



CANYONS & CAVES

A Newsletter from the Resources Stewardship & Science Division

Issue No. 34

Fall 2004



Well-dispersed spring and summer rains have turned much of the park a pleasing green and very lush (for the desert). (NPS Photo by Kristen Dorman-Johnson)

Edited by Dale L. Pate

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RESOURCE NEWS

SPRING & SUMMER RAINS – For calendar year 2004, the Park has received well-distributed rainfall since April and in greater quantities than recent years. This well-distributed rainfall has allowed native plants to produce larger quantities of viable seeds, especially the grasses. In some areas you can almost visualize how the area may have looked before settlers moved into the area in the 1880s. As of October 1, 2004 and

based on readings from the RAWS weather station maintained at the park headquarters area, we have received a total of 18.16 inches for calendar year 2004. Much of this has fallen during the months of April through September with September 20 – 30 receiving 5.66 inches.

The calendar year 2002 saw a total of 10.96 inches with 6.22 inches falling April through September.

The calendar year 2003 saw a total of 6.48 inches with 2.87 falling April through September.

The following chart compares the rainfall during April through September for calendar years 2002, 2003, and 2004.

	April	May	June	July	Aug	Sept
2002	.00	.15	.15	1.21	2.03	2.68
2003	.00	.62	.58	.73	.54	.40
2004	2.64	.63	1.80	4.02	2.23	5.69



The Black River in flood stage at Washington Ranch during one of the July storm events. (NPS Photo by Dave Roemer.)

NEW RS&S CHIEF – Congratulations to Gopaul Noojibail who has been selected as new Chief for the Resources Stewardship & Science Division.

CAVE RESEARCH FOUNDATION RECEIVES AWARD

by Dale Pate

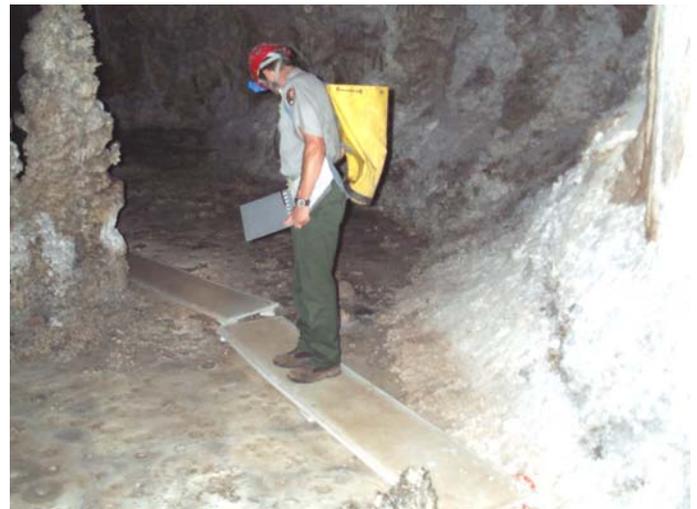
At this year’s annual National Speleological Society Convention in Marquette, Michigan, members of the Guadalupe Area Cave Research Foundation (CRF) were awarded a Certificate of Merit for their dedication to conservation and restoration projects at Carlsbad Caverns National Park. Under Barbe Barker’s leadership since 1996, dozens of individuals have donated thousands of hours of their time and expertise to restoring many areas in Carlsbad Cavern. Without the CRF members’ interest and hard work, Carlsbad Cavern would not be the place it is today.

Areas in Carlsbad Cavern that are in the process of being restored by CRF members include portions of the Main

Corridor, Scenic Rooms, Big Room, Lower Cave, Left-Hand Tunnel, Lake of the Clouds, New Mexico Room, New Section, Hall of the White Giant, and the Guadalupe Room. Restoration of these areas has taken thousands of hours of meticulous work by dozens of individuals—and many of them are still being worked on. The dedication of numerous individuals within the Guadalupe Area CRF makes these significant long-term projects possible. Following are examples of some of the projects they have been working on.



CRF members cleaning the Rookery.



Stan Allison inspects the restored flowstone in the Rookery.

LOWER CAVE – First entered by Jim White around 1905, the Rookery in Lower Cave is a flowstone-covered area with pools of water that at one time held thousands of cave pearls. It was obvious that over the years people had walked on the flowstone with muddy boots. Visitor tours to Lower Cave began on an irregular basis in the 1980s; and by the early 1990s, tours were given on a regular basis, five times a week. The trail through Lower Cave crossed the Rookery flowstone numerous times and with more and more people walking through the area, the flowstone was becoming a muddy mess. The CRF started restoring the Rookery and found that the flowstone under the mud was actually white and quite

beautiful. The park soon realized that it would have to install raised walkways over the flowstone to stop the mud from being washed right back into the cleaned areas. With the installation of walkways, the CRF went back to re-cleaning the flowstone and have since restored most of the area. The restoration also yielded hundreds of cave pearls that had been hiding in the mud for all those years.

GUADALUPE ROOM – Discovered in 1966 by CRF members while surveying, the Guadalupe Room has seen less traffic than most of the cave, but has still seen quite a bit. An area of flowstone and soda straws within the Guadalupe Room named the Soda Straw Forest was a favorite spot to visit for many years. Here to, the flowstone became very muddied from these visits. A project was begun to clean the flowstone by park employees, but was soon taken over by CRF as one of their projects. As restoration progressed, an amazing transformation took place. What was once a large area of mud-covered flowstone is now a natural flowstone floor. Though the flowstone floor is nearly restored, the CRF still has lots of work planned for the Guadalupe Room.



A before picture showing muddy flowstone in the Guadalupe Room.



An after photo of the same area.

LAKE OF THE CLOUDS – Discovered around 1930, Lake of the Clouds is the deepest known point in Carlsbad Cavern. Not much is known about the history of its discovery, but since that time numerous individuals with muddy boots have walked across a large section of mammary deposits that jut out into the lake. CRF members have spent and will continue to spend hundreds of hours restoring this beautiful area. One discovery that resulted from cleaning the mud off the deposits was a signature from 1930. This important find may be from the first exploration team to enter the Lake of the Clouds area.

These are just a few of the restoration and conservation projects that members of the local CRF have performed at the park. Though we all know that the true reward from the restoration efforts in Carlsbad Cavern has been the transformation of impacted areas to beautifully restored areas, it is also important that the organization and the unique individuals that form the Guadalupe Area Cave Research Foundation be recognized for their efforts and contributions. Carlsbad Caverns National Park is pleased that this organization has been recognized nationally for the work they have done and the park looks forward to working with the CRF for many years to come.

BIG SUMMER FOR MAMMALS AT CARLSBAD CAVERNS

by David Roemer

It isn't often that two new mammal species never before seen in a national park are discovered in one year. But while we were focusing on a parkwide reptiles and amphibians survey, the mammals inventory, an occasional project, turned up two new species in one night of biology work.

On August 4, 2004, Dr. Troy Best and 11 students from Auburn University set mist nets in the orchard and along the pond at Rattlesnake Springs to sample bat diversity. Troy Best and Ken Geluso and their students have made this an annual event for several years. In addition to bats, students also set Sherman live traps in the horse corral area of Rattlesnake Springs. The traps were set in the hopes of catching a Chihuahuan desert pocket mouse (*Chaetodipus eremicus*) which is known from lands adjacent to the park but has never been captured in the park. We tried for the pocket mouse in the same area with no luck in 2003.

Results this time were amazing. Among the seven bat species that we caught in the mist nets was an eastern pipistrelle (*Pipistrellus subflavus*). It was an adult male captured in a mist net over the south end of the pond and was immediately recognizable to the Auburn students, who encounter them in Alabama. Eastern pipistrelles had never been caught in the park before. In fact, it wasn't even on anyone's potential species list. It is only the second eastern pipistrelle for New Mexico. Keith Geluso caught the first one in Union County (NE part of the state) in late 2003. Other recent records in west Texas and the northern Great Plains suggest a westward range expansion for the species. Eastern pipistrelles are not long-distance migrants like Mexican free-tailed bats, so their presence here indicates a real change in their distribution.

The next morning the Sherman traps were checked. We caught a silky pocket mouse (*Perognathus flavus*), a Merriam's kangaroo rat (*Dipodomys merriami*), and 5 individuals of the Chihuahuan desert pocket mouse (*Chaetodipus eremicus*), including post-lactating females and a young-of-the-year. It was the second new mammal for the park in one night, although, not as much of a surprise as the bat. These rodents prefer desert shrub habitats and likely range in and out of suitable park areas depending on weather and food availability. Note that while pocket mice are not as "sexy" as bats, the park is home to four of these species, including the only Nelson's pocket mouse records (*Chaetodipus nelsoni*) for New Mexico. On the criteria of state endemism, Nelson's pocket mouse would be our number one park mammal. Many thanks are given to Troy and his students for their work, and we can't wait to see what they will turn up next year!

However, our exciting mammals summer doesn't end there. In late 2003 we began to notice eastern fox squirrels (*Sciurus niger*) at Rattlesnake Springs. This animal is non-native to New Mexico. The population in the town of Carlsbad was deliberately introduced in the late 1950s or early 1960s from Council Bluff, Iowa. We didn't suspect that the squirrels migrated across miles of unsuitable habitat to Rattlesnake

Springs without some human assistance, which was confirmed when the park received an e-mail describing our animals as the result of an animal rescue group in Carlsbad. In June, I collected two squirrels at Rattlesnake Springs. So far, we haven't seen any more of them, but they have been seen at neighboring Washington Ranch.

On a more natural note, a rarely-seen native mammal has made a recent reappearance in the park. Western spotted skunk (*Spilogale gracilis*) had not been reported in the park since one was found dead along Walnut Canyon Road in 1985. Biologists have been hoping to see one for some time, and have road-cruised and trapped with no success. While driving late in the park on August 21, I saw one on Walnut Canyon Road near the top of the big hill. Spotted skunks are smaller than our other two skunks—the striped and hog-nosed—and remind one of a weasel more than a skunk. It is an agile animal. This one seemed to dance across the road before jumping over a rock retaining wall. I returned home, dreaming of spotted skunks, and scheming of a way to obtain a photo voucher. The opportunity came earlier than expected, when I found one dead on the road in lower Walnut Canyon on September 1. This unfortunate animal was an adult male, but we have voucher photos now, and will prepare the skull as a museum specimen. There are reports that other park staff have seen spotted skunks recently—please send the Biology Branch your wildlife observations of this charming mammal. Ken Geluso recently pointed me to Vernon Bailey's account of the spotted skunk in *Animal Life of the Carlsbad Cavern* (1928) in which Bailey contends that they possess "intelligent faces" and "are the most attractive of the skunk tribe." Bailey kept one as a pet in his quarters, and was apparently quite fond of them.

On a final note, *The Mammals of Carlsbad Caverns National Park* by Ken N. Geluso and Keith Geluso is nearing publication and should be available in the bookstore later this fall. This book covers everything that is known about mammals in the park from Vernon Bailey to the present (2000) including many observations from park staff throughout the years. This book will be a superb reference for the park and for visitors who want in-depth information on bats, pocket mice, skunks, and all of our park mammals.

THE TAKEOVER OF CARLSBAD CAVERN

JULY 10, 1979

by Bob Hoff

Written December 1992

What you and your park people accomplished in that time of crisis and danger is in keeping with the highest standards and precepts of the National Park Service, the Department of Interior, and the entire Federal Service. I want you all to know that you deserve the highest respect and praise of our citizenry.

Quote from Secretary of Interior Cecil Andrus to Park Superintendent Donald Dayton, Superintendent's Monthly Log, July 1979

So wrote Secretary of Interior Cecil Andrus to Carlsbad Caverns National Park Superintendent Donald Dayton about Dayton's park staff in August 1979. What crisis and danger had confronted that park staff less than a month earlier?

The crisis began on Tuesday, July 10, 1979, at 3:20 p.m. when four Odessa, Texas men, hiding firearms, took the elevator down to the underground lunchroom, intent on seizing hostages and making terrorist demands. Elevator operator Celia Valdez and passenger Park Technician Linda Phillips were taken hostage on the elevator ride down, and forced out of the elevator at gunpoint. Valdez escaped at her first opportunity by running into a crowd; for Phillips, being a hostage lasted nearly four hours.

The four terrorists, two Native Americans—Eugene Meroney (31) and William Lovejoy (28), and two Caucasians—Dennis Mark (39) and David Kuczynski (28), cleared the underground lunchroom, demanding that park employees help get the visitors out. During the evacuation of about 200 visitors from the underground lunchroom, several gunshots rang out. Meroney ordered one of the park employees, Park Technician Jesus Fierro, to help get visitors out of the lunchroom; Meroney left Fierro, but quickly returned, pointed his rifle at Fierro's feet, cocked the weapon, and pulled the trigger. The rifle failed to fire (**"Operator Heard Episode Start," El Paso Times, July 12 1979**).

Holed up in the underground lunchroom, with hostage Park Technician Linda Phillips, their weapons, and a bottle of whiskey, the terrorists made known their demands: to talk to a reporter, to receive a million dollars, and to be flown to Brazil. Whether or not the four terrorists knew about the 100 or so visitors hiding at the Top of the Cross area is unclear, but what is clear is that they allowed some visitors to return to the surface in the elevators. Other visitors and employees walked out through the Natural Entrance.

During the shooting spree by the terrorists, a wooden bench, a wooden door, a wooden handrail, some audiovisual equipment, and a dress jacket were damaged by gunshot pellets.

At 4:40 p.m. Carlsbad Current Argus publisher Ned Cantwell arrived and attempted to call the terrorists by telephone; they insisted that he come into the cave and talk to them in person. He went down to the terrorist-controlled underground lunchroom at 5:40 p.m.

At 5:25 p.m. FBI Agent Jim Gallagher arrived at park and at 6:35 p.m. El Paso Special Agent Wallace Crossman, specially trained in hostage negotiations, arrived. Crossman assisted Area Manager Jack Linahan and Agent Gallagher in evaluating the gunmen's demands.⁶ Crossman ordered an FBI Special Weapons Attack Team, which arrived 8:00 p.m. and put on stand-by.

Negotiations continued between Area Manager Jack Linahan and the hostage-takers via phone. At one point the gunmen offered to release the hostages in return for a bottle of whiskey, but Linahan refused. Linahan did indicate, however,

that the US Attorney might be receptive to negotiating their demands.

Eventually, the abductors agreed to release Park Technician Phillips and newspaper publisher Cantwell, if the charges against the four Odessa, Texans would be reduced to misdemeanors. The FBI agreed and Phillips and Cantwell were released at 7:07 p.m.

Having traded their demands for a million dollars and a plane ride to Brazil for reduced criminal charges against them, the four gunmen surrendered at 8:47 p.m. Once arrested, the four terrorists faced bail of \$250,000 per terrorist.

Setting the bail was easy compared to what followed. In the days that followed, legal authorities argued two major points: (1) Who rightfully had legal jurisdiction in this bizarre case—New Mexico or the Federal government? (2) Was the guaranteeing of a reduced misdemeanor charge inappropriate for an armed terrorist situation involving so many people

When the legal arguments were resolved, the four Texans found themselves in Albuquerque rather than Brazil:

The four gunmen who took over the Cavern on July 10 pleaded guilty to misdemeanor charges before U.S. Magistrate Robert McCoy in Albuquerque on August 2 (1979 added by Hoff) and were sentenced to one year in prison. According to information received, they will have to serve the full sentence and will not be eligible for paroles.

(Superintendent's Monthly Log, August 1979)

The hostage situation had ended none too soon on July 10, 1979 for maintenance employee Brenda Buris, one of the 100 plus people trapped at the Top of the Cross. Suffering epileptic seizures, Buris, who was without her medication, became unconscious and faced a life-threatening situation. Park Technician Carol Metzger, who managed Buris' medical emergency and the other visitors during the long hours of the cave-takeover, controlled the situation until help could arrive once the hostages had surrendered.

For Ned Cantwell, his part in resolving the terrorist situation brought him an unexpected admirer. On July 27, 1979, in Washington D.C. at a President Jimmy Carter Conference, Cantwell stood in line to shake hands with the Chief Executive. When Cantwell reached the President, Carter read Cantwell's name tag, saw that he was from Carlsbad, and asked him "if he had been the one who went into the Caverns and talked to the four gunmen." Cantwell admitted the distinction and President Carter told the story to the rest of those present, citing Cantwell for "a great act of heroism."

Because the park staff responded so well to that time of crisis and danger, they received a Unit Award for Excellence of Service in January 1980. You might recognize the names of some of these people:

Harold West, Bobby Crisman, Manny Cortez, Tom "Boomer" Bemis, Peggy Justice, Diane Esquibel, Celia Valdez, Bob Turner, and Amelia Tully

July 10, 1979, had indeed included a time of crisis and danger. Four erratic and unpredictable terrorists had taken over the underground lunchroom in a cave in a major National Park on a summer visitation day. They took hostages and in the process fired an estimated 100-200 round of ammunition in the lunchroom. They indirectly kept over a 100 people in the cave against their will for over five hours.

Under these trying conditions, the park staff, local and other law enforcement authorities, and a local newspaper publisher provided for the safety and protection of all the visitors and employees.

And in the process, the NPS staff at CAVE returned the cave to its' rightful owners.

A BRIEF HISTORY OF THE MEXICAN FREE-TAIL BAT CENSUS WORK AT CARLSBAD CAVERN NATIONAL PARK

*Adapted from: "Assess Mexican Free-tailed Bat
Population at Carlsbad Cavern Using Advanced
Thermal Infrared Imaging"
by Myra Barnes*

Mexican free-tailed bats (*Tadarida brasilienses mexicana*) form some of the largest aggregations of mammals known. In addition to the educational and aesthetic value for visitors who visit the spectacular cave formations at Carlsbad Caverns, the world-renowned bat colony contributes to Carlsbad Caverns status as a World Heritage Site. Visitors are able to observe a dense column of bats flying out of the natural entrance during the spring and summer months every year. Foraging bats consume many tons of insects in natural and agricultural areas, providing a critical ecosystem service. These fascinating mammals are known to migrate great distances between summer and winter roosts, using high altitude (up to 10,000 ft) jet stream air currents to carry them hundreds or thousands of miles to their destination.

Despite their importance of being a critical part of many ecosystems and providing valuable ecosystem services, bats are rarely considered in ecosystem management plans for the protection of critical roosting and foraging habitats. This failure, in large part, reflects the lack of data on population estimates, diet and foraging behavior. Understanding the ecological and economic importance of these and other insect predators requires reliable estimates of numbers and composition (Naylor and Ehrlich, 1997). From a management and conservation perspective, it is also important to understand factors which may cause populations to vary seasonally and annually, and further to understand the processes which govern the regulation of long-term population trends (Ricklefs, 1996). This latter goal can only be achieved if accurate long-term assessment and modeling are conducted.

Allison's (1937) emergence count of 8,741,760 bats emerging from Carlsbad Caverns, New Mexico, on June 16, 1936, is the earliest published estimate of colony size, and is the source of the number (8.7 million bats) that is widely cited as the historic population size of Mexican free-tailed bats at this cave. To derive this number, Allison (1937) timed the duration of emerging bats and visually estimated their flight speed, the cross-sectional area of the emerging column of bats, and the density of bats in the column (see McCracken, 2001). Allison (1937) described his measurements, assumptions, and calculations in detail. Allison (1937) also repeated the suggestion of Bailey (1928) that still photography and motion pictures could be used to more accurately estimate the number of emerging bats.

In the summer of 1957, Constantine (1967) estimated the size of the Mexican free-tailed bat colony at Carlsbad Caverns by extrapolating the density of bats roosting on the cave surface to the total cave area occupied by bats. Constantine (1967) estimated an average roosting density of 300 adult bats/ft² of cave surface area. He measured the total roosting surface in the cave as units of "discs of light." Cave ceiling height was measured from the length of a string attached to a helium-filled balloon, and the actual areas of the "discs" were measured over a range of ceiling heights. Extrapolating 300 bats/ft² multiplied by measurements of the cave surface occupied by the bats, Constantine (1967) estimated the numbers of bats occupying Carlsbad Caverns at 28-day intervals between April and October 1957. These estimates showed an increasing population from the arrival of bats in April, peaking at approximately 4 million individuals in September. Constantine (1967) acknowledged that irregularities in the cave surface were a primary source of measurement error.

Historically, the most sophisticated exit count reported for Mexican free-tailed bats, Altenbach et al. (1979) attempted to account for the various passage rates and flight directions of bats by using high-speed motion picture photography and still photography. Working at Carlsbad Caverns in the summer of 1973, Altenbach et al. (1979) observed nightly emergences over several weeks and identified a single, restricted space at the cave entrance through which most bats emerged. On September 1, 1973, still (flash) photographs were taken at the exit space every 30 seconds, for the first 44.5 minutes of the emergence, and still photos were taken at 60-second intervals for the following 15 minutes, until all bats had departed the cave. Simultaneously, during the first 45 minutes of the emergence, 5-second high-speed motion pictures (200 fps) were taken at 5-minute intervals. Glossy, 8 x 10 prints of the still photos were used to count bats and record their direction of flight. The motion picture runs were used to calibrate and correct for bats flying into versus out of the cave, and to compute the average replacement time that it took for a group of bats photographed at one instant to be replaced by the next group of bats. The numbers of bats passing through the exit space during each 30-second (or 1-min) interval were then computed and summed for the full emergence. Using these procedures, Altenbach et al. (1979) calculated that 218,1563 bats emerged from Carlsbad Caverns on September 1, 1973, about 5% of Allison's estimate in June 1936.

Dr. Nickolay Hristov and Dr. Thomas Kunz are currently working on censusing Mexican free-tail bats at Carlsbad Caverns using thermal imaging technology to determine bat population densities. Dr. Kunz and his team at Boston University have been working since 1995 to develop software that can be used with advanced thermal infrared imaging. This is the most accurate method of estimating the number of bats emerging from large colonies. His thermal infrared work was featured on National Geographic Explorer program "Phantoms of the Night" and in The Nature Conservancy magazine.

The advanced infrared imaging system is capable of accurately and reliably counting the number of Mexican free-tailed bats during a nightly emergence. This census method is far superior to others that have been used to census large bat populations (reviewed in Kunz et al., 1996). This automated censusing method allows frequent, accurate, and repeatable estimates of the number of bats present independent of colony size, ambient light, and weather conditions, and without causing disturbance to the colony. The censusing protocol involves: 1) passive detection of individual bats based on advanced infrared thermal imaging, 2) recording real-time, high-fidelity digital infrared images, and 3) processing the recorded digital data into reduced data sets for further analysis.

Based on Kunz's previous research and field experience, this infrared imaging system makes it possible to reliably detect and resolve individual bats in flight. All objects with a temperature above absolute zero (0°K or -273°C) emit in the infrared spectrum. Thus, flying bats with body temperatures of about 39°C become high-contrast targets against variable and cluttered backgrounds in the relevant infrared band. Unlike image intensification methods (e.g., night vision devices), this system can passively detect infrared emissions in the 3 μ to 5 μ thermal waveband, independent of visible illumination. This method can be used in virtually any lighting condition from full daylight to completely moonless, overcast nights. By eliminating the need for artificial illumination at any waveband (visible or infrared), this census method is completely non-invasive. Use of the 3 μ to 5 μ waveband also provides near 100% transmission through the atmosphere allowing the detection of individual bats at ranges of several kilometers using appropriate optics.

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HOW MANY BATS? ADVANCED THERMAL IMAGING: AN ANSWER TO A CENTURY OLD QUESTION

Season 1 Update
by Dr. Nickolay Hristov

Mexican free-tailed bats (*Tadarida brasiliensis mexicana*) form some of the largest aggregations of mammals known. With its relatively small size the colony of free-tail bats at Carlsbad Caverns does not rank high on the list of largest colonies in the US, nevertheless because of its easy access for the public, rich history as part of the park and characteristic emergence pattern of the bats, it is well recognized around the world, making it a principle attraction for the park, second only to the Cavern itself.

As a result thousands of visitors each year converge to the natural entrance of the cave every night to observe the bats as they take on the wing for their nightly feast. Yet, as the visitors come to learn about the bats' reproductive, feeding and migrating behavior, the experience that most people take with them is the powerful and fascinating sensation of the thousands and thousands of bats flying in a thick column out of the cave. Not surprisingly, the question most frequently asked is: "how many bats are there?"

The question has had a long and difficult history. Attempts to provide the answer date back to as early as the discovery of the cave and its bat colony. Different approaches have been used through the decades, unfortunately, all providing far from definitive answers (see article by Myra Barnes in this issue).

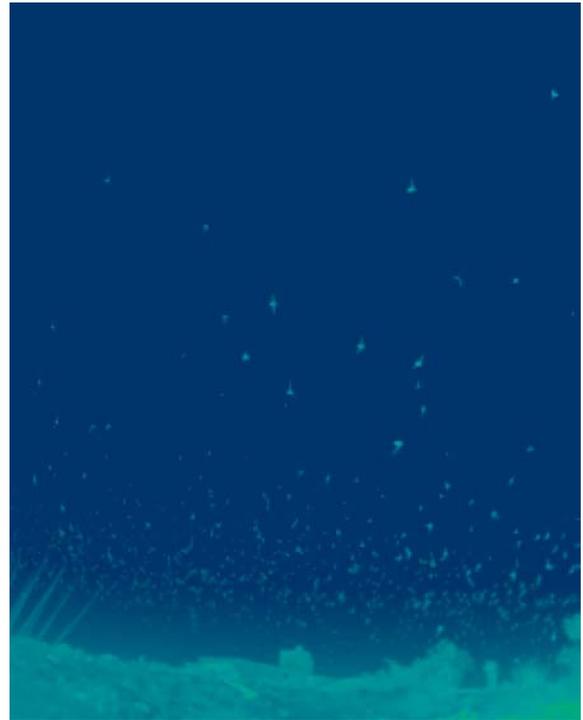
This summer a team from Boston University and funded by the National Park Service has initiated a 3-year project to census the colony of Mexican free-tailed bats in Carlsbad Caverns and study the changes in the size of the colony throughout the season. Unlike previous attempts to census the colony, which relied on approximation techniques, the project utilizes a novel and promising approach based on the principles of advanced thermal imaging. Thermally sensitive cameras detect differences in the temperature of objects in the field of view. Since bats in flight are usually warmer than the surrounding environment, they are recorded as bright objects against a darker background. The stored information is exported to custom software developed at Boston University which in a series of filtering steps separates the moving bats from the stationary background and other randomly moving objects (Figure 1). The result is an accurate and reliable way of counting the bats that is minimally disturbing while at the same time is virtually independent of colony size, ambient light and weather conditions. Prior census methods were disturbing to the bats, very labor intensive and could take weeks if not months to compile the information. The new method can produce a reliable and repeatable count of every bat in the colony in just a few days.

The goal of the first season for the project was to familiarize the researchers with the specificities of the emergence pattern of bats, provide pilot census data, as well as to explore alternative applications of the available technology. Preliminary analysis of the results indicate a steady increase in the size of the population from about 100,000 bats in the middle of August to about 200,000 by the end of August and beginning of September to about 400,000 by the end of September and beginning of October. The source of the incoming bats is unknown but presumed from northern colonies migrating south and using the cave as a stop over. The objective in the next few weeks is to record the changes in the size of the colony as the bats start to migrate to Mexico during the month of October.

Other applications of the technology allow recording of the activity pattern of bats as they emerge and return to the cave several times throughout the night. In addition thermal imaging in combination with 3D modeling might prove useful in the study of the emerging vortex of bats at the opening of the cave as well as in the study of how free-tailed bats, detect, approach and capture their food.

The long terms goals for the project are to develop a monitoring protocol that is optimal for detecting significant population changes as part of a general, science-based, resource management plan.

A



B

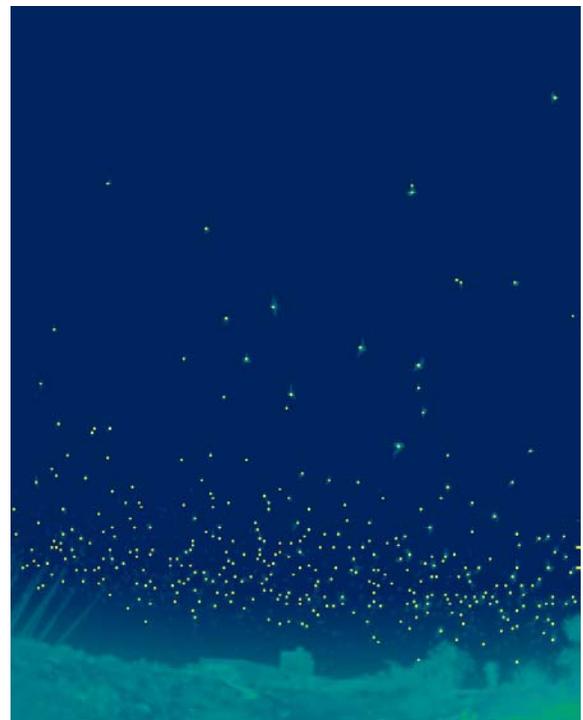


Figure 1: Illustration of the adaptive filtering procedure in the identification and counting of emerging bats at Carlsbad Caverns National Park: (A) Unprocessed view of free-tailed bats emerging south of the cave entrance with the park visitor center in the background; (B) Moving bats are identified and tagged by the computer; (C) *On next page* - Processed view of the original image; bats are separated from the background and other non-directionally moving objects and counted by the computer.

C



Look for Issues of *Canyons & Caves* at the following websites:
<http://www.nps.gov/cave/pub-pdf.htm> Thanks to Kelly Thomas and Bridget Einfeldt all issues can be downloaded as a PDF file from the park website.
<http://www.caver.net/> Once there, go to the Canyons & Caves icon. Bill Bentley has placed all issues on his personal website and can also be downloaded as PDF files.

Address: 3225 National Parks Highway, Carlsbad, New Mexico 88220