Cave and Karst Programs

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This Issue Edited by Rodney D. Horrocks, Wind Cave National Park

A Newsletter of the Cave & Karst Programs of the National Park Service

Peg Palmer lights up the north end of the Chimera Room in the North Section of Wind Cave. Photo by Art Palmer, 2003.

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Feature Article:

TEMPERATURE FLUCTUATIONS CAUSED BY THE LIGHTING SYSTEM IN WIND CAVE, SOUTH DAKOTA

Marc Ohms
Physical Science Technician
Wind Cave National Park

Introduction

Wind Cave became a national park in 1903, but the cave did not have an electrical lighting system until 1931. The lighting system underwent many changes over the years, and the current system has been in place since 1979. It consists of 650 light fixtures and 6 transformers. This system illuminates over one mile of passage for three different tour routes. The system has one power switch that runs all three tour routes.

This study is part of a comprehensive project investigating all possible causes of unnatural temperature fluctuations within the cave. These include the lighting system, human presence, and manmade or modified cave entrances.

Methodology

Onset Hobo Pro Series data loggers were used to record temperature. The data loggers were left in place for 6-7 days at each location and readings were taken every 15 minutes. All temperature readings are given in degrees Fahrenheit. The sites were chosen for their proximity to a potential heat source. A control was established at each site, in a location not influenced by the targeted heat source. This was to ensure that the only source for any recorded temperature fluctuations would be the targeted source.

Transformers

To determine if the temperature in the cave fluctuates due to the lighting system transformers, two transformers were selected and monitored. Transformer #1 is in an enclosed area, surrounded by both natural cave walls and a manmade rock wall. Transformer #2 is in an open area in the middle of a large room.

As can be seen in figures 1 and 2 the temperature at transformer #2 is not affected beyond 1 foot, whereas transformer #1 affected the temperature up to 3 feet away. The highest temperature for transformer #1 was 55.97 degrees (*a 1.39 degree increase*), while the highest temperature at transformer #2 was 55.28 degrees (*a 2.09 degree increase*). The most notable effect from the transformers was the length of time the surrounding air was affected after the power was shut off. At transformer #1 it took 10 hours before the temperature returned to the normal cave temperature (the temperature recorded by the control), and at transformer #2 it never returned to normal temperature. This is likely due to the transformer's ability to hold heat for long periods of time.

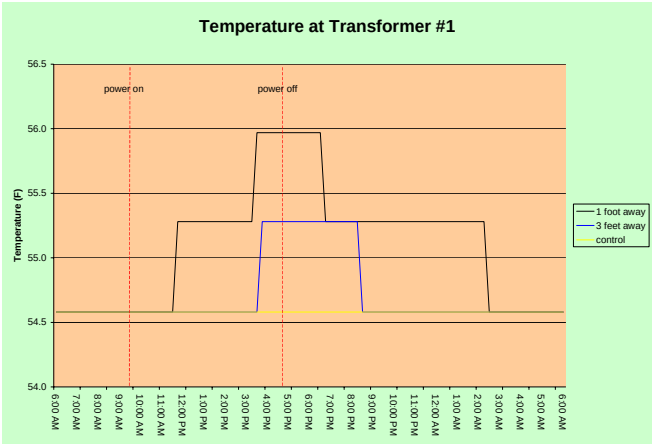

Figure 1- Temperature at transformer #1 during a 24-hour period

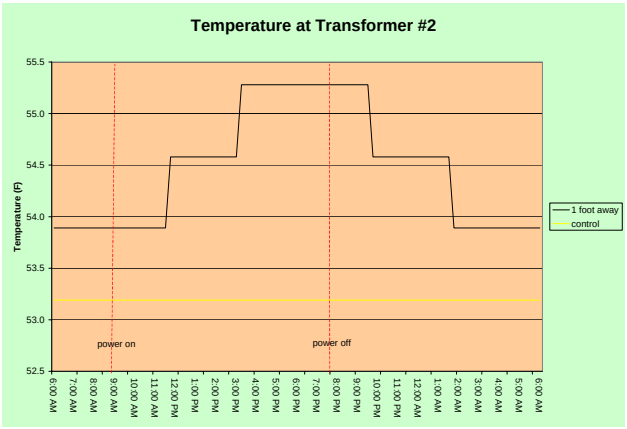

Figure 2- Temperature at transformer #2 during a 24-hour period

Lights

To determine if the temperature in the cave fluctuates due to the lights, three lights were selected and monitored.

During a study at Lehman Cave, Stark discovered that there were significant temperature increases around the lights (Stark 1969). He determined that the more enclosed a light was, the higher the temperature fluctuation. This also can be seen in the data from Wind Cave.

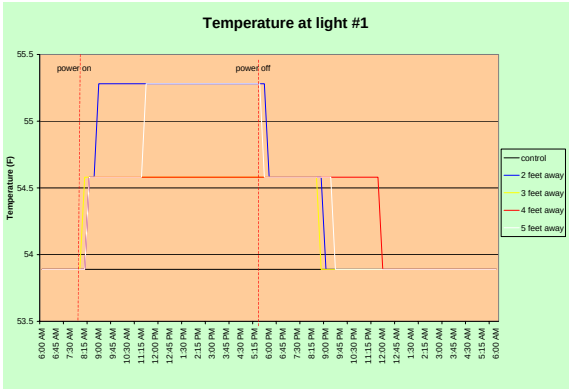

Figure 3- Temperature at light #1 during a 24-hour period

Light #1 (*figure 3*) is a 60-watt bulb, located on the floor under a shelf near the edge of a large room. Data loggers were placed at 1-foot intervals starting at 2 feet from the light and extending to a distance of 5 feet, to a cave wall. The temperature changed at every interval with a maximum temperature increase of 1.39 degrees. Although this light had a lower maximum temperature, its fluctuations extended a greater distance from the light and it had longer recovery times then the other sites.

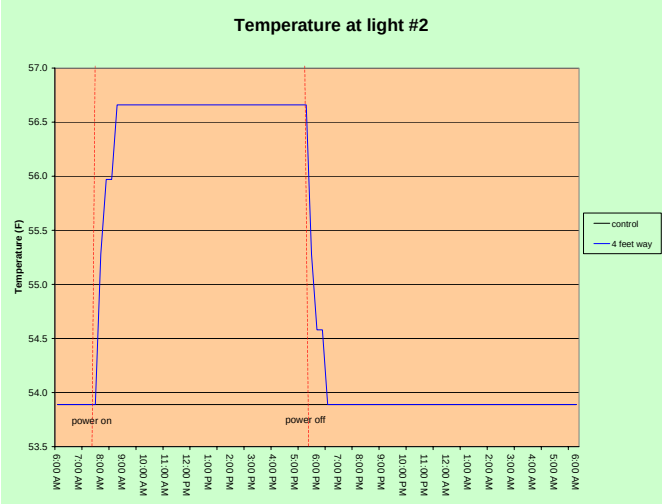

Figure 4- Temperature at light #2 during a 24-hour period

Light #2 (*figure 4*) is a 60-watt bulb, located on the floor of a large room. The data loggers were spaced along the passage at 4-foot intervals in front of the light to a distance of 20 feet. Only the data logger closest to the light at a distance of 4 feet showed any fluctuation in temperature. The temperature rose immediately once the power was turned on and sharply dropped once the power was turned off. It took one hour for the temperature to return to normal. The maximum temperature increase was 2.77 degrees.

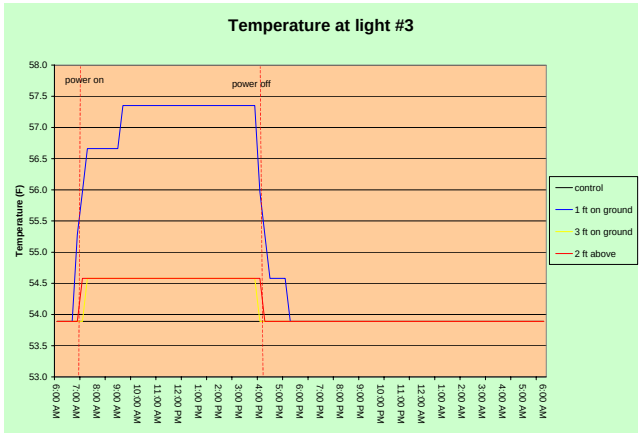

Figure 5- Temperature at light #3 during a 24-hour period

Light #3 (*figure 5*) is a 60-watt bulb and is located on the floor in a large room. To determine if heat from the light rose straight up from the fixture, three data loggers were hung on string from the ceiling at 2-foot intervals. Two additional data loggers were placed in front of the light at a distance of 1 and 3 feet. The largest rise in temperature was 3.46 degrees and was at the 1-foot interval in front of the light. The data loggers hanging above the fixture at the 2 and 4–foot intervals as well as the data logger at 3 feet in front of the light all recorded a rise in temperature of 0.69 degrees.

Conclusions

The study indicates that the lighting system does affect the air temperature locally, but does not appear to affect the overall cave temperature. The loggers used as controls were placed away from the lights but within the same passage, and did not record any rise in temperature when the power was on. The influence of the lighting system appears to be localized within a few feet from each light. This may be due to the airflow throughout the cave, which constantly moves the air.

Although the influence of the lights does not extend far, it should not be concluded that there is no impact to the cave. Albeit small, the rise in temperature surrounding each light promotes algae growth and increases evaporation by lowering the relative humidity. This increased evaporation dries out the sediments, minerals, and speleothems around each light. In Castellana Cave (*Forti, 1980*) the humidity decreased from 95-100 percent to 55-60 percent in a few seconds after the lights was turned on. Changes in temperature and humidity can influence the type, form, or morphology of a speleothem (*Hill and Forti 1997*).

Recommendations

The park has currently received funding to replace the lighting system throughout the cave in 2006. It is highly recommended that the park utilizes cooler light bulbs and adds additional circuits to the system so that each tour route will have a separate power switch. Additional switches should be installed in areas where the lights are directed onto a wet area or an area with cave formations. Park staff may then turn on the light only when needed, drastically reducing the time the light is on.

References

Forti, Paolo. 1980. FORMAZIONE DI ARAGONITE NEDA GROTTA DI CASTELLANA: UN ESEMPIO DELLA MODIFICAZIONE INDOTTA DALLA TURISTICIZZAZIONE. Grotte d'Italia, s. 4, 8, 1-10.

Hill, Carol, and Paolo Forti. 1997. CAVE MICROCLIMATE AND SPELEOTHEMS. Cave Minerals of the World, second edition, p. 258-261.

Stark, N. 1969. MICROECOSYSTEMS IN LEHMAN CAVE, NEVADA. NSS Bulletin, v. 31, no. 3, p. 73-81.

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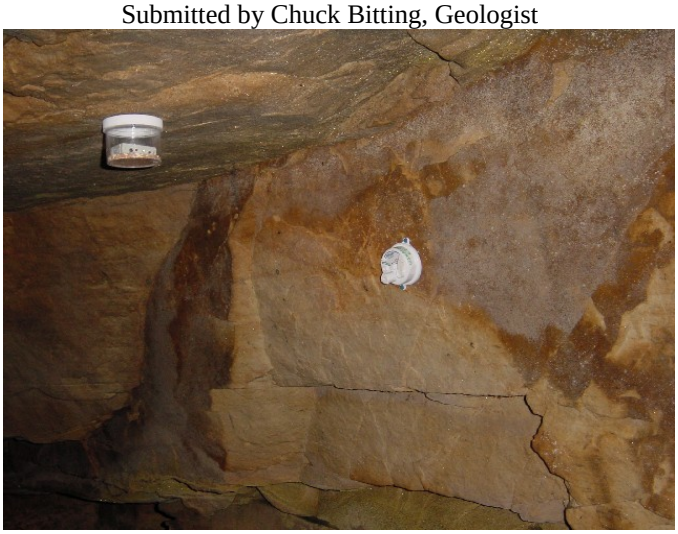
Park Updates (Listed alphabetically):

BUFFALO NATIONAL RIVER

Submitted by Chuck Bitting, Geologist



Three dataloggers were recently installed inside of fifteen Buffalo National River caves to study temperature and humidity conditions in bat roosts of endangered species.

Bat Roost Micro-Climates at Buffalo National River

In the summer of 2003 Buffalo National River and Arkansas State University began a cooperative study to assess the temperature and humidity conditions of fifteen caves that function as roosts for endangered bats. During this study, temperature and relative humidity readings will be recorded every three hours by HOBO® dataloggers. There are three dataloggers inside and one outside of each cave. The in-cave dataloggers are placed adjacent to roost locations. The exterior dataloggers are placed in areas that will not be influenced by cave air. These data will represent the climatic conditions present at the bat roosts, and how they relate to surface temperature fluctuations. Several researchers have been participating in a similar inquiry of Indiana (*Myotis sodalis*) bat roost conditions throughout the species range. The results of this investigation can be compared with those of the related studies to determine the climatic quality of the Indiana bat roosts on the National River. The current investigation is also measuring the conditions at Gray (*Myotis grisescens*) and Ozark Big-Ear (*Corynorhinus townsendii ingens*) bat roosts throughout the National River. Only two of the roost caves being studied have full gates protecting the roosts from human disturbance. The remaining thirteen are protected with either a fence or closure signs. Part of this investigation is an assessment of human disturbance of the roosts. Parameters to perform this analysis are being measured using HOBO® event recorders, and by making careful observations of indicators of human activity during each visit. This information will be combined with the climatological data to determine a range and priority of management actions to maximize protection of each species roosting habitat. This assessment has received monetary or in-kind support from the National Park Service, Arkansas State University, Arkansas Game and Fish Commission, United States Fish and Wildlife Service, and Bat Conservation International.

CARLSBAD CAVERNS NATIONAL PARK

Submitted by Dale Pate, Supervisory Physical Scientist

THANKS AND GOODBYE – Congratulations to Superintendent Mary Gibson Scott. She has been selected to be the new Superintendent at Grand Teton National Park beginning in early May. We have appreciated the Superintendent's ability to make a number of critical projects take major steps forward while still protecting park resources. We will miss her energy and drive and know that Grand Teton National Park will be in good hands.

NEW DEPTH & LENGTH FOR LECHUGUILLA CAVE – A more reliable depth for Lechuguilla Cave has been determined to be 1,604 feet (489.0 meters). No new deeper passage has been found, but several significant survey loop closure errors have been fixed over the last few years. By fixing these errors, we have a better idea of the actual depth of the known cave. As the survey data becomes more reliable, particularly in relationship to the depth of the cave, we may have to adjust our depth figures once again. For now, the known depth of the cave is 1,604 feet (489 meters) deep. A total of nine survey expeditions were permitted in 2003. These expeditions resurveyed 2.8 miles of passages and added 2.7 miles of new discoveries bringing the total length by the end of 2003 for the cave to 111.92 miles (180.1 kilometers).

UPCOMING CONSTRUCTION PROJECTS – To help serve visitors to the park and to better protect resources, there are several significant changes scheduled for the park in the next few years. The first will be the Visitor Center Rehabilitation Project that will completely rehab the current Visitor Center (a Mission 66 building from the late 1950's). This rehab will not change the overall footprint other than place new restrooms outside the front of the building and the kennel is to be moved to the west side of the building. This project is slated to cost $7.2 million with construction to begin within a year or so. Closely following this project will be the repair and rehab of Walnut Canyon Drive and the three parking lots associated with the Visitor Center for $2.45 million. This 7-mile long paved road was first built in 1930 and several problems will be fixed during this project. Additionally, problems associated with the parking lots will be fixed along with the addition of oil and gas separators being installed. Also under this project, the bat flight parking area will be reconfigured with a bus drop-off and handicapped parking put in place on the west end and with pavement from much of the current parking area to be removed. As part of the Caverns Historic District, the rock walls will be left in place for most of this area. The third project, the replacement and realigning of the outfall sewer

line will be completed after the others at a cost of $2.57 million. Scheduled for replacement will be the line from the Bat Flight restrooms to the front of the Visitor Center, the outfall system from the Visitor Center down to the present sewage lagoons, and the rehab of the present sewage lagoons.

ONE MORE CAVE – A new cave was recently documented bringing the total known caves in the park to 107.

CIVIL DEFENSE BARRELS REMOVED – At the height of the Cold War, the Underground Concessions area of Carlsbad Cavern was declared a Fallout Shelter. In early 1963, food, water, and medical supplies were received and stored in an area off of Pickle Alley. While most of the items were removed from the cave a number of years ago, seven steel water barrels had been left in an alcove off of Left-hand Tunnel only a short distance from the paved concessions area. For long-term protection of the barrels as well as for resource protection (the barrels had been rusting), the barrels were removed from the cave and temporarily stored at the Cultural Resources office.

Civil defense barrels stored in the Left-Hand Tunnel since 1963, when Carlsbad Caverns was declared a fallout shelter, were recently removed due to natural and cultural resource protection issues.

JEWEL CAVE NATIONAL MONUMENT

Submitted by Rene Ohms, Physical Science Technician & Mike Wiles, Cave Specialist

Mid-Winter Bat Count
The annual hibernating bat count was conducted on January 5, 2004, in the Historic Area of Jewel Cave. A total of 1,345 bats were counted, including 886 *Corynorhinus townsendii* (Townsend's big-eared bats), 2 *Eptesicus fuscus* (big brown bats), and 457 of the genus *Myotis*.

New Cave Management Volunteer
Jewel Cave's new cave resource management volunteer, Peggy Renwick, arrives at the end of May. We look forward to working with her!

Four-Day Camp Trip
A four-day camp trip in January 2004 netted a half-mile of additional survey at the end of the cave, bringing Jewel's total surveyed length to 129.75 miles.

Ruggedized Laptop
A ruggedized laptop was purchased last year, and was hauled to the camp site 7 hours into Jewel Cave on the January camp trip. The laptop is being left in the cave, and will be used to plot new survey on multi-day caving trips. A rechargeable battery and compact flash data card will be carried in on each trip.

Airflow Study
Dr. Andreas Pflitsch, of Bochum University in Germany, is conducting airflow research at Jewel Cave using ultrasonic anemometers. Direction and velocity data are being recorded at the Historic entrance, Hurricane Corner, and Hell's Half Acre. One of the goals of this study is to calculate an airflow mass balance.

Lint Tarp Cleaning
In March, the Paha Sapa Grotto assisted park staff with cleaning the "lint tarps," which are suspended under each stairway and platform along the Scenic Tour route. The tarps catch lint, hair, and everything else left behind by visitors on tours.

MOJAVE NATIONAL PRESERVE

Submitted by Ted Weasma, Geologist

Mojave National Preserve has less than 50 known caves and most are short with little in the way of speleothems. One of the largest is Clark Mountain Cave. It is a dead cave that was discovered by miners long before the Preserve was established. Most of its speleothems were broken off and sold as curios. The one known lava tube in the park is the only cave that gets a fair amount of public caving use. Mitchell Caverns, which is a state of California park unit surrounded by the Preserve, also gets a fair amount of public use on its guided tours.

The park is working with the Southern California Grotto to map and inventory all the known caves in the Preserve and to search for new ones. The American Women Geoscientists organization has recently agreed to sponsor, through the Geologist in the Park Program, an American Women Geoscientist to come to the Preserve and assist in this project.

OREGON CAVES NATIONAL MONUMENT

Submitted by John E. Roth, Natural Resources Specialist

The Environmental Assessment, Errata and FONSI for special cave tours are now complete and are awaiting a signature from the regional director. Revision of the subsurface management plan continues, with two public meetings held 19 photomonitoring points of cave trails were

installed by Jim and Val Werker. With the help of NRPP funding of a three year term supervisor of cave restoration, the number of cave restoration volunteer hours has doubled. 4075 square ft. (algae, rubble, lint) of cave surfaces were restored. 170 square ft. of vinyl tarps and organic settling basins below cave stairs were installed. A 100 page room-by-room interpretive guide on the main trail was revised.

Biology: Hibernating bats in the cave have been declining in numbers for the last two winters, presumably due to warmer winters preventing the near freezing cave temperatures that Townsend big-eared bats prefer. However, a study by Dr. Steve Cross indicates that summer use remains fairly constant although most bats are now using a different entrance into the cave than they had used before. Harvestmen also appear to be moving around more and leaving the cave earlier than was the case three years ago. Dr. Stewart Peck is describing what appears to be a new genus of eyeless leioidid beetle found in the cave a decade ago and now found in deep soils habitats of the Monument. Dr. Rod Crawford is describing two new species of millipedes. DNA work has started on grylloblattids, two species of which are also undescribed. DNA sampling of the proposed caving route is complete but the full analysis is not yet done. Previous compaction appears to have some affect on the biodiversity of bacteria via changes in water, nutrient, and/or air flow. Visitor impact mapping starting this summer should baseline the extent and percentage of compaction using a penetrometer. Fossil or sub-fossil bones of 14 species, including elk, wolf, and possible wolverine (all extirpated), were identified. The oldest dated radiocarbon jaguar remains, as well as the northernmost, and apparently the most complete remains, were dated at 38,600 years. Cave microfungi were identified with 34 species new to ORCA. Cave bibliographies, glossaries, and benthic, infaunal, epifaunal, interstitial, hyporheic, cave, and groundwater species lists for North America north of Mexico were updated.

Geology: Crystals that may have once been aragonite were x-rayed and turned out to be calcite. Surface soil mapping and chemical tests over the cave are complete and will be used to determine soil affects on ions, pH, etc. in cave water. A cave climate baseline with dataloggers, marble blocks, and more water ion monitoring will begin this summer to assess the effect of global warming and carbon dioxide increases on cave calcite solubility, radon, relative humidity, and temperature. A three year baseline for cave water quality and quantity is complete and will be used to assess the effects of prescribed burns. Chloride concentrations in rainwater and cave water indicates a >90% evapotranspiration rate likely due to more shrub and small tree growth on the surface. Less water in the cave affects speleothem growth. Due to body or limb elongation and the loss of waxy cuticles, troglobitic species are more vulnerable to dessication than most surface species. A Master's thesis on a broken stalagmite in the main cave indicates a temperature cycle of 190 years between ~13,500 and 9,500 years ago, most likely a solar luminosity cycle. A year-long radon survey was done for the main public trail and the proposed caving route.

A new cave restoration supervisor position at Oregon Caves National Monument recently directed a project to install vinyl catchment tarps underneath stairs along the tour route in Oregon Caves.

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SEQUOIA AND KINGS CANYON

Submitted by Shane Fryer, Cave Technician, and Joel Despain, Cave Specialist

The Cave Resource program is preparing for a busy field season at Sequoia and Kings Canyon. Currently on our plate are three major projects.

The first will replace gates on two caves in the southwestern corner of Sequoia National Park, and a gate on a previously un-gated entrance to Crystal Cave. Due to recent cases of vandalism and poor design, both Soldiers Cave and Clough Cave will be refitted with much sturdier and more biologically friendly ACCA-style gates. At Crystal Cave a very small entrance, known as Red Belly, will be gated due to its proximity to the tourist trail to the main cave entrance. The implementation plan for this project is finished, project funding has been received, and we are now seeking bids and hope to award a contract within the next 6 weeks.

The second project involves the removal of restroom facilities from inside Crystal Cave as well as trail renovation, and hose cleaning in areas sullied by years of caver and tourist traffic. Due to the restroom's failure to meet state sanitation requirements, they have been abandoned for five years. The Cave Resource Program is planning on removing walls, fixtures, and plumbing in the bathrooms to restore twilight-zone habitat, and to return the cave to a more natural setting using volunteer labor from the

Western Region of the National Speleological Society. Also sections of elevated trail will be replaced with a railed catwalk in the Organ Room. This work will move visitors away from the Organ formation, which has been severely vandalized on two occasions and will restore many square feet of cave floors. The project is currently highly ranked and we hope to receive funding this year.

Jean Krejca, from Zara Environmental will return to the parks at the end of April to continue her work with the Cave Biological Inventory project. She will be here for three weeks, along with Peter Sprouse, to collect cave invertebrates during the wetter and cooler springtime.

In other news, three new caves, South Fork View, Pine Grossbeak, and Rock Wren, were found in Sequoia this spring bringing the grand total to 211 known caves in the parks.

WIND CAVE NATIONAL PARK

Submitted By Rodney D. Horrocks, Physical Sciences Specialist & Marc Ohms, Physical Science Technician

Cave Resource Management at Wind Cave National Park is as busy as ever. Some of the highlights that have occurred at the park since the last issue of Inside Earth include:

A timeline has been established for the revision of our Cave & Karst Resource Management Plan. We are currently in the process of conducting internal scoping, which will determine the desired future conditions of the park's cave and karst resources and how we obtain those conditions. Once that has been completed, we will be drafting a new Cave and Karst Resource Management Plan and the necessary environmental compliance documentation. The goal is to have them ready to be released to the public in November.

Allen Heakin of the USGS is finalizing a report on the work done over the course of the last three years on water quality of the park's streams, parking lot runoff, and Wind Cave.

Marc Ohms recently presented a "*Status of the Groundwater Lakes in Wind Cave*" at the Western South Dakota Hydrology Conference in Rapid City. His presentation summarized what is known about the cave lakes in Wind Cave and their relationship to nearby monitoring wells in the Madison Aquifer.

Marc recently finished a project to determine the influence cave lights have on temperatures along the tour routes within Wind Cave (see feature article in this issue).

Our Maintenance crew has finished a winter project to install new handrails along the Natural Entrance tour route in Wind Cave. This project is replacing all existing aluminum and steel rails with stainless steel rails that are a standardized design, size, and height. In addition, some new rails have been added to stairs that previously had no handrails.

The park is slated to receive line-item funding to replace the Wind Cave lighting system in 2006. In preparation for this work, we recently completed a map of the proposed new cable routes and circuits. We used these maps during a three day value analysis meeting to examine a list of alternatives for this project. In order to select a preferred alternative, we looked at light types, cables and routing, costs, energy, safety, cultural resources, and impact from installation and use.

We recently completed updating two more of our cave quadrangle maps. These quadrangle maps are being drafted in pencil on pre-printed Mylar sheets, so they can be easily kept up to date with new cave survey as it is completed. There are currently three additional quadrangles at various stages of completion, which leaves only one quad left to update. We anticipate that all 21 Wind Cave quadrangles will be completed by September of 2004.

The Wind Cave survey continues to make interesting discoveries. One recent survey discovered a thick manganese deposit that is more reminiscent of the manganese in nearby Jewel Cave. The surveyors named the area, the Manganese Stop. Since the last reported length of Wind Cave within the Inside Earth newsletter, volunteer cavers have increased the surveyed length of the cave by 2.87 miles, establishing the current length of 110.97 miles.

Book Announcement:

Ice Age Cave Faunas of North America
Edited by Blaine W. Schubert, Jim I. Mead, and Russell Wm. Graham
An up-to-date exploration of vertebrate cave life during the Ice Age

This book gathers the findings of a number of studies on North American cave paleontology. Although not intended to be all-inclusive, *Ice Age Cave Faunas of North America* contains contributions that range from overviews of the significance of cave fossils to reports about new localities and studies of specific vertebrate groups. These essays describe how cave remains record the evolutionary patterns of organisms and their biogeography, how they can help reconstruct past ecosystems and climatic fluctuations, how they provide an important record of the evolution of modern ecosystems, and even how some of these caves contain traces of human activity. The book's eclectic nature should appeal to students, professional and amateur paleontologists, biologists, geologists, speleologists, and cavers. The chapters of the book are:

1. Sloth Remains from North American Caves and Associated Karst Features H. Gregory McDonald

2. The Late Wisconsin Vertebrate History of Prince of Wales Island, Southeast Alaska Timothy H. Heaton and Frederick Grady
3. Arvicoline Rodents from Screaming Neotoma Cave, Southern Colorado Plateau, Apache County, Arizona, with Comments on the Pleistocene Biogeography of *Lemmiscus curtatus* Christopher J. Bell and Jennifer Glennon
4. Late Pleistocene Faunas from Caves in the Eastern Grand Canyon, Arizona Jim I. Mead, Larry L. Coats, and Blaine W. Schubert
5. Pleistocene Tapir from Hill Top Cave, Trigg County, Kentucky, and a Review of Plio-Pleistocene Tapirs of North America and Their Paleoecology Russell Wm. Graham
6. Paleoecological Interpretation of Late Holocene and Late Pleistocene Micromammal Faunules from Duhme Cave, Eastern Iowa Carmen M. Jans-Langel and Holmes A. Semken, Jr.
7. A Late Pleistocene and Early Holocene Mammalian Fauna from Little Beaver Cave, Central Ozarks, Missouri Blaine W. Schubert
8. A History of Paleontological Investigations of Quaternary Cave Deposits on the Edwards Plateau, Central Texas Ernest L. Lundelius, Jr.
9. Mammalian Fauna and Paleomagnetics of the Middle Irvingtonian (Early Pleistocene) Fyllan Cave and Kitchen Door Localities, Travis County, Texas Alisa J. Winkler and Wulf Gose
10. A Preliminary Report of the Late Quaternary Mammal Fauna from Loltún Cave, Yucatán, Mexico Joaquin Arroyo-Cabrales and Ticul Alvarez (deceased)
11. Caves and the Pleistocene Vertebrate Paleontology of Mexico Joaquin Arroyo-Cabrales and Oscar J. Polaco

The book is part of the Series**:** Life of the Past Series published by Indiana University Press in association with the Denver Museum of Nature & Science and is cloth covered with 400 pages, plus and index and with 79 black and white photos. The cost is $65.00. The ISBN is 0-253-34268-6.

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