahuan Desert rates as the third most diverse desert in the world. Only the Namib-Karoo of southern Africa and the Great Sandy Desert of Australia tout more biological richness than this North American desert. *"There are more mammal species than Great Yellowstone, more bird species than the Florida Everglades, more plant species than the forests of the Pacific Northwest, and more reptile species than the Sonoran Desert…The Chihuahuan Desert supports 350 of the 1500 known species of cacti in the world (and) is home to 250 species of butterflies, including North America's largest butterfly, the Giant Swallowtail"*. The "sky islands" mountain ranges and the gypsum soils of New Mexico claim a high number of endemic species, those species specific to a region. For endemic species, the Chihuahuan Desert ranks among the top 10 ecoregions in North America.

But what especially sets off the Chihuahuan Desert from its top two rivals are the water-dependent endemics: fish, mollusks and plants. Neither the Namib-Karoo nor the Great Sandy deserts can claim such high diversity.

To me, the most interesting aspect of Jennifer's presentation was her discussion of the global recognition of the diversity of the Chihuahuan Desert. Those of us who have been able to visually compare the different deserts of the Southwest already appreciate the seeming lushness of this region. It is great to have international scientists agree.

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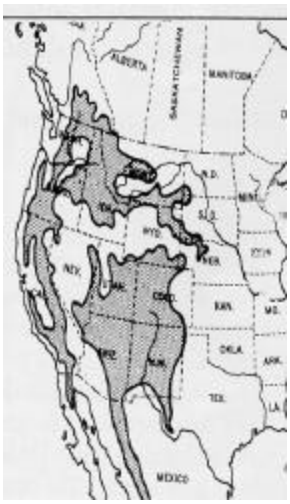
WWF website: www.worldwildlife.org

PINE TREES OF THE PARK

by Dale L. Pate

Three species of pine trees occur in Carlsbad Caverns National Park. These are the ponderosa, pinyon and southwestern white pines. All three are classified within the Family Pinaceae and exhibit characteristics that include being evergreen, resinous, containing both male and female reproductive capabilities within the same plant and having needlelike leaves. Throughout the Northern Hemisphere, there are 10 genera and about 250 species within this family. Trees of this family are of great economic importance and represent most of the timber and pulpwood used in the country. Additionally, the ponderosa, pinyon and southwestern white pines are classified within the Genus *Pinus* and contain approximately 100 species throughout the Northern Hemisphere. There are 35 species of *Pinus* known in North America north of Mexico. These pines in the Guadalupe Mountains are remnants of a much larger relict coniferous forest (a forest containing predominantly evergreen, cone-bearing trees), though oaks and other trees may be in association with these pines

PONDEROSA PINE *(Pinus ponderosa)* - Also known as Western Yellow Pine, ponderosa pines are found in the higher elevations and within the deeper canyons of the western portion of the park. These magnificent trees can reach heights of 60 to 80 feet in the park with trunks 2 to 3 feet in diameter. Specimens of this species on the Pacific Coast are known to have reached heights of over 230 feet with a trunk up to 8 feet in diameter. The bark of the ponderosa is easily distinguished by its yellow-brown to cinnamon-red color and large, flat plates separated by deep, irregular fissures. The growth and age of ponderosa pines vary considerably with locality, but some trees are known to be more than 500 years old. A ponderosa pine from southwestern Colorado was reported in 1914 to be 1,047 years old. The ponderosa is exceedingly drought resistant.



Distributional range of *Pinus ponderosa*. Borrowed from Harlow and Harrar, 1958.

Jason Richards stands beneath a ponderosa in the back country. (NPS Photo by Dale Pate)

PINYON PINE (*Pinus edulis*) – Found in the higher elevations and within the canyons of the western portion of the park, the pinyon pine typically reaches heights of 10 to 40 feet with a spreading, rounded crown. The pinyon pine is the State Tree of New Mexico and produces an edible, soft-shelled seed that is of economic value. This pine is one of the most drought resistant pines, reaches maturity in 250 to 350 years and is usually found in association with junipers. This pinyon-juniper woodland is associated with middle and upper elevation slopes and valleys where precipitation exceeds 15 inches per year.

A Pinyon Pine found in the housing area of the park. This pinyon was planted a number of years ago. Pinyons are typically found above 6,000 feet in elevation in the park. (NPS Photo by Dale Pate)

SOUTHWESTERN WHITE PINE *(Pinus strobiformis)* – A less common pine, the southwestern white pine is easily distinguished from the ponderosa pine by its smooth whitish-grey bark and its leaf shape. This tree is typically 25 to 50 feet tall with an open, broad crown and large, often droopy branches. These pines can also be found in the higher elevations and deeper canyons of the western portion of the park. These trees reach maturity in 200 to 300 years and are typically found on summits and rocky slopes. Populations of this pine are on the eastern margin of their range in the Guadalupe Mountains.

Mark Bremer stands beneath a Southwestern White Pine. This particular specimen was photographed in Lincoln National Forest near Cloudcroft. Photo © Dale L. Pate

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THE LECHUGUILLA CULVERT REPLACEMENT PROJECT

by Jason M. Richards

The replacement of the Lechuguilla Cave access culvert is underway. Officially, the culvert project started last January with the writing of a draft Environmental Assessment. Public review and the issuance of a Finding of No Significant Impact or FONSI followed this assessment. The real work (of course I might argue strongly that writing the EA was the real work) started January 22 with a volunteer crew from the Permian Basin Speleological Society (PBSS) excavating and removing the old culvert. The PBSS crew was comprised of 8 men and 2 women who volunteered their strength and time for 8 days of very hard work. By the end of the 8 days, the culvert had been completely removed and the slope going into the cave partially excavated.

Thomas Fuller crawls through the old culvert one last time. (NPS Photo by Miho Horokoshi)

After the removal of the culvert we faced a new problem, an unstable and slightly dangerous slope that still needed more excavation before the installation of the new culvert could occur. Phone calls were made to the management of the Waste Isolation Pilot Project (WIPP) and help was on the way. Rick Supka, a senior geotechnical engineer from WIPP has been on "*loan*" to us on two different occasions and will be able to continue to help us until the project is finished. Rick will be helping us stabilize the rocky slope that will in turn make for a much safer work environment. WIPP generously loaned us (*permanent loan*) some Tensar stabilization netting and rock bolts to stabilize the slope as we excavate. The three rolls of Tensar netting (two 10-foot and one 12-foot), 30 rock bolts weighing 10 pounds each, and plates (another 100 pounds), were carried to the cave by Judy, Ruby and Jack. Judy, Ruby and Jack really didn't complain much, however, I do know now that mules do have facial expressions and can indeed give very dirty looks.

Judy, Ruby & Jack, led by Jack Kincaid, move some of the heavy items to the cave entrance. (NPS Photo by Jason Richards)

Jack Kincaid and Javier Godinez from Guadalupe Mountains National Park brought their mules and two horses to get the supplies to the cave. It took two trips to ferry the supplies to the entrance. I, of course walked, dodging rocks from their hooves and avoiding occasional horse and mule apples. We are only slightly behind schedule for the Lechuguilla Culvert Replacement Project and hopefully will be completed by the middle of June 2000.

RESOURCES CAREERS INITIATIVE: IMPROVING SCIENCE IN THE PARKS

by Gary Vequist

National Park Service Director Stanton announced the immediate implementation of the Resources Careers program, an initiative that evolved from the 1994 Vail Agenda, but has roots back to the 1963 Leopold and National Research Council reports. These reports identified the NPS need to engage in sustained science and resource management aimed at acquiring information needed to manage and protect parks. First it is essential to create and maintain a highly professional organization and work force. The Resources Careers program institutes a commitment to stewardship of natural and cultural resource, something that has been wanting in NPS for the past 85 years.

Many factors contributed to the low priority given to natural resource management in the Park Service: competing demands, unchanging agency culture and distrusting of science/scientists. As stated in a National Research Council report:

> *Research in the National Park Service has lacked continuity, coordination, and depth. It has been marked by expediency rather than long-term consideration. It has in general lacked direction, has been fragmented between divisions, has been applied piecemeal, and has suffered failure to ensure the implementation of the results of research in operational management.*

Meanwhile NPS resources suffer with less than 5% of NPS personnel and funding dedicated to natural resource management. Here at Carlsbad Caverns 7% of the park employees are professional resource specialists and this is about to improve due to a base budget increase with $324,000 going to cave and surface resource management. The budget increase is split between supporting cave protection programs and providing additional professional resource staff. A cave resources protection ranger, wildlife biologist, karst hydrologist, cave resources technician and term archive specialist are currently being recruited.

The passage of the 1998 National Park Omnibus Management Act of 1998 set the foundation and authority for enhancing resource management efforts in NPS. The Act stated that one of its purposes is:

> *to enhance management and protection of National Park resources by providing clear authority and direction for the conduct of scientific study in the National Park Service and use the information gathered for management purposes… The Secretary shall develop a comprehensive training program for employees in all professional careers for the purpose of assuring that the work force has available the best, up-to-date knowledge, skills and abilities with which to manage, interpret, and protect the resources of the National Park Service*

Resources Careers has established the incentive to restructure and increase the professional expertise in park resource management. The building blocks for effective natural and cultural resource stewardship is a fully professional science staff of trained resource managers. Resources Careers establishes a commitment to establish career ladders for GS-5/7/9/11 for 24 professional cultural and natural fields. This professional ladder was initiated with the upgrade of two Carlsbad Caverns National Park biologists to GS-11 level. Professional resource stewardship positions must meet the science oriented educational requirements. Work is professional when it requires the exercise of discretion, judgement, and personal responsibility for the application of scientific knowledge to make new interpretations and to improve the data, materials and methods. It is critical to integrate resource professionalism in the decision-making at the park level and resolve resource policy disputes in a professional manner – allowing for both policy adherence review and technical recommendations.

Benchmark positions were also developed for nine technician series. Technicians support professional work and carry out tasks, methods, procedures, and/or computations that are covered by established precedents and guidelines requiring a high degree of technical skill, care, and precision.

Beyond the position description, Resources Careers includes position management and professional development guidelines. Resources Careers review teams confirmed that professional resource management work exists in every park, whether or not it is recognized, and that the appropriate grade level for full performance, is the GS-11 level. A position review resulted in a determination that the park needs professional positions, requiring knowledge in specialized fields of science characteristically acquired through education equivalent to a bachelor's degree or higher. Resource professionals with advanced degrees in specialized fields of study have the credibility and knowledge to deal with the complex issue involving resource stewardship in natural protected areas.

SCIENCE AT LECHUGUILLA: 1999 REVIEW

by Paul Burger

Summary

There is a great deal of active research going on in the backcountry caves of Carlsbad Caverns National Park, especially in Lechuguilla Cave. This report is intended to update cave scientists, cave surveyors, and the interested public on what has been going on in the past year and to provide some very preliminary results of these studies. All of these reports have been compiled from trip reports and communication with the investigators. Some of the research being conducted in Lechuguilla has been reported at conferences this year and can be found in the references listed at the end of this report. If any researchers have conducted trips or presented papers not shown below, please let me know.

There are some long-term projects that continued this year, including Harvey DuChene's mineral inventory, Diana Northup's study of human impacts on cave microbes, and Penny Boston's study of potential urine dump remediation. New studies that began this year include a study of life in extreme environments headed by Diana and Penny , a study that could provide analogs to Martian life by Mike Spilde, and a water tracing study by Jake Turin.

The park also instituted a new system for tracking the science stations in the cave. A simple form has been developed that ties the science locations into survey stations and records what type of sample was taken. Part of the form includes spaces to keep track of equipment being left in the cave. Hopefully, this will allow the park and the researchers to keep better track of experiments in the cave.

Mineral Inventory

Investigator: Harvey DuChene

Purpose: To document the mineralogic and geologic features of Lechuguilla Cave to help the cave resource staff make management decisions and to aid other researchers doing geologic and hydrologic work in the cave.

November 10-13, 1999

Fubar

Linda Doran and John Lyles led an inventory trip into the Clam Bake area of Fubar and into Northern Exposure, both in the Western Borehole. The Clam Bake area contains well-preserved Permian fossils protruding from the walls and ceiling (seen in the August, 1999 issue of the NSS News). The most abundant fossils are algae and crinoids, but there are also abundant brachiopods, gastropods, nautiloids, sponges, and preserved as part of a fossil "hash." In several places, reddish-brown urchin spines 4-5 cm long protrude from the rock like rusty nails, some with ribs that look like thorns attached.

Well-compacted, horizontal algal mounds more than a meter tall and dark brown in color were found at EXAF 6, 15, and 16. One algal mound at EXAF 16 is approximately 4 meters tall and takes up an entire wall of the passage. In a narrow passage just below it (EXAF 15), an algal mound is bisected by a fault line trending about 30°.

In addition to the fossils, they made several observations about the secondary deposits in the passages. Amber-colored scalenohedral calcite spar covers the exposed surfaces of walls, floors, and breakdown blocks below a former water level, and dark brown corrosion residue covers the calcite spar and the bedrock. The floors are coated with gypsum over a layer of corroded, brown travertine that is cracked and slipping in places. In several places, they found a powdery floor coating containing varying amounts of gypsum, moonmilk, silt, and/or corrosion residue.

Pink clay deposits, possibly manganese carbonates, were found in much of the EXAF survey. Moonmilk is present in significant amounts and sometimes appears to gradate into pinkish clay deposits in wall and floor recesses.

Northern Exposure/Zanzibar

The predominant features in the IBDA survey of the Northern Exposure are breakdown blocks, speleothems such as popcorn and aragonite, and corrosion residues. The IBD survey is characterized by travertine-coated mammillaries, not as many breakdown blocks, and more frequent deposits of gypsum crust.

The IBD passage provides evidence that the cave experienced a greater influx of water in the past. Features of note include a dry pool, "Teardrop Pool," with a well-defined former lake level. Above the pool is a large dome decorated with teardrop-shaped mammillaries. Both the floor and dome are deeply cracked. An acid lake basin appears to have undercut carbonate bedrock in the Zanzibar Pool Basin.

Life in Extreme Environments (LExEn)

Investigators: Cliff Dahm, Laura Crossey, Diana Northup, Mike Spilde, University of New Mexico;Penny Boston, Complex Systems Research, Inc.; Larry Mallory, Biomes, Inc.

Purpose: To clarify the nature of microbiological communities in the corrosion residue habitat in Lechuguilla Cave and to discover the interactions between microbial communities and the rocks, minerals, and air of the cave.

January 6-9, 1999

Corrosion residue and punk rock (weathered limestone found beneath the corrosion residues) samples were taken in the Sanctuary area of the Western Borehole. These samples were taken for microbial and SEM analysis and for bulk chemistry. AO/Int in spider and enrichments

January 27-31, 1999

Corrosion residue and punk rock samples were taken in the Red Lake area of the Western Borehole. These samples were taken for microbial and SEM analysis and for bulk chemistry.

June 23-26, 1999

Water, air, and some rock samples were taken in the Pearlsian Gulf and Lip Service areas of the Southwest. A small fragment of broken spitzkarren was also taken near

Lip Service. Enzyme exposures were taken on the sulfur deposits in the Voids and some small sulfur samples were taken for stable isotope analysis.

June 28-30, 1999
Sampled the corrosion residue and punk rock in the Sanctuary in the Western branch for mineralogic analysis. An AO/INT analysis was performed on the corrosion residue to determine the ratio of total cells to total respiring cells. Manganese and Iron enrichment cultures were taken to grow microbes in the laboratory to understand their energy sources. Samples were taken and AO/INT analyses were done in the EA survey near EF Junction.

October 8, 1999
Sampled corrosion residue and punk rock in the Ghost Busters Hall area. Collected an additional sample of corrosion residue near the start of S&M Crawl in Apricot Pit.

December 2, 1999
Took additional samples of corrosion residue in the Ghost Busters Hall area.

Preliminary Results

The samples taken this year are part of a three-year study. This year Diana Northup and her colleagues have concentrated on the origin of the corrosion residue in Lechuguilla Cave. The AO/INT analysis gives an indication of the biological activity of a particular sample. Results from the corrosion samples taken from the EA sample site show that about 18% of the cells in the corrosion residue and 26% of the cells in the punk rock samples are actively respiring. These results are significant and strongly point to a biologic origin for corrosion residue.

Preliminary results from chemical analysis of the black corrosion residue indicate that manganese may be enriched many thousands of times over the level of manganese found in the bedrock. In the red corrosion residue, iron is highly enriched over most other elements. Both of these enrichments may be the result of microbial activity, using iron and manganese as energy sources.

The location of these types of deposits at the top of circulation cells appear to be the result of warm, moist air condensing on the cooler rock surfaces and providing the water the microbes need to survive. However, corrosion residue can also be found on top of boulders and other locations where it is less obvious that air circulation may be a factor.

Balancing Conservation and Exploration in Lechuguilla Cave
Investigator: Diana Northup, University of New Mexico

Purpose: To study the impacts of humans on microbial communities in Lechuguilla Cave by comparing areas with low-impact areas.

This study is ongoing and no collecting trips were taken this year. Glass slides have been left in several of pool areas and camp spots throughout the cave to collect microbes. These slides are left near camp areas for one to five years as a comparison to slides left in relatively non-impacted areas of the cave.

Terrestrial Biomarkers
Investigator: Mike Spilde, University of New Mexico, Institute of Meteorites

Purpose: To identify geologic material that may serve as indicators (biomarkers) of microbiological activity that will aid in the search for microbiological life in meteorites and eventual geologic samples from Mars.

December 17, 1999
Collected corrosion residue samples from the crawlway just before the Void Overlook. Five of the samples were thread-like strands of corrosion residue hanging down from the ceiling and one was taken from the floor.

Preliminary Results

Researchers have concentrated on manganese minerals in this study because manganese is an element that can be utilized by microbes as an energy source. Certain oxidized forms of the element are rare in nature and their presence may be due to microbial activity. Unusual filamentous manganese minerals have been found in these samples and may represent mineralized bacterial filaments.

Cosmogenic Tracer Study
Investigator: Jake Turin, Los Alamos National Lab

Purpose: Determination of water flow and solute transport properties of the unsaturated rocks overlying Lechuguilla Cave, using tritium and chlorine-36.

November 10-13, 1999
Collected water samples from Golden Road Pit, Red Sea pool, Zanzibar, Oasis Pool, and Lake Louise, and Little Lake Lechuguilla in the western branch of the cave.

Development of Urine remediation technology
Investigator: Penny Boston, Complex Systems Research, Inc.

Purpose: To develop a method to remediate and eliminate impacts of urine dumping in the cave.

January 27-31, 1999
Water samples were taken to test for coliforms at Deep Secrets, Lake Louise, and Red Lake. Microbe slides were left at second pool at Red lake. Field coliform tests showed that there were a significant number of coliforms at Red Lake.

Remediation Feasibility Investigation: Lechuguilla Urine Dumps

Investigator: Cathy Borer, University of Vermont, School of Natural Resources

Purpose: To evaluate chemical and biological characteristics of the urine dumps and to evaluate potential remediation techniques.

August 7, 1999

Collected two slides near the Deep Seas camp in the western branch. One was in the urine dump area and one was a control slide outside the urine dump area.

Web Links

Diana Northup (LExEn and other Lechuguilla studies): ***www.i-pi.com/~diana/***

Larry Mallory: ***www.biomes.com***

LEARN home page (Includes text of Penny Boston's report about contamination of Red Lake):
http://www.redshift.com/~mrosbrook/learn/index.htm

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PRELIMINARY SURVEY OF WINTERING SITES OF MEXICAN FREE-TAILED BATS FROM CARLSBAD CAVERN NEW MEXICO

by David Roemer

Some very basic facts regarding the long distance seasonal migration of Mexican free-tailed bats (*Tadarida brasiliensis mexicana*) are generally understood. These bats arrive at summer roosts, such as Carlsbad Cavern, in March and April, and depart for southern locations in Mexico by late October. These basic facts actually leave quite a lot of room for questions. Where exactly do the bats go in Mexico? Do they more or less group together? How far do they migrate in any given night? Where do they stop over and how far south do they eventually go? The fact is that despite being one of the most numerous mammals in the Southwest, the whereabouts and status of winter populations of these animals is still largely unknown. The answers to these questions hold much interest for ecologists and natural resource stewards, who cannot develop sound conservation strategies without some knowledge of the bat's winter habits.

We would probably know even less about wintering Mexican free-tailed bats were it not for the fact that bats are host to the rabies virus. The discovery of rabies in bats in 1953 led to the funding of numerous ecological investigations of insectivorous bats by the U.S. Public Health Service (Davis et al. 1962). This research included banding of large numbers of Mexican free-tailed bats at Carlsbad Cavern (Constantine 1967) and other locations in New Mexico, Arizona (Cockrum 1969), Texas (Davis et al. 1962), Oklahoma (Glass 1958), and Mexico (Villa and Cockrum 1962). These efforts, conducted during the late 1950s and 1960s, established multiple connections between bats at Carlsbad Cavern and other localities, including several winter records from Mexico.

In December, 1999, a team of biologists visited four known wintering sites for Mexican free-tailed bats from Carlsbad Cavern (Table 1) to verify that the caves are still used by the bats, record ecological data for the caves, and determine relative numbers of other associated bat species.

Table 1.-- Sites inventoried for winter use by Mexican free-tailed bats, December 1999.

Site	State	Date of Survey
Cueva del Rincón de la Virgen	Nuevo León	10 Dec. 1999
Cueva de Guano	Durango	12 Dec. 1999
Cueva de la Chinacatera	Sinaloa	15 Dec. 1999
Cuevas de las Garrochas	Jalisco	17 Dec. 1999

The cave sites ranged from desert habitats in northeastern Mexico, to tropical environs in the state of Jalisco, 800 miles south of Carlsbad Cavern (Fig. 1). The project was led by Dr. Troy Best (Department of Biological Sciences, Auburn University) and Dr. Celia Lopéz-González (CIIDIR-IPN, Unidad Durango). Other project participants included John Hunt and Lisa McWilliams from Auburn University, Gabriel Vellagas-Guzmán and Luís Guevara-Chumacero from CIIDIR-IPN, and David Roemer from Carlsbad Caverns National Park. The project was funded by the Adopt-a-Bat program, with support from the National Park Service, Auburn University, and CIIDIR-IPN.

Fig. 1.- Sites with known winter records of Mexican free-tailed bats from Carlsbad Caverns surveyed in December 1999.

The first cave that we visited was La Cueva del Rincón de la Virgen, perched high above the Chihuahuan Desert among limestone cliffs near Villa de García in Nuevo León. A local goat herder steered us in the right direction, as we had originally set out for La Cueva de la Bruja, not La Cueva de la Virgen at all. Hiking to the cave was very much like hiking in Carlsbad Caverns National Park – rugged country with lechuguilla, catclaw, and ocotillo at every turn. When we finally reached the cave we found that the roost was empty, but there was a lot of guano and other evidence to consider. Among the numerous bat bones in the cave we identified *Tadarida* males, females, and babies (Fig. 2). The large amount of undisturbed guano also points strongly towards the use of that cave as a summer roost for *Tadarida*. Even though there were no bats in the cave, we set up mist nets and captured 10 *Tadarida* (4 males and 6 females) flying into the cave.

We arrived in the vicinity of La Cueva de Guano on December 12, which was a festival day. Our hosts in Nazareno Tres were feeding the entire village, in addition to our team. There was some confusion about where the cave actually was. Our original source told us to look for La Cueva de Laguna Seca in the state of Coahuila, but interviews with local residents informed us that there was only one notable guano cave in the area. This turned out to be on the other side of the state line in Durango. Our hosts guided us to the cave, which has a reasonable four-wheel-drive road leading to it to facilitate guano mining. We captured 53 *Tadarida* (35 males and 18 females) and 153 ghost-faced bats (*Mormoops megalophyla*). As the name suggests, La Cueva de Guano is also a likely summer roost for *Tadarida*, or the guano bat.

Fig. 2. Skeletal evidence for *Tadarida brasiliensis mexicana* at La Cueva del Rincón de la Virgen, Nuevo León, Mexico.

The team spent a lot of time on the road (in a crowded VW bus) to reach the next two sites. Leaving Durango, we descended mountainous Route 40 to Mazatlán, crossing the Tropic of Cancer on the way, and then headed up the coast to look for La Cueva de la Chinacatera (Fig. 3).

Fig. 3. Mist-netting bats at La Cueva de la Chinacatera, Sinaloa, Mexico.

Our hosts in the village of Caimanero arranged for someone to guide us to the cave the next day. There we discovered another *Mormoops* roost of perhaps 200 bats. We also captured Parnell's moustached bat (*Pteronotus parnellii*) and the naked-backed bat (*Pteronotus davyi*). The naked-backed bat has a wing membrane stretching across the back, which helps to explain its name. The amount of guano in the cave, plus interviews with local residents, suggest that La Cueva de la Chinacatera is also used as a summer roost by *Tadarida*. Local residents had mined 300 sacks of guano from the cave that year for agricultural use.

The last cave on our itinerary is actually a set of three adjacent caves, near the village of Soyatlán del Oro, in Jalisco. Las Cuevas de las Garrochas was on our list because of a bat banded in Carlsbad Cavern on September 18, 1952, that turned up there on November 26th of the same year (Constantine 1967). We failed to find *Tadarida* there, but we did find a roost of vampire bats (*Desmodus rotundus*) with young (Fig. 4). The vampires and a leaf-nosed bat (*Anoura geoffroyi*) were in the first cave. The second cave smelled like *Tadarida*, and had lots of guano and *Tadarida* bones. The third cave was too small for bats to use. Interviews with local residents, and guano sacks in the caves, indicate that this site too, is primarily a summer *Tadarida* roost.

Fig. 4. Vampire bat from Las Cuevas de las Garrochas, Jalisco, Mexico.

Our findings illustrate how little is known about the winter habits and migration of Mexican free-tailed bats. Other authors have noted winter congregations of these bats in Mexico (e.g., Villa and Cockrum 1962, Constantine 1967) although most observations are based on isolated visits. It is possible that these bats retreat farther south than any of the banding data suggest, or perhaps that the bats are less colonial in the winter than they are in the summer. The caves that we visited seem to be relatively free of human disturbance. So we are still left wondering, where do the bats go?

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ARCHEOLOGY: DEFINITIONS, TERMS & TIME PERIODS

by David W. Kayser

ARCHEOLOGY is the scientific study of the life and culture of ancient peoples, as by excavation of ancient cities, relics, artifacts, trash dumps, etc… essentially, it is going through people's garbage.

DEFINITIONS

Prehistory concerns people and their lives before recorded history, as learned from archeology.

Pre-Columbian history concerns people and their lives in the New World before the arrival of Columbus.

Ancient - This concerns any time period that is considered old. Federal and state agencies often define historic resources as those that are 50 or 100 years in age or older**.**

Artifacts and the stories they tell – An artifact is any object made by human work. Artifacts, rather than occurring alone, are associated with other artifacts spread over and in the ground. Many kinds of artifacts are often not recognized by people. Each piece of painted pottery or stone projectile point or old bottle and even that tin can is part of a cultural context, an association of items dating to or about the same period. The seemingly random artifact scatters actually represent places where people conducted activities in the past. Artifact scatters are archaeological sites. A relic collector might not see structures or other cultural features in the vicinity of artifacts, but the surface artifacts often indicate locations where people built houses, or conducted activities centered around outdoor fireplaces, storage pits, agricultural works, where they killed game, collected wild natural resources, or buried their dead. Taking artifacts away from a site removes clues to what was going on, and also removes the best information available for identifying the site's age. Many artifact styles were only used during particular time periods. The artifact stored in a box in someone's closet could have helped determine the approximate age of other things if it had been left in place for archaeologists to find and study.

Artifacts and other cultural materials found at archaeological sites are often the only source of information we have to answer questions about the lives of a people. These artifacts are used to make scientific interpretations about what the people looked like, what they ate, how they constructed their houses, what language they spoke, what they believed in, and how they created beauty in their lives. Artifacts are pages in a history book. Much important information is lost when an artifact is removed from its original context without carefully recording where it was found and what other kinds of items were associated with it. Taking an artifact from a site is like ripping out a page of a history book. We lose a little bit every time something is removed from a site. Moreover, the artifact and its relationship to other artifacts are lost to scientific study. The position of associated artifacts may provide very useful information.

SOUTHWESTERN ARCHEOLOGY

Southwestern Archeology is the scientific study of the life and culture of the ancient peoples of the southwestern United States and northwestern Mexico by the collection of data on ancient villages, artifacts, and other material remains. This data may be collected by excavation, or by non-intrusive means such as remote sensing and ground penetrating radar, study of museum and private collections, oral histories, written histories, and by other means.

Historic people are groups of people who live or lived certain life styles and who called themselves (or were known) by a group name. Examples of these are Apaches, Comanches, Kiowas, Hopis, Tanos, Zias, Mansos, Tiqua, Sumas, Piros and Jumanos. Often the name we know a people by, such as Taosenos of Pueblo is not what these groups call themselves. Examples would be the Navajo call themselves Dine and the Pima call themselves Ohotohono Akimuilt.

Archeological culture: There are various terms archeologists have developed to identify artifact style, a group of artifacts, a particular lifestyle, or a geographic area and the people who made the artifacts or lived a particular life style or lived in a geographic area. These terms were developed because what the people may have called themselves is unknown to the archeologists. These should not be confused with known and named groups of historic people. An archeological culture may include more than one group of people and a group of people may also be identified by more than one archeological culture. Some common terms are as follows: Jornada Mogollon, Eastern Extension of the Jornada Mogollon, Archaic Hunters and Gatherers, PaleoIndians, Clovis People, Folsom, Midland, Hunters and Gatherers, Big Game Hunters, Basket Makers Pueblos and Chaco Culture.

SOUTHEASTERN NEW MEXICO ARCHEOLOGY
MAJOR CULTURAL PERIODS

Native American – People who have inhabited the area from around 13,000 BC to the present. These include many different groups of people and many life styles from nomads to settled farmers. These groups are divided into a number of subdivisions denoting time periods, locations or other criteria.

Euro-American – People of European origin that began arriving in the area around 1536 to the present. These are divided into *Spanish-American* and *Anglo-American* divisions and also contain a number of subdivisions denoting time periods.

CARLSBAD CAVERNS NATIONAL PARK AND ADJACENT AREAS: TIME PERIODS

Native Americans: *Pre-Clovis* – denotes older than 12,000 B. C.; *PaleoIndians* – ranging in time from 12,000 to 8000 BC; *Archaic Period* – ranging in time from 8000 BC to AD 500; *Jornada Mogollon* – ranging in time from AD 500 to 1350; *Protohistoric* – ranging in time from AD 1400 to 1600; *Historic* – ranging in time from AD 1600 to the present.
COMMON TERMS USED IN THE AREA: ring middens, mescal, fluted projectile point, Clovis, Folsom, extinct mega-fauna, Basket Makers, wickiup, rock art, pre-Clovis, fire cracked rock, rock art, pit house and pueblo.

Euro-American: *Early Exploration* - AD 1536 to 1598; *Spanish Colonial*: *Early* - AD 1598 to 1680, *Late*: 1692 to 1821; *Pueblo Revolt* - AD 1680 to 1692; *Mexican Republic* - AD 1821 to 1846, *Territorial* - AD 1848 to 1912; *Early Statehood* - AD 1912 to 1941; *WW II* - AD 1941 to 1950; *Recent* - AD 1950 to the present.

COMMON TERMS USED IN THE AREA: Cabeza de Baca, Coronado, Cibola, War of Annexation, General Kearney, Pope's Crossing, Treaty of Guadalupe y Hidalgo, Lincoln County War, Little Texas, cattle drives, Henry Harrison Homestead Site, Charles Slaughter Ranch, Lowe Ranch and the CCC.

TIMETABLE: REGIONAL CHRONOLOGICAL SEQUENCES FOR SOUTHEASTERN NEW MEXICO

REGIONAL PERIOD	SOUTHEAST NM EVENTS	HOW LONG AGO	DATE
RECENT	Oil and Gas / WIPP	15-50 yrs.	post A. D. 1950
WW II	Army Air Corps/ Potash Mines	55 yrs.	A. D. 1941-1950
EARLY STATEHOOD	Guano Mining, NPS, CCC	85 yrs.	A. D. 1912-1941
TERRITORIAL	Harrison Homestead, Eddy Irrigation Co, Ranching .	150 yrs.	A. D. 1846-1912
MEXICAN REPUBLIC	Camino Rio Azul, Comanchero	175 yrs.	A. D. 1821-1846
LATE SPANISH COLONIAL	Presidio El Paso	274 yrs.	A. D. 1692-1821
PUEBLO REVOLT	El Paso del Norte,	320 yrs.	A. D. 1680-1692
EARLY SPANISH COLONIAL	Pecos River Buffalo Hunts,	401 yrs.	A. D. 1598-1680
EUROPEAN EXPLORATION	Cabeza de Baca, Coronado	463 yrs.	A. D. 1536-1598

REGIONAL PERIOD	PECOS RIVER PHASE	AGE RANGE	DATE AND RANGE
HISTORIC	Apache, Comanche, Kiowa.	100-450 yrs. ago	post- A. D. 1540
PROTOHISTORICAL	"	"	"
LATE PREHISTORIC	Late	500-450 "	A. D. 1450-1540
	Middle	800-500 "	A. D. 1150-1450
	Early	800-1200 "	A. D. 750-1150
ARCHAIC	Terminal	1950-1250 yrs. ago	A. D. 1- 750
	Late	3000-2000 "	1000 B. C. - 1 A. D.
	Middle	5000-3000 "	3000 B. C.- 1000 B. C.
	Early	8000-5000 "	6000 B. C. -3000 B. C.
PALEO-INDIAN	Clovis, Folsom, Midland.	14000-8000 "	12,000 B.C.-6000 B. C.
PRE-CLOVIS		> 14000 "	> 12,000 B. C.