Canyons & Caves

A Newsletter from the Resource Management Offices
Carlsbad Caverns National Park

Issue No. 21 **Summer 2001**

Strawberry cactus (*Echinocereus straminius*) brightens a limestone ledge in Walnut Canyon. (NPS Photo by Dale Pate)

Edited by Dale L. Pate
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 Canyons & Caves icon. Bill Bentley has placed all issues on his personal website. **http://www.nps.gov/cave/** Thanks to Kelly Thomas the first nineteen issues can be downloaded as a PDF file from the park website.

RESOURCE NEWS

WELCOME TO NEW CHIEF - Congratulations and welcome to Chuck Barat who was recently selected as the new Chief for the Science and Resource Management Division. Chuck is currently the Chief of Resource Management at Lava Beds National Monument in northern California.

FIRE MANAGEMENT PLAN - A scoping letter has been mailed to interested parties to begin public involvement in the update of the park's Fire Management Plan. Comments need to be received by the park by June 30. A draft plan will be available for public review later in the year.

NEW WORLD CAVE DEPTH RECORD - A team of Ukraninian and Russian cavers have recently set a new world depth record in Voronja Cave in the Caucasus Mountains in the Republic of Georgia. Voronja Cave has been surveyed to 1,710 meters (5,610 feet) in depth. In comparison, Lechuguilla Cave is 1,567 feet (478 meters) deep.

CARLSBAD CAVERN VANDALISM - Vandalism continues to be a problem in Carlsbad Cavern. Recent incidents discovered by Dale Smith after the Memorial Day Weekend were as follows: (1) Several large broken pieces of drapery were scattered along the floor of Jim White's Tunnel. A number of smaller pieces were scattered along the trail from the Doll's Theater to Jim White's Tunnel. (2) At a point between the Boneyard and Big Room Junction, several large pieces of aragonite had been broken by someone climbing up a slope off the trail. Smaller pieces were also scattered in the same area.

A separate incident on June 9 occurred when two visitors were found hiding off the paved trail in the Queen's Chamber in possession of three freshly broken stalactites,

Small pieces of broken drapery laying near Jim White's Tunnel in the Big Room. (NPS Photo by Tom Bemis) drug paraphernalia and several grams of marijuana. The pair were charged with destruction of natural resources, being off the paved trail and entering a closed area, possession of a controlled substance and smoking in the cave. Nine mandatory-appearance violation notices were issued.

Broken aragonite pieces recovered from area between the Boneyard and the Big Room. (NPS Photo by Stan Allison)

RESEARCHERS ON THE GO - Spring is always a busy time for surface resources. The following researchers have been or will be in the park studying our wonderful surface treasures.

Fire Literature Review - On May 17, Dr. Halvorson (USGS-BRD) and Brooke Gebow (U of AZ, Tucson) reported on their project to evaluate literature on fire and its effect on vegetation of Carlsbad Caverns National Park. Some highlights included: a table of the different assumed fire frequencies according to the literature, summary of the 1854 Pope report, and overviews of what the literature does and does not say. The big message was that no study was ever done long enough to be truly useful and that we should avoid additional short-term studies in the future, concentrating on long-term research. Approximately 20 people from NPS, BLM, USFS, USFWS and universities attended the presentation. Their final report is due in July.

Endangered Species - On June 4 -11, Dr. Marc Baker continued to study our federally listed *Coryphantha sneedii* varieties using morphometrics, i.e. measuring key characteristics to determine varieties and species. His work in the past has shown that there is good evidence that both Sneed and Lee pincushion cacti do exist in the Guadalupe Mountains. These species are federally listed as endangered and threatened, respectively. The presence of Sneed pincushion has been questioned, with all the discussion occurring in writing but with no fieldwork as supporting evidence. Dr. Baker is the first person to actually survey the Guadalupe Mountains for this variety and his work seems to reconfirm the presence of this cactus in the area.

Vegetation Mapping - Dr. Esteban Muldavin of the New Mexico Natural Heritage Program is the Principal Investigator on the park's vegetation community mapping project. On June 13-17, Dr. Muldavin and other researchers continued their work on the project, surveying Double Canyon, Walnut Canyon, Rattlesnake Springs, and along the Scenic Loop Road. The map and associated report should be completed at the end of this year.

Bat Identification - On June 20 – 26, Dr. Lianne Ball and Matt Rahn will help us develop an echolocation library of vocalizations of bats found at Carlsbad Caverns using an ANABAT bat detector. They will initiate an acoustical survey of backcountry caves and help us develop a monitoring plan to determine important landscape features for protecting all of our bat species.

WATER TANK REMOVAL

NOW YOU SEE IT! The 500,000-Gallon Water Tank on March 17, 2001. (NPS Photo by Dale Pate)

NOW YOU DON'T! The Same Area on April 28, 2001. (NPS Photo by Dale Pate)

MICROBIAL RESEARCH - At a special session of the George Wright Society Conference recently held in Denver, Dr. Larry Mallory and Dale Pate presented integrated talks on the value of microbes found in caves and how management of Lechuguilla Cave has been affected by microbial research. The National Park Service is currently producing a NEPA document that will address future microbial research within units of the NPS. Because of the large volume of ongoing microbial research at Yellowstone National Park, their resource management staff is the lead on producing this important document.

JUNE 2001 BAT PHOTOMONITORING UPDATE

by David Roemer

The evening flight of Mexican free-tailed bats (*Tadarida brasiliensis mexicana*) from the entrance of Carlsbad Cavern is one of the park's principal visitor attractions, second only to the cavern itself. Free-tailed bats are a migratory, colonial species that feeds entirely on insects. The colony at Carlsbad gives birth and fledges young from June through September before migrating south to winter in Mexico.

Scientists and resource staff at Carlsbad Caverns National Park have documented a population decline and large-scale die-offs in the bat colony beginning in 1955 (Ahlstrand 1974, Altenbach et al. 1979, Constantine 1967). Similar declines have been noted throughout the southwestern U.S. and Mexico. Residues of organochlorine pesticides (primarily DDT and its metabolite DDE) have probably contributed to the decline of the bat colony at Carlsbad and elsewhere (Geluso et al. 1976, Clark 1988). Despite the ban of DDT in the U.S. in 1972, DDT contamination in the Pecos River Valley and Guadalupe Mountains may still cause harmful effects to wildlife (Clark and Krynitsky 1983). Whether bats are on the road to recovery is uncertain.

The health of the free-tailed bat colony at Carlsbad is therefore an important concern of park visitors, ecologists, and resource managers. What are the population trends of the colony? Has the bat population recovered following the plugging of the guano shafts in 1980? How has the population responded to a decrease in the use of DDT and other organochlorine pesticides? Are bat numbers as high as they may have been in the early 1900s? And what degree of fluctuation in the colony can be considered to be a "normal" response to changing environmental conditions, such as drought?

Attempts to answer these questions have been hampered by the problems inherent in sampling the bat colony (i.e., roost geography and inaccessibility, nocturnal behavior of bats, large numbers of bats, etc.). The size of the free-tailed bat colony at Carlsbad has been estimated using a variety of techniques since the 1920s, providing estimates ranging from 8.7 million to 200,000 bats. These estimates have included visual observations of activity (Bailey 1928, Allison 1937), capture-recapture studies (Constantine 1967), still photography (Altenbach et al. 1979) and computer-assisted video analysis of outflights. These methods have been generally limited by cost and labor intensiveness, sources of error (i.e., observer bias), and a lack of statistical precision, thereby limiting their usefulness as a method for assessing long-term trends in the colony.

Infrared Photomonitoring

Since 1996, Carlsbad Caverns National Park has been using reflective infrared photography to document the location and size of the bat colony within the Bat Cave portion of Carlsbad Cavern. This method, funded in part by the Adopt-a-Bat program, uses black and white infrared photographs taken from permanent photo-points established along the floor of Bat Cave. These photographs, taken during five days in early summer, ten days in mid-summer (when pups are present), and five days in late summer, are then overlaid with a grid that measures square feet of ceiling space. Colony size can be estimated by taking the area and multiplying by 200 bats per square foot (2,153/m^2), a conservative estimate of roosting density (McCraken 1984).

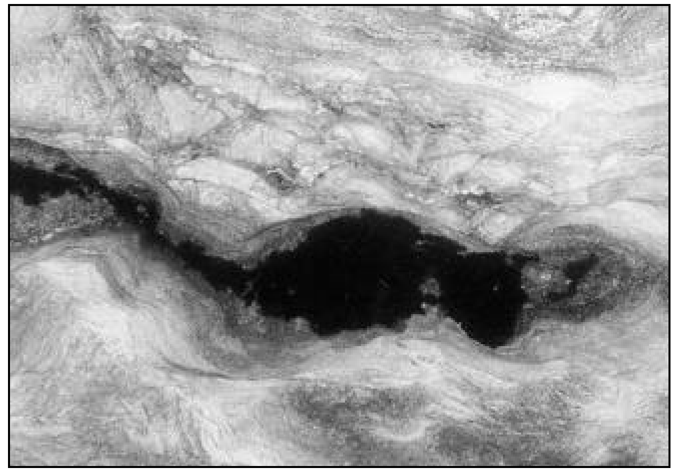


Fig. 1. Mexican free-tailed bats (black patches) roosting in natural domes along the cave ceiling in the Bat Cave portion of Carlsbad Cavern, New Mexico. Image taken June 5, 2001 using reflective infrared photography.

June 2001 Results

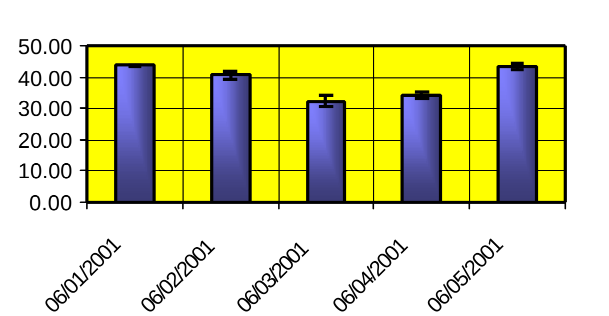
The results from this year's count are presented below. The photographs were taken and developed by Val Hildreth-Werker and Jim Werker of Southwestern Composites and Photography. The ceiling area was independently calculated by Jim Werker, Susan Berg, and David Roemer. The separate counts of ceiling area were pretty close, as they have been throughout our application of this method. Average ceiling area occupied by bats for the 5-day period was 38.96 square meters. Applying a conservative roost density of 200 bats per square foot (2,153/m^2), the population for the 5-day period was 84,000 +/- 10,000 (95% confidence interval).[1]

Discussion

We observed some daily variability in the bat roost during the photo-period, which we've come to expect. This is possibly due to bats emigrating from the roost in dry weather, and returning when conditions are more favorable. The photo-period coincided with a period of hot dry-winds that may have affected the humidity in Bat Cave. The relative humidity in Bat Cave recovered on the last day of the photo-session, on which bat numbers also appeared to increase. It is not known why bats switch roosts. Other possible factors for the apparent variation in bat numbers include response to predators, disturbance by humans, ongoing migration (e.g., a group of migrants temporarily joining the summer colony), or changes in roost conditions or availability of food resources.

[1] Actual roost density is unknown. Constantine (1967) estimated roost density in Carlsbad Cavern to be 300 bats per square foot. If the bats are roosting at higher densities, then the actual number of bats in the roost would be greater.

The differences in ceiling area observed could also be due to changes in roosting density, or variable utilization of roosting surfaces that are not visible to the camera (i.e., domes and cracks). In other words, there *could* be the exact same number of bats in the cave each day, only they are spaced and aligned rather differently as to appear greater on some days than on others. Constantine (1967) acknowledged that irregularity in the cave ceiling is a source of error in estimating bat numbers through ceiling area calculations. The extent to which these errors mask the detection of actual changes in bat population is unknown.



Estimate of ceiling area (m²) of roosting Mexican free-tailed bats in Bat Cave, Carlsbad Caverns National Park, New Mexico, June 1-5, 2001

Fig. 2. Ceiling area figures are averaged from independent counts by three people. Error bars depict one standard deviation from the mean.

Bat immigration and emigration with respect to the roost at Carlsbad Cavern is not a new phenomenon. During 1936 when Allison (1937) calculated a bat population of 8.7 million, there were many disappointing bat flights in August when “not over 100 bats flew out” according to park files. During the summer of 1998, Auburn University researchers Lisa McWilliams and Michael Mulheisen noted Mexican free-tailed bats flying into the cavern with baby bats attached to them. Presumably, these bats were born in other nursery locations in the region, and were moved to Carlsbad when conditions became favorable here, or unfavorable elsewhere. While this elasticity in roost habitat is truly fascinating, it greatly complicates our monitoring efforts.

Despite the sometimes tricky task of arriving at a population figure for the bats, the infrared photographs do shed some light on the changing roost configurations of the colony, and provide adequate data to determine population trends. These photographs serve as a permanent record of the colony, and can help us examine how the colony changes within season and from year to year.

Evaluating colony size and assessing long-term trends in the Mexican free-tailed bat population at Carlsbad Caverns is a critical need for informed resource stewardship. For this and future bat inventory and monitoring efforts to be successful, methods should:

- Provide a consistent estimate of the minimum population size;
- Provide a measure of statistical precision so that annual trends could be compared;
- Be user-friendly so that revolving park staff can collect consistent data;
- Be relatively inexpensive so that monitoring can be done annually; and
- Have the potential for being comparable with data collected elsewhere so that immigration and emigration, as well as regional trends, can be assessed.

We will be conducting our next counts during July 11-20 and August 22-26. The ten-day count in mid-July is an interesting time to monitor, as any pups born in Bat Cave this year should still be present and dependent on their moms for feeding. Adult female bats that are lactating are expected to exhibit a strong fidelity to the roost site during this period, and thus be regularly photographed during the photo-session.

Thermal Infrared Video

Carlsbad Caverns National Park is presently investigating the use of thermal infrared imaging as a method to census bats as they emerge from the cave. An automated system in use at the Eckert James River Cave in Mason County, Texas has been able to reliably detect and resolve individual bats in flight without causing disturbance to the colony. Through the use of this leading-edge technology, Carlsbad Caverns National Park would be able to census bats with greater accuracy and contribute much to our understanding of bat ecology. Dr. Myra Barnes is working with Dr. Tom Kunz of Boston University to obtain funding for this project.

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DYE TRACING AT CARLSBAD CAVERN

by Paul Burger

On May 10, 2001, Cave Resources personnel released 25,000 gallons of bright green water into Bat Cave Draw, the small valley near the entrance to Carlsbad Cavern. This water is being used to simulate a half-inch rainstorm on the parking area that was built near the cave entrance in the 1930s.

Water with fluorescein dye runs off Bat Cave parking lot.
(NPS Photo by Paul Burger)

A 1996 report found that there was heavy metal contamination in some of the pools in Carlsbad and attributed it to runoff from parking lots. Much like people's driveways, fluids such as oil, antifreeze, and brake fluid leak from the thousands of cars that are parked above the cave each year. During a rainstorm, these fluids are carried off of the parking lots and into the drainage above the cave. Eventually, this water works its way through the rock and into the cave in the form of drips and pools.

Although we know that there is contamination in the cave, we don't know whether or not what we are seeing in the cave is just the beginning of a contaminant plume that has been working downward for years, or if we are seeing the cumulative results of more than 50 years of parking lot runoff. One way to help answer this question is to determine how long it takes water to move from the surface into the cave and determine what path it is taking. A good way to do this is to trace the water using fluorescein dye.

Fluorescein is a non-toxic organic dye that is commonly used to trace groundwater in karst areas. Before we released the dye, we placed dye traps in twenty pools and drips throughout the cave. These traps are simply packets of activated charcoal that absorb organic material, in our case the dye. In the lab, we use a special chemical mixture to get the dye back out. Using a fluorimeter, we can measure the level of dye in the trap and in water samples.

To release the dye, we set up a portable 1,500-gallon tank and filled it usng hoses from a fire hydrant. We were also able to use a fire tender truck to get water from a different hydrant and provide us with an additional 1,500 gallons every fifteen minutes. Using these water supplies, we were able to release 25,000 gallons of dyed water into the draw in a little over two hours.

Waylon Cox, Stan Allison and Tilo Garcia mix freshwater with fluroescein dye that was then allowed to flow into Bat Cave Draw.
(NPS Photo by Paul Burger)

How long will it take for the water to get into the cave? We don't know for sure. An earlier study using oxygen and hydrogen isotopes to trace rainstorm water going into the cave suggested that it could take up to eight months for water to reach some parts of the cave. It could take much less time to reach some of the higher parts of the cave beneath Bat Cave Draw. As of this writing, one month since we released the dye, nothing has shown up in any of our sampling locations.

An interesting side note to the study is that we did find trace levels of fluorescein in two of our samples before we even began the test. Fluorescein is also used to give antifreeze its distinct green color. The preliminary results suggest that there is still a significant (lower levels than would pose a threat to humans) amount of parking lot contamination in the system even though the Bat Cave Draw parking lot has been closed to all but limited traffic for more than three years.

Green fluorescein dye flows into Bat Cave Draw.
(NPS Photo by Paul Burger)

We would like to thank all of the people from all of the divisions that made the dye release a success, but especially: Mark Bremer, Dan Cockrum, Earl Coppersmith, Ed Queen (Facilities Management); Susan Herpin and Ted Firkins (Interpretation); Mark Maciha and Tom Schaff (Visitor Protection); Stan Allison, Tom Bemis, Waylon Cox, Tilo Garcia, Dale Pate, and Tim Stubbs (Resource Management).

GROUND-NESTING BEES: WITHOUT THEM, WE'D BE IN BIG TROUBLE

by Renée West

Did you know there are somewhere between 20,000 and 40,000 species of bees in the world? It's true. And the greatest diversity of bee species is found in warm, arid or semiarid areas, especially in the American Southwest and Mexico[1,2]. When we hear the word 'bees', most of us think of honey bees or the infamous Africanized honey bees. I kind of did too, until last month when people started asking about all those bees buzzing around those little holes in the soil in the park's developed area. I looked into the situation and found a fascinating world.

By far the most numerous and ecologically important bees are the natives known as **solitary bees**. Solitary bees nest individually, each female making her own nest — a hole in the ground, a hole in some wood, etc., depending on the species. <u>Over 90 percent of all bee species on earth are solitary bees</u>[3]. This group includes, among many others, such wonderfully named critters as sweat bees, carpenter bees, cactus bees, shaggy fuzzyfoot bees, digger bees, mason bees, leafcutting bees, and plasterer bees — these last are apparently the most common kind we see here around the Cavern's natural entrance. By contrast, honey bees and Africanized honey bees are called **social bees** because they make communal nests with one female (the queen) or a few females laying all the eggs.

Far from being scary or dangerous, solitary bees rarely sting people and they play a critical role in sustaining our ecosystems and all life on earth. Almost all species of flowering plants on earth rely on animal pollinators; just a few are wind-pollinated or water-pollinated[4]. [*Pollination* is the transfer of pollen from one flower to another, an essential step that leads to fertilization and then fruit and seed production.] And pollinators of all types around the world are in decline, threatened by habitat loss and pesticide overuse. According to the Forgotten Pollinators Campaign, "If we do not take concerted actions to protect these pollinators, we stand to lose some of the very interactions between plants and animals that we depend on for diverse ecosystems and for a third of the food we eat."[2]

A Plasterer Bee Approaches its Nest. (NPS Photo by Luke Gaillard)

"It is time to protect our native beneficial bees through habitat conservation and sustainable agriculture," according to Dr. Suzanne Batra[5]. A group called Appropriate Technology Transfer for Rural Areas recommends that farmers encourage native bees by understanding bee biologies, providing nesting habitats, stopping the use of harmful pesticides, and furnishing suitable crops and wild forage[5].

In our national park we should relish their appearance as a sign of a healthy ecosystem. We should protect the nest holes from damage and disturbance during the busy pollen-collecting period by not walking on, driving on, or otherwise disturbing the holes. The effects will be far-reaching: when we protect any one creature in our ecosystem, we are preserving much more than we realize. At home, I feel quite honored to have them nesting in my garden soil: I must be doing something right if there is habitat they can use.

Solitary bees are not aggressive in defending nests and they do not perform mass attacks like honey bees[6]. When social bees nest, it's a group nest and one queen. The bees actively defend the nest, even at risk of being killed. The individual bees in the colony are 'expendable' because their eggs still get produced. By contrast, female solitary bees are less likely to take the risk of getting killed and thereby failing to reproduce (the males cannot sting at all). There is no advantage to defending a nest if you never even get to lay eggs in it. These bees rarely sting, and they "generally only do so if you pick them up or step on them or do something drastic. Usually their stings are much less painful than social bees and wasps; more like a pin prick."[7] (However, a solitary bee will sting you if you reach down into some flowers to pull a weed and trap her against a flower with your arm... ask me how I know this!)

In North America – where honeybees are NOT native – there are over 3,500 species of solitary bees[5]. It is estimated there are over 1,000 species in the area of Tucson, Arizona, alone.[8] Solitary bees are found all over the world, as far away as Finland and Australia. In fact, most of the 2,000 species native to Australia are solitary bees[9].

Bee Biology and Behavior

While their biology and behaviors have not been as well studied as many other wildlife groups, there is some fascinating research going on. Bryan N. Danforth of Cornell University has been studying the reproductive cycle of solitary bees in the Chihuahuan Desert[10]. It has been known that the bees lay eggs in their nests in the ground, gather nectar and pollen to nourish the larvae, then close the nests and leave them alone. New bees come out in the warmth of spring, under the right conditions – which do not happen every year. The larvae lie in wait in the desert soil for a chance to emerge, a survival strategy called "diapause".

What Danforth found out, which had not been known, was that not all the viable larvae emerge in any one year of diapause, and their emergence is triggered by rain. This reduces the chance of a catastrophic loss in the bee population in dry years (like the year 2000 at CCNP).

"The bees are giving up reproduction in year one to reproduce in year two, and this is the first study that shows that rainfall triggers emergence in bees," said Danforth[10]. "This is evidence of a bet-hedging life history… As humans we do a lot of bet-hedging, too. We use a bet-hedging strategy when we buy mutual funds for investments. As humans, we learn to spread out our risks all the time. Well, so have plants, and now we learn, so have the desert bees."

Danforth describes the similarity between these bees and desert plants under the same conditions. Seeds of desert annual plants and the overwintering desert bee larvae mature and reproduce over a short period of time following the monsoon rains. The rains trigger plants to flower (annuals and perennials) and the bees to emerge. It's easy to see why this is such a successful strategy, both for plants that rely on bees as pollinators and for the bees that rely on the plants for food.

Let's check those results with our situation at CCNP this spring: We had warm weather the week of May 7, followed by a monsoon rainstorm the night of May 11. The cacti responded by flowering heavily, some of them for the second time this year. And the ground-nesting bees on the Guano Road/Nature Trail were first noticed May 13 by an alert Interpretation Ranger (Kale Bowling-Schaff). Activity at the nest sites was winding down in early June. But then a modest rainstorm hit early on June 8 and that afternoon renewed nesting was noticed that very afternoon (by Myra Barnes). Rattlesnake Springs got some rain the next morning, and on June 11 a nesting group was observed by the pond in vegetated soil (by Paula Carrington).

Activity at the nest holes seems to continue for about three weeks, mostly at bare soil areas along the Guano Road and in the housing area, south of the playground where they have been seen in previous years. Even after the activity at the nesting colonies ends, the adult bees will be around for much of the summer, feeding on flower nectar and, in the process, pollinating flowers. Our large group of nest holes are what's called a 'nesting aggregation.' They're still solitary bees with individual nests, but they choose to nest close together. Scientists don't really know why this happens. Aggregations can have as many as 100 nests per square meter[8]; in the park this year we probably came close to this.

A Plasterer Bee heads for a nest. (NPS Photo by Luke Gaillard)

According to sources at the University of Arizona[8], many ground-nesting bees like to nest in open, dry, sandy or dusty ground, especially if it is exposed to the morning sun (sounds like the Guano Road, doesn't it?). Some species of the bees choose to nest in the same place year after year (like the area south of the playground). Other species aggregate in a different place each year.

Watching the activity at the bee nests is fascinating. You can see hundreds of insects rapidly buzzing around over the nest holes. Some of them are the nesting females, and you can watch them returning with loads of yellow pollen on their legs. They seem to check various nest entrances until they find their own and enter. It doesn't take them long to come back out, with legs empty of pollen. Some of the insects hovering over the nests are males waiting to mate with females. Sometimes the hovering is an entirely different critter: bee-flies and cuckoo wasps are parasites on solitary bee nests. This means they don't make their own nests, but lay eggs in other species' nests. Velvet ants – the red-and-black ants that are actually flightless bees – also parasitize ground bee nests. Below ground, the nests of different species can vary from single tubes to more intricate series of channels[11].

Those big black carpenter bees are solitary bees, too. While monitoring the plasterer bee nests this spring, I saw a carpenter bee enter a hole in a sotol stem. Later I found in a book a cross-section drawing of just such a carpenter bee nest in a sotol stalk in Arizona[4].

When the busy activity at the nesting holes is over, the place looks dead – but it isn't. The eggs that were laid in the holes will continue to develop through the larval and pupal stages into adults by next year (or later years).

Park's Bee Collection

The park's museum has a nice, but small, collection of solitary bee specimens. It probably represents a tiny fraction of the bee species diversity that this park harbors. The park has not had thorough surveys for *invertebrate animals*, but think of the possibilities: the Bureau of Land Management's Grand Staircase-Escalante National Monument in the southern Utah desert found 174 species of native solitary bees in a literature search for species on its land![12] Our museum has about 30 specimens so far. The collection includes plasterer, leafcutting, sweat, cuckoo, carpenter, and cactus bees. [*Invertebrate animals* are insects, spiders, scorpions, snails, etc.]

One ground-nesting solitary bee that has been collected and place in the park's museum is a cactus bee, *Diadasia rinconis*. There are several research projects on this species being carried out at the USDA Carl Hayden Bee Research Center in Tucson[8] in which they are attempting to find out how and why certain bee species select certain flower species, and how nesting aggregations form.

Conservation of these native pollinators and their habitat is very important to the continued functioning of the ecosystem we protect, the beauty we enjoy, and even the food we eat. For the most part animals, including insects, are needed to pollinate flowers and make reproduction possible. "Pollination – the transfer of pollen from one flower to another – is a fundamental ecological service provided by native bees, butterflies, bats, birds, and many other wildlife species."[5]

As Merlin D. Tuttle of Bat Conservation International said of the rain forest, "Without bats pollinating flowers or dispersing seeds, the diversity of animals and plants living in rain forests diminishes, threatening delicate balances with unknown consequences."[13]

Reasons Why We Should Protect the Birds and the Bees

The Forgotten Pollinators Campaign is a joint effort led by the Arizona-Sonora Desert Museum to increase public awareness and action to protect native pollinators. Here (in condensed form) are the Campaign's "Ten Essential Reasons to Protect the Birds and the Bees"[2]:

1. The future of our farms depends on pollinators. Recent surveys document that hundreds of species of animals are required to pollinate the 100 or so crops that feed the world. Only 15 percent of these crops are serviced by domestic honey bees, while at least 80 percent are pollinated by wild bees and other wildlife.

2. We need to appreciate the benefits that a diversity of pollinators provides. A recent survey of zoo visitors in Washington, D.C., revealed that only a small percentage of the American public understands the process of pollination or the diversity of beneficial animals involved. Our recent analyses of global inventories of biodiversity indicate that more than 100,000 different animal species – and perhaps as many as 200,000 – play roles in pollinating the 250,000 kinds of wild flowering plants on this planet.

3. Honey bees are in decline. Commercial honey bee colonies and feral honey bees (non-native bees that make hives in the wild) have both suffered severe declines in recent decades. Ground-nesting solitary bees are becoming increasingly important as pollinators of crops as well as native vegetation.

4. All pollinators require protection from toxins. Pollinators need protection from excessive exposure to the pesticides and other chemicals that can either poison them or impair their reproduction. These chemicals can also eliminate nectar sources for pollinators, destroy larval host plants for moths and butterflies, and deplete nesting materials for bees.

5. Habitat loss is a major threat to pollinators. Small isolated patches of wild habitat may look natural and healthy, but they often lack essential pollinators and seed dispersers that ensure regeneration of the biotic community. When large habitats are fragmented into small isolated patches, it is not long before some of the animal residents decline in numbers to the point that they no longer provide effective ecological services beneficial to plants.

6. Fewer pollinators ultimately mean fewer plants. In the larger picture, native pollinators are as important for plants in wild habitats as they are for those in agricultural landscapes. Yet the ultimate reproductive consequences of pollinator scarcity on wild plants is not appreciated and remains understudied.

7. Endangered species protection need not be incompatible with food production. Current Environmental Protection Agency and U.S. Fish and Wildlife Service policies prohibit pesticide and herbicide spraying in the areas immediately surrounding endangered plants. Unfortunately, in the past these "spraying setback distances" have sometimes been generalized such that they have placed unnecessary burdens on landowners and land managers. This situation not only frustrates ranchers and farmers but also remains inadequate for actually protecting the species. More work needs to be done to determine safe setback distances for specific endangered species.

8. Plants and pollinators both need protected habitat. For example, the last remaining natural populations of a rare evening primrose live in California's Antioch Dunes National Wildlife Refuge. Though the primrose is protected, its hawkmoth pollinator has not reappeared after years of pesticide spraying in nearby vineyards, and reproduction has remained low. This plant remains in jeopardy as it produces few fruits and low percentages of viable seeds, while its weedy neighbors produce many.

9. Migratory pollinators require interstate AND international protection. Bats, hummingbirds, moths and butterflies are among the pollinators that seasonally migrate long and short distances between mountain ranges, regions, and countries.
10. Pollination is a threatened ecological service. The interactions between plants and their pollinators are essential to a viable structure and healthy functioning of wild and agricultural communities. Habitat loss, disease, and pesticides take their toll in different ways, but all of them imperil these vital ecological relationships, many of which developed through thousands of years of natural and cultural selection.

In an era when human activities place increasing pressure on both natural and rural landscapes, we cannot ignore the vital role of pollination services and the frequently negative impacts that we are having on plant-pollinator relationships.

**For a wonderful easy-to-read overview of pollinators in the southwest deserts and around the world, check out *The Forgotten Pollinators* by Stephen L. Buchmann and Gary Paul Nabhan. This book is sold at the CCGMA bookstore .

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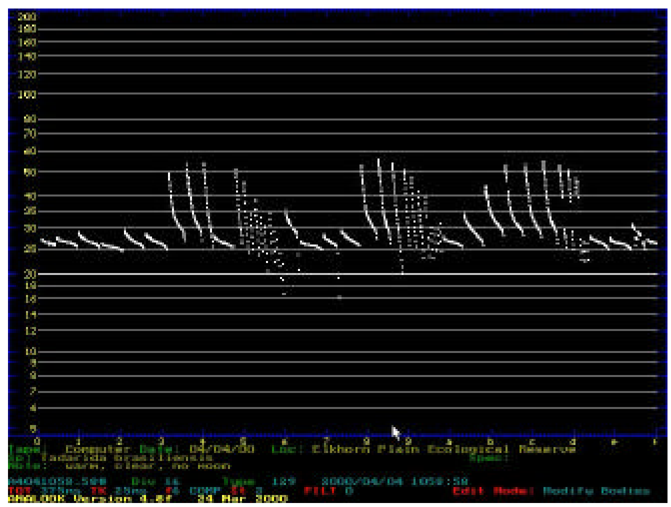
LISTENING FOR BATS

by Myra Barnes

The flight of tens of thousands of Mexican Free-tailed bats emerging from Carlsbad Cavern is a spectacular site. However, sixteen other species of bats have been observed in the park. With all of the caves, crevices, and boulder fields in the park, there are many places where bats may roost. While a large roost of bats may be easy to locate in a cave, many species roost in smaller numbers in crevices. In our complex caves, many with vertical entrances, it would be easy to overlook a small colony of bats in a crevice or other area of the cave that is difficult to see. The ANABAT bat detector records the echolocation vocalizations of bats as a sonogram that can be viewed on a laptop computer screen and stored for future reference. Since ANABAT can be used at the cave entrance, there is no risk of disturbing roosting bats and bats are not stressed by capture or handling. Information can easily be collected from caves that require technical climbing skills to enter or that have inaccessible areas.



Echolocation pattern from Mexican Free-tailed bat. (Courtesy of California State University, Stanislaus Foundation)

In June, Dr. Lianne Ball and Matt Rahn will be here for a week to help us develop an echolocation library of the bat species at Carlsbad Caverns. Once calls for our bats have been recorded and identified, we will be able to compare the echolocation pattern of any flying bat to our vocalization library. Most bat conservation efforts focus on protecting maternity roosts. However, identifying bachelor roosts, temporary foraging roosts, transition roosts, and hibernacula are also important. In addition to identifying bats flying in or out of caves, we will be able to identify bats drinking at water sources or foraging in the park.

Information gained from ANABAT surveys can be the foundation for additional research studies. For example, the limited water resources in the park may be critical for drinking water but the bats may not forage in the riparian area. Data on vegetation within foraging distance of drinking water and roosts can be used to generate hypotheses about foraging habitat that can be tested with ANABAT surveys. Acoustical surveys will allow us to monitor all of our bat species at Carlsbad Caverns NP with minimal disturbance to the bats. With this information we can better protect all of the habitat features required for bats throughout the park year round.

WORLD'S LONGEST CAVES

(Borrowed from Bob Gulden's lists published in GEO², V.27, Nos.1-3)

No. Cave Name	Country	State	Length (mile)	Length (meters)
1. Mammoth Cave	USA	Kentucky	355.00	571,317
2. Optimisticeskaja	Ukraine	Ukrainskaja	131.73	212,000
3. Jewel Cave	USA	South Dakota	124.67	200,637
4. Holloch	Switzerland	Schwyz	113.43	182,540
5. Lechuguilla Cave	USA	New Mexico	105.79	170,252
6. Fisher Ridge Cave System	USA	Kentucky	98.37	158,310
7. Wind Cave	USA	South Dakota	96.95	156,026
8. Siebenhengste-hohgant Hohlensystem	Switzerland	Bern	90.10	145,000
9. Ozernaja	Ukraine	Ukrainskaja	72.70	117,000
10. Gua Air jernih-Lubang Batau Padeng (Clearwater Cave)	Malaysia	Sarawak	67.73	109,000
11. Reseau Felix Trombe-Henne mor	France	Naute-Garonne	62.76	101,000
12. Systeme de Ojo Guarena	Spain	Burgos	62.14	100,000
13. Sistema Purificacion	Mexico	Tamaulipas	56.22	90,470
14. Zolushka	Moldova/Ukraine	Moldarskaja	56.05	90,200
15. Hirlatzhohle	Austria	Oberosterreich	53.07	85,400
16. Toca da Boca Vista	Brazil	Bahia	52.20	84,000
17. Friar's Hole Cave System	USA	West Virginia	44.91	72,272
18. Raucherkarhohle	Austria	Oberosterreich	44.63	71,826
19. Sistema Ox Bel Ha	Mexico	Quintana Roo	43.90	70,650
20. Easegill System	United Kingdom	Yorkshire Dales	43.81	70,500
42. Carlsbad Cavern	USA	New Mexico	30.90	49,729

WORLD'S DEEPEST CAVES

			(feet)	(meters)
1. Veronja Cave	Georgia	Abkhazia	5,610	1,710
2. Lamprechtsofen-Vogelshacht	Austria	Salzburg	5,354	1,632
3. Gouffre Mirolda/Lucien Bouclier	France	Haute-Savoie	5,302	1,616
4. Reseau Jean Bernard	France	Haute-Savoie	5,256	1,602
5. Torca del Cerro	Spain	Asturias	5,213	1,589
6. Shakta Vjacheslav Pantjukhina	Georgia	Abkhazia	4,948	1,508
7. Ceki 2 (Cehi II) "la Vendetta)	Slovenia	Rombonski Podi	4,856	1,480
8. Sistema Huautla	Mexico	Oaxaca	4,839	1,475
9. Sistema del Trave	Spain	Asturias	4,728	1,441
10. Boj-Bulok	Uzbekistan	Uzbekistan	4,642	1,415
11. (Il) laminako Aterneko Leizea	Spain	Nararra	4,619	1,408
12. Sustav Lukina jama - Trojama	Croatia	Velebit	4,567	1,392
13. Sistema Cheve	Mexico	Oaxaca	4,547	1,386
14. Evren GUNAY sinkhole	Turkey	Cukurpinar	4,518	1,377
15. Sniezhnaja-Mezhonnogo	Georgia	Abkhazia	4,495	1,370
16. Reseau de la Pierre Saint Martin	France/Spain	Pyre/Atlantigues	4,403	1,342
17. Siebenhengste-hohgant Hohlensystem	Switzerland	Bern	4,396	1,340
18. Slovacka jama	Croatia	Velebit	4,268	1,301
19. Cosanostraloch-Berger-Platteneck Hohle	Austria	Salzburg	4,236	1,291
20. Gouffre Berger-Gouffre de la Fromagere	France	Isere	4,170	1,271
50. Kazumura Cave	USA	Hawaii	3,612	1,101
Lechuguilla Cave	USA	New Mexico	1,567	477

(Eds. Note: The length of Lechuguilla Cave has been changed from Bob Gulden's list to reflect the official length as determined by Carlsbad Caverns National Park.)