Cave and Karst Programs

National Park Service
U.S. Department of the Interior

Inside Earth

Not all caves in Grand Canyon National Park are dry and dusty. Stan Allison (CAVE) begins the sketching process at the entrance of Abyss River Cave. NPS Photo

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April 2012
30th Geoscience abstracts due for NSS convention
May 2012
20-23rd Digital Mapping Techniques in Champaign, IL http://www.isgs.illinois.edu/research/DMT/links.shtml
25-27th International Congress of Speleology on Mayan Caves http://espeleoquintanaroo2012.orgmx.net/espeleo-quintanaroo
June 2012
4-23rd Karst Field Studies Program , KY, MO, and NM www.karstfieldstudies.com
18-23rd International Karstological School on "Classical Karst", Slovenia http://izrk.zrc_sazu.si/en
25-29th National Speleological Society Convention in Lewisburg, WV http://nss2012.com/
August 2012
14th abstracts due for Geological Society of America (GSA), Annual Meeting
27-31st Black Hills Cave Restoration Camp, SD. Email Kelly_C_Mathis@nps.gov
September 2012
12th International Symposium on Psuedokarst, Galicia, Spain http://www.mauxo.com/isp2012g.html
October 2012
1st Technical Assistance Request first call http://nrpcstar/
November 2012
4-7th Geological Society of America (GSA), Charlotte, NC http://www.geosociety.org/meetings/2012/
January 2013
7-11th A Karst Waters Institute Symposium on Carbon and Boundaries in Karst, Carlsbad, New Mexico http://www.karstwaters.org/

Submit Entries for the Calendar to: andrea_croskrey@nps.gov

A Word from WASO

Submitted By Dale Pate

New Beginnings

With the retirement of Ronal Kerbo in February 2007, the Cave and Karst Program Coordinator position became a funded ½ time detail in May of that year. I have had the opportunity to work as the Acting Cave and Karst Program Coordinator in this detail since that time. As many know, this detail is about to end because the position is currently in the process of being filled as a full-time term position. While this ½ time detail has been able to help numerous parks with technical assistance requests and keep the national program alive, it has also meant that the scope of the program has been limited. With the placement of a full-time position imminent, the Cave and Karst Program will once again benefit from a lead coordinator that can focus their entire attention on the national program.

Dale Pate, Supervisory Physical Scientist at Carlsbad Caverns National Park, has been working on a half-time detail as the NPS Cave and Karst Coordinator since May 2007.

Inside Earth Newsletter - Many thanks to Rod Horrocks who served as Editor of *Inside Earth*, producing eight issues from Spring 2004 through the Summer of 2010. Rod did an excellent job keeping the newsletter up-to-date and his efforts to keep cave and karst parks informed have been greatly appreciated. Begun in Spring 1998, *Inside Earth* has been an excellent communication tool for the national program and has also served as a documented history of cave and karst management activities within the National Park Service (NPS).

Andrea Croskrey (GRD) has taken over the duties of producing *Inside Earth* and plans on producing two issues a year beginning with this issue. All parks with cave and karst resources are encouraged to contribute to this newsletter.

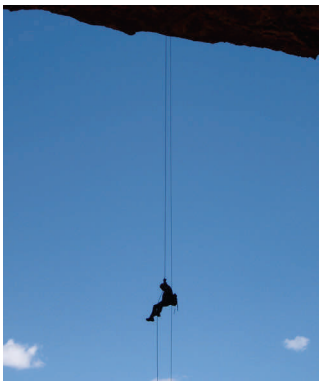
It has been with the support of GRD management over the last five years that the Cave and Karst Program has been kept alive despite budget constraints and other considerations. This support has been greatly appreciated and has allowed the NPS to continue a successful program of helping parks to protect and conserve cave and karst resources while keeping visitor access and education as one of several important goals. Meanwhile, there were some significant milestones and events during this lean budgetary time. A couple of these are as follows:

Technical Assistance Requests (TARs) – Helping parks with technical assistance has continued to be a primary focus for the Cave and Karst Program. Different types of assistance have been provided to parks depending on their individual needs. This has included providing guidance for the development of park Cave and Karst Management Plans, reviews of cave and karst programs, recommendations for gates and other structures including the need for oil and grit separators on parking lots in karst areas, evaluations of surveys in park caves and other work from volunteers, and recommendations for identified scientific studies. Approximately fourteen parks, some with several different requests, have benefited from this program over the last five years. Parks with technical assistance needs are encouraged to enter their requests into

the STAR system (http://nrpcstar/). These requests can be entered at any time though there is usually a call for Technical Assistance Requests at the first of the fiscal year.

Survey and Inventory Funding – Before retiring Ronal Kerbo had obtained funding for a project titled *Cave Assessments for Visitor Safety, Planning, and Resource Protection* within parks that would qualify for 20% Fee Demo monies. Parks eligible to receive 20% Fee Demo money must take in less than $200,000 in revenue a year. Begun in 2006 and with funding postponed several years, final funding for this project was awarded in 2010. Eight parks received portions of the available $225,000 and were able to complete numerous cave surveys and inventories. These parks were WRST, CHOH, MOJA, LABE, PUHO, KALA, WAPA, and ELMA.

Rebuilding the Program - The next few months and years will be an exciting time and an opportunity to rebuild a stronger, more viable program that fulfills the needs of NPS upper management, parks with cave and karst resources, researchers and educators, those interested in cave and karst, and the general public. There is a lot to do and a number of things to consider as the program moves forward. For those going to the NSS Convention in West Virginia this coming June, there will be a half-day session for NPS cave and karst managers. One of the topics to be discussed will be future directions for the national program. Please take the time to consider where you think this program should be heading and how the national program can help parks. Together we can make significant contributions to the status of and the long-term protection and conservation of cave and karst resources within the NPS.



Dale Pate rappels the Red Wall at GRCA. Photo by Steve Rice

Renewal of Interagency Agreement for Cave and Karst Resources Management

Submitted By Dale Pate

The Federal Cave Resources Protection Act (FCRPA) of 1988 and its subsequent regulations authorized the Secretaries of Agriculture and Interior to "secure, protect, and preserve significant caves on Federal lands under their management and to foster communication, cooperation, and exchange of information between land managers, those who utilize caves, and the public." While communication and cooperation were already ongoing with resource staffs of the affected agencies, the FCRPA formalized the process at a national level and brought the BLM, USFWS, USGS and NPS from within the Department of Interior and the USFS from within the Department of Agriculture together to develop a formal Interagency Agreement. This first national-level Interagency Agreement was completed in 2003.

The renewal of this Interagency Cave and Karst Resources Management Agreement between the BLM, USFWS, USGS, USFS and NPS has now been completed with updated sections and approval and signatures from each agencies Director. This five-year document lays the groundwork for continued interagency cooperation on various cave and karst issues including environmental education, training, protection of sensitive information, research agreements, publications, land-use planning, and in the preparation of NEPA documents.

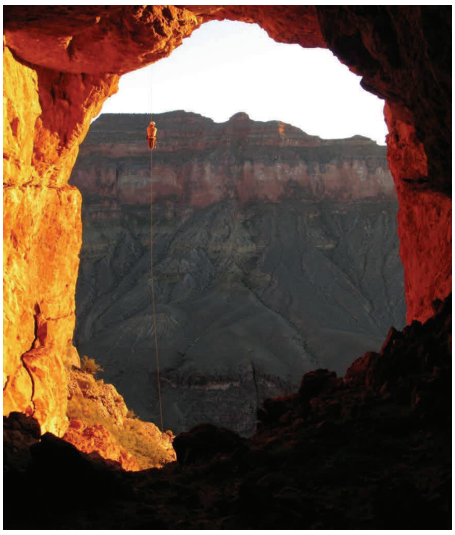
Quoting from the Interagency Agreement, the "purpose of this agreement is to achieve more effective and efficient management of cave and karst resources through cooperative action by each agency. This agreement identifies areas of mutual concern and establishes avenues for collaboration and conservation of cave and karst resources." With energy development, urban expansion, critical water-related needs, changes in recreational habits, and other issues effecting cave and karst areas across multiple agency-managed lands, this agreement will be a useful and important tool in the management of these fragile and irreplaceable resources. This agreement continues to provide guidance and direction that will help land-management agencies gain a better understanding of complex cave and karst systems within their managed properties and will continue to enhance communication and cooperation across agency boundaries for the long-term protection and conservation of cave and karst resources.

If you would like to know more about the Interagency Agreemtn contact Dale Pate at dale_pate@nps.gov or check the agreement out on the NPS Cave and Karst Website http://www.nature.nps.gov/geology/caves/index.htm

Reports From the Field

Surveying Leandras Cave, Longest in Arizona

Submitted By Steven E. Rice, Hydrologist and Cave Resources Manager for Grand Canyon National Park



Entrance drop into Leandras Cave, currently the largest known cave in Arizona. Photo by Jason Ballensky

While travelling along a remote section of the South Rim in 2006, a cave researcher noticed what appeared to be a large cave entrance across the canyon on a cliff below the North Rim. Hiking out to this remote area on a later trip, it was found that the entrance did lead to a large cave entrance that ultimately resulted in 1,800ft (550m) of a single large walking passage, and it was named Athenas Cave. For a Grand Canyon cave, this was an exciting find, and relatively large compared to most others in the Park. Thinking that this remote area of the Park may hold additional caves, a ridge-walk along the top of the Redwall Limestone was conducted in the area to search for more entrances. Tucked into a side canyon and along a 600ft (180m) tall cliff face, a massive black entrance was spotted that appeared to have great promise. Eager to explore this new find, a small group returned a few weeks later and what they discovered was beyond their imaginations. This marked the first of many more trips to what would be later known as Leandras Cave, the most substantial cave find in Grand Canyon National Park and the State of Arizona to date.

Access to the vast majority of caves in Grand Canyon is a strenuous endeavor, and Leandras Cave is no different. An off-trail bushwhack route drops off the rim precipitously, descending roughly 2,500ft (760m) over only one mile (1.6km), including several tricky climbing sections and one short rappel. There is no water along the route so all must be hiked in. The camp is roughly four miles from the nearest road, the cave is another mile from camp along a loose slope above the sheer 600ft (180m) Redwall Limestone cliff, and to top it off, access to the cave requires a 120ft (36m) free-hanging rappel off the edge of this cliff. The gaping entrance that was spotted from across the canyon proved to be even more impressive in-person, and the exploration team was unprepared for what they would find next.

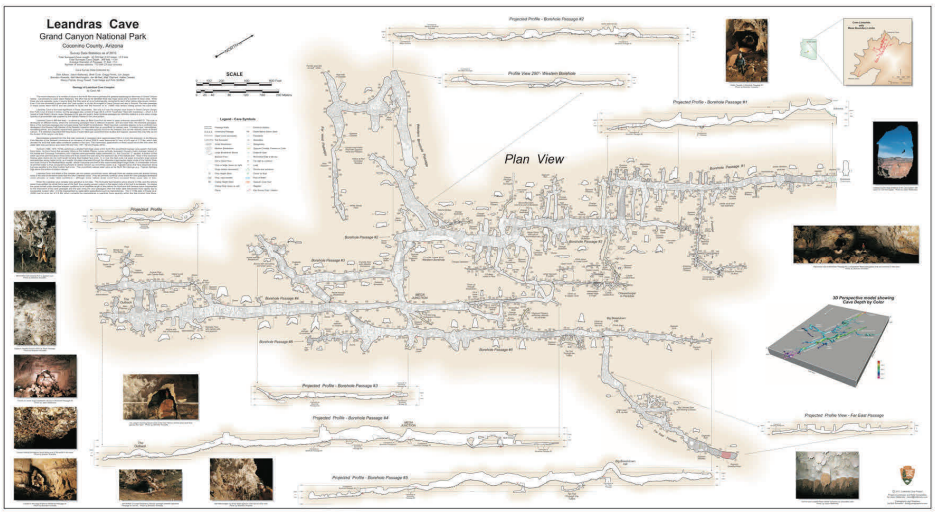
The cave passage began as a singular large borehole passage with short perpendicular passages. This eventually came to an intersection where massive cave passage departed in different directions. Knowing then that they had an immense discovery on their hands, the team left the cave with only a small amount of survey conducted and began planning for a return trip with a larger survey team. In 2007 a return trip surveyed 1.25 miles (2km) of passage in two days. The scale of this cave continued to amaze the survey team, as large borehole passages often 100ft high and 80ft wide (30m x 24m) had so many perpendicular offshoot passages of walking height or larger that they were difficult to get all on the map. A 2008 survey trip divided into two separate survey teams, and increased the length of the cave to nearly 5 miles (8km). The final survey trip was conducted in 2009 and brought the total length of the cave to 42,329ft, or just over 8 miles (12.8km). This made Leandras Cave the longest cave in Arizona, but volume-wise likely one of the largest caves in the Western U.S. To get a sense of the size of the cave, the *average* passage diameter was 37ft (11.3m).

The sheer scale of Leandras Cave is only part of the story however. Unique mineralogical and biological finds add to the intrigue of this amazing discovery. An ever present, often puzzling, and sometimes disconcerting detail about Leandras Cave is the sheer number of mummified bats found within. Thousands of impeccably preserved bats line the walls and floors of the cave in some areas, with very little evidence of current bat use. These bats were investigated more thoroughly during the 2009 survey trip, and 9 distinct species were identified, including the Pallid, Townsend's Big-Eared, Big Brown, Allen's Lappet-Browned, Silver-Haired, Hoary, Western Small-Footed Myotis, Long-Eared Myotis, Fringed Myotis, and potentially Canyon Bat. From a mineralogical perspective, many of the passages in Leandras Cave are densely decorated with incredible gypsum formations. Some of these exceeded four feet (1.2m) in length and likely represent the longest specimens of these formations in the world. Additionally, many passage walls were coated in thick mammilary deposits. These deposits are formed just below the water table when the cave was still actively forming, and similar deposits from other caves in Grand Canyon have been dated to offer a theory on the timing of the incision of Grand Canyon itself.

Another impressive statistic on Leandras Cave is the sheer number of volunteer hours associated with the project. Several teams of highly skilled, hard working, and dedicated cavers spent a combined 700 hours on cave survey in Leandras Cave, not counting the strenuous hikes to and from the cave and the travel time for many coming in from other parts of the country to participate. The sketch maps

and survey data were compiled by a volunteer and drafted into a beautiful and functional map that accounted for another 500 hours of volunteer time.

The details of Leandras Cave were kept secret until the project could be completed. The map was unveiled at the 2011 National Speleological Society annual conference and was awarded "Best in Show" in the cartography competition. A presentation on the discovery and survey was very well received and resulted in numerous inquiries by individuals and groups interested in conducting cave-related research at Grand Canyon National Park. Cave exploration in Grand Canyon continues on, and with hundreds of remote side canyons and thousands of miles of exposed cliff faces, the next big discovery is waiting to be made.



The award winning map for Leandras Cave. The Cave and Karst Program is currently in the process of updating the website and an announcement will be made when it is up and a full size version of this map will be posted on it. Cartography by Bob Richards

The Evolution of Winter Bat Survey Methodology at Lava Beds NM

Submitted By Shawn Thomas, Physical Science Technician, Lava Beds National Monument

Winter hibernacula counts at Lava Beds National Monument are primarily aimed at monitoring populations of Townsend's big-eared bats (*Corynorhinus townsendii*), the bat species most commonly encountered in caves in the park. Winter monitoring efforts have established Lava Beds NM as the site with the highest abundance of *C. townsendii* in the state of California and one of the most significant sites in the western United States. Hibernating Townsend's big-eared bats at Lava Beds NM are quite discriminatory and select caves with favorable microclimates (temperature, relative humidity, airflow) for entering torpor and conserving energy. Often hibernating bats are encountered within a very specific section of a cave, almost always deep within the cave where environmental conditions are relatively stable. Townsend's big-eared bats hibernate on cave walls and ceilings as solitary individuals or in tightly packed groups called clusters. Clusters at Lava Beds NM commonly range in size from two to 20 bats, though clusters can approach 40 bats or more. While hibernating, *C. townsendii* use their namesake big ears for thermoregulation, either curling them in to retain body heat or extending them to release heat and cool down. Some bats will even extend just one ear while keeping the other curled.

Townsend's big-eared bats comprise an overwhelming majority of the bats counted during hibernacula surveys; for example, out of the 1368 total bats counted during the 2012 winter surveys, 1346 were *C. townsendii*, representing over 98% of the total count. The other bats counted included two big brown bats (*Eptesicus fuscus*) and 20 bats of the Myotis genus; most of the *Myotis sp.* appear to be either the California myotis (*Myotis californicus*) or the small-footed myotis (*Myotis ciliolabrum*), though differentiating the species is not possible without handling the bats and/or recording their acoustic calls.

Partially hidden and hibernating *Myotis sp*. NPS Photo by Shawn Thomas

Though only 20 Myotis bats were counted, it is suspected that they are more abundant than what we are able to count, as they commonly stuff themselves into cracks and crevices where they are difficult or impossible to detect.

The Evolution of Winter Bat Survey continued...

Survey work in January of this year marked the third consecutive year of implementing new methodology for conducting surveys. These methods, developed in late 2009 and first used for the 2010 hibernacula counts, are aimed at improving the data resolution of counts and obtaining datasets capable of tracking monument-wide population trends of hibernating bat populations. In 2009, review of past winter survey data was used to create a prioritized list of hibernacula or potential hibernacula that meet two criteria: 1) site fidelity and 2) significant bat populations. Site fidelity refers to the use of a hibernaculum from year to year, i.e., the site is reliably occupied by bats each winter. Defining a "significant" bat population was more troublesome, as countless caves at Lava Beds NM contain a bat or two in the winter. Determining the threshold population level to declare a cave as a significant hibernaculum was somewhat arbitrary but was ultimately set at sites that average greater than or equal to 10 hibernating bats. This effort yielded an initial list of established hibernacula as well as several additional caves with limited past records that warranted further investigation. All of these caves were surveyed in 2010 (25 total caves), and based on the results, a final list of priority sites (15 total caves) was created. This list was meant to represent the sites that should be counted during every annual hibernacula survey at Lava Beds. A few of the caves that made this list had not been surveyed in many years or were represented by only a single count from past data, so 2010 surveys confirmed them as significant hibernacula. 2010 also marked the first year in which surveys employed cluster data to represent all solitary bats and clusters of bats as separate data points, providing greater data resolution as compared to a single total count. Another new survey effort was instituted by establishing survey zones in hibernacula. These zones are based on physical characteristics of the caves, such as passage junctions or constrictions, which are easy to identify while conducting surveys. Zone maps were created in a GIS and used as field references along with custom data sheets that match the number of zones for each site. Surveying by zones provides increased spatial resolution of data, which allows a means of tracking potential movement of bat habitat selection through consecutive winters.

Hibernating cluster of *Corynorhinus townsendii*. NPS Photo by Shawn Thomas

The 2011 winter surveys offered the opportunity to verify the site fidelity and bat populations of all the caves added to the priority site list; additionally 2011 marked two consecutive years of comparable monument-wide datasets. A new element was also added to the survey methodology in 2011 by establishing a requirement that all sites be surveyed in the shortest window of time possible. This element of the protocol was adopted as a means of minimizing the possibility of double counting bats or missing bats in the event that cave-to-cave bat movement occurs during the winter. The winter movement of bats between sites has been well documented in other areas of the country, even during periods of cold weather, though it is unknown why bats sometimes choose to switch locations during hibernation. To test this possibility at Lava Beds NM, two hibernacula were selected for a repeat count later in the winter to determine whether population levels would be different. Overall counts for the two sites did change slightly, but what was most interesting is the degree to which the clusters of bats within each cave had broken apart. During the first count, a number of large clusters of bats were observed, as well as solitary individuals, whereas in the second count, most of the large clusters had broken into smaller groups and there were far more solitary bats. This behavior is likely a thermoregulatory response of the bats and may be the result of changing climatic conditions over the course of the winter. It was determined that bats definitely move around within a cave during the winter, and the minor differences in the counts also suggest the possibility of Lava Beds NM bats moving between caves during the hibernation season.

After two winters of developing and refining our hibernacula survey methodology, the 2012 counts started to feel like

business as usual. Still, we were able to improve on some aspects of the monitoring, primarily through the development of hibernacula survey field sheets. These field sheets were developed to help prepare surveyors for the specific conditions and equipment requirements of each cave. Though the hibernacula sites do share similar conditions that make them favorable for winter bat use, they are all very unique caves with their own set of survey challenges. The field sheets provide zone descriptions to accompany the zone map and offer recommended routes in regard to which order zones should be surveyed to achieve maximum efficiency (and thus spend less time in the cave, lowering disturbance potential). The field sheets also recommend the ideal number of surveyors, which is generally two but in some cases a single surveyor or three surveyors can make the counts more efficient. Field sheets provide a list of specialized equipment for each cave; for example, some of the sites have higher ceilings that require the use of binoculars, and a small number of sites contain large enough cluster sizes (approx. 20 or greater) to warrant the use of photography (photos are analyzed in GIS to count noses, providing a more accurate count than is possible in the cave). Finally, field sheets offer general descriptions of the cave conditions and the typical location and abundance of hibernating bats. Since winter bat surveys are part of a long-term monitoring protocol for the Klamath Network Inventory & Monitoring Program, it is hoped that these hibernacula field sheets will anticipate the questions of future surveyors who are not familiar with these sites and aid in achieving consistent data collection to reduce survey bias and ensure that long-term trend analysis is as reliable as possible.

Among the highlights of the 2012 surveys, Lava Beds NM was included as a research site for a long-term continental study on *Geomyces destructans* (*G.d.*) transmission dynamics led by Dr. Winifred Frick (University of California - Santa Cruz). Students of Dr. Frick accompanied Lava Beds NM staff to five hibernacula sites to collect swab samples from the muzzles and forearms of hibernating bats, as well as substrate (e.g., cave wall) adjacent to the bats. These samples will be pooled into the continent-wide dataset to analyze the presence and spread of *G.d.* Though the results are not in yet, it is expected that Lava Beds NM bats will be shown to be *G.d.* free.

Another exciting aspect of the 2012 survey season was the discovery of a new hibernaculum in the monument. In addition to surveying our priority sites every winter, an attempt is made to opportunistically survey new sites each year, as time allows, for the purpose of potentially discovering new hibernacula. An ongoing paleontological project made for a great opportunity to search sites for bighorn sheep material while also looking for bats. During one of the paleo surveys, we entered a cave that contained a sloping debris pile in the entrance that led down to a flat floor. Reaching this flat floor, the cave gave off the "feel" that bats might be found ahead (with enough experience, surveyors develop the ability to generally sense whether a cave might be a hibernaculum, allowing us to make educated guesses on which caves to include in opportunistic winter surveys). In this particular cave, soon after proceeding down passage we began to see several solitary bats, dispersed over the walls and ceilings but in great enough abundance to immediately signify that we had made a significant discovery. Upon reaching the end of the cave, we had counted over 40 hibernating bats, placing this new site among the upper ranks of our known hibernacula. This cave will be now be added to our priority site list and counted in future winter surveys, along with an additional site that was verified as a significant hibernaculum this year after an initial survey in 2011.

Finally, 2012 marked a new high count in comparison to the previous two winters. A few of the 15 priority sites showed substantial increases in bats (10-70% population growth), and the total 2012 count of 1260 Townsend's big-eared bats (15 priority sites only) marked an increase of 168 compared to the same dataset from the previous year. It is difficult to understand whether this represents a true increase of the population at Lava Beds NM, as only the 15 caves with the consistently highest numbers are represented by this trend, whereas countless other caves in the monument commonly contain small numbers of hibernating bats. This apparent population increase could simply represent a shift of bats that previously occupied other dispersed sites in the monument (or even on surrounding Forest Service land). Another possibility that must be considered is whether the survey quality (and therefore accuracy) has increased; i.e., are we simply getting better at counting bats due to experience with our methodology? This possibility was examined and appears unlikely to be the case, as the error margin on counts has always been low due to the ease of finding and counting the relatively small clusters and solitary bats that characterize the majority of our sites. Furthermore, no new bat locations within our priority sites have been found between the 2011 and 2012 surveys (whereas there was a minor increase in search area/confidence from 2010 to 2011); thus, we did not find any new areas of bat concentrations in the cave in 2012 that could explain the population increase. Rather, there were simply more bats in the same areas counted the previous two winters. Whatever the explanation for this real or apparent population increase, we are pleased to know that Lava Beds NM remains a refuge for a healthy population of Townsend's big-eared bats.

Bighorn Sheep Paleontological Survey at Lava Beds NM

Submitted By Katrina Smith, SCA Cave Management Intern, Lava Beds National Monument

In 2007, a visitor appeared at Lava Beds National Monument (NM) holding a beautiful bighorn sheep (*Ovis canadensis*) skull with both horn sheaths attached. He had taken it from a backcountry cave at Lava Beds many decades ago, and finally felt the need to return it to its original place. Radiocarbon dating results of several bighorn skulls found in the monument show ages ranging from about 100 to over 6,000 years old. Because of the significance of these resources and the evidence of visitor theft, resource management staff realized the need for survey and documentation of paleontological resources in the caves of the monument.

Bighorns roamed the area until about 1910, when they became extirpated due to unrestricted hunting practices. A valiant reintroduction effort was attempted in 1971 when 10 bighorn sheep were transported from British Columbia to an 1100 acre protective enclosure atop Gillem's Bluff, a ridge that runs along the northwestern edge of the monument. The reintroduction was temporarily successful as the population grew to a high of 43 individuals and experienced only minor incidences of disease, but ultimately failed 9 years later when the remaining group died from pneumonia likely contracted from infected domestic sheep in the area (Campbell, 1980).

Throughout the winter of 2011-2012, cave management staff and volunteers have been performing paleontological surveys in select caves throughout the monument. Survey sites were chosen based on several criteria. First, the proximity to roads and trails reflected the vulnerability of paleontological resources to increased visitation and theft. Next, the proximity to known bighorn paleontological sites led us to areas of the park where bighorn bones may be more abundant. Finally, large cave entrances and passages, along with the presence of vertical entrances allowed us to select caves that would be more accessible for bighorn sheep and may catch those falling to their death in a pit. Archaeological records were consulted for those caves that met the previous criteria and signs of unrecorded archaeological activity at selected sites were documented during surveys.

Bighorn sheep skull reclaimed in 2007 from a visitor who took it from a monument cave many years ago. NPS Photo

Due to time restraints and the significance of these resources, we focused our efforts on finding and documenting only potential bighorn sheep bones. Most other bones encountered were rodent sized, though we did come upon one coyote skull. Species identification of bones was based on morphological characteristics described in several references including Mammalian Osteology (Gilbert, 1990), A Key-guide to Mammal Skulls and Lower Jaws (Roest, 1991), and Animal Skulls (Elbroch, 2006). Data collection and photo documentation of bone type, condition, and location was conducted for each paleontological resource observed.

In the field, inspecting cave floors and benches for signs of paleontological resources began, at times, to feel similar to searching for a needle in a haystack. Many of the cave floors are covered in large breakdown blocks, creating numerous pockets where bones are well concealed. We were, however, able to keep our wits about us and came upon some fantastic new discoveries.

Before the survey started, we knew of 94 suspected or confirmed *O. canadensis* bones, including 43 skulls, at 21 sites based on monument collections and a previous paleontological survey. As this season's survey nears completion, we stand at 243 suspected or confirmed *O. canadensis* bones, including 58 skulls, at 32 sites within the monument. Types of bones most commonly encountered include skulls, horn cores, horn sheaths, vertebrae, mandibles, and long bones. Many of these bones were well weathered or chewed upon by rodents, but some were still in surprisingly good condition, such as the section of seven vertebrae still connected by tissue remnants. Along with paleontological resources, we also discovered a new Townsend's big-eared bat hibernaculum and several pieces of modern and historic trash.

The largest paleontological site in the monument has over 50 suspected or confirmed *O. canadensis* bones. In comparison, the next largest site has 22, and most sites have less than 5. The location of each bone was measured and marked on existing maps, but because of the significance of our largest site, this cave will be re-surveyed with all paleontological resources surveyed into the map to document their exact location and orientation.

Expressions of excitement came from each of us as we found the new hibernaculum and paleontological specimens, and we got especially excited upon discovering new bighorn skulls. Though we fought cold weather a few times, the lack

of precipitation this winter worked in our favor when exploring backcountry sites.

Back in the office, a rating system was developed to indicate the vulnerability and significance of paleontological resources in each cave. An inspection schedule will be created based on these ratings, including suggested intervals at which monument staff should re-confirm the presence of these resources and assess any damages which may have occurred.

At this point, we cannot discern whether the bighorn sheep entered these caves and died on their own account, leaving their bones behind, or if their presence was due to anthropogenic activity. The concentration of skulls without many other bones along with the presence of archaeological artifacts in some locations may point to the anthropogenic hypothesis, but it is also possible that other, less dense bone types have degraded or been carried off by other animals and that the presence of artifacts is a mere coincidence. Many of the caves with paleontological resources have large entrances and similarly large passages, making it quite possible for bighorn sheep to have entered the cave on their own free will. Despite the debate about why these resources are found within the caves of Lava Beds National Monument, it is clear that they add an interesting significance to the area.

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Bighorn sheep horn sheath showing extensive rodent chew marks in a cave at Lava Beds National Monument. NPS Photo by Katrina Smith

New Fly Species Announced

Submitted By Gretchen Baker, Ecologist, Great Basin National Park

A new species of fly has been found in the park. It was recently identified and described in the journal *ZooKeys* by taxonomists Pekka Vilkamaa of Finland and Heikki Hippa of Sweden along with cave biologist Steve Taylor from the Illinois Natural History Survey.

The new fly belongs to the order Diptera (flies) and family Sciaridae (dark-winged fungus gnats). Its scientific name is *Captochaeta prolixa*. *Prolixa* means stretched out, referring to the very long extremities of the fly. *Camptochaeta* is Latin for "flexible, long hair."

Most Sciaridae eat fungi or decaying organic matter and like moist environments.

Of note, this species is very similar to species found in European and Russian caves. Ten of the eleven specimens of *C. prolixa* were collected in the dark zones of the caves (Lehman, Root, and Lehman Annex Caves). The type locality is Root Cave, so the common name for this fly is Root Cave Dark- Winged Fungus Gnat.

The new species of fly is in the family Sciaridae, the Dark-winged Fungus Gnats.

Additional new species of cave flies are expected to be forthcoming as experts have time to closely study them.

You can help look for new fly species in the 2012 Bioblitz, which will concentrate on flies. Join us June 19-21 and help us learn more.

The Wind Cave Resurvey Project

Submitted By Rod Horrocks, Physical Sciences Specialist, Wind Cave National Park

Soon after stating as a Cave Management Technician at Wind Cave National Park in 1999, Marc Ohms began to work with the Wind Cave survey data. It didn't take long for him to realize there were problems in the Wind Cave survey data. Marc found significant loop closure problems/blunders in 25% of the 900+ loops that existed in the data at that time. It was also noted that many of the surveyors had not recorded LRUD (left, right, up, or down) data or inclination on low-angle shots.

Rod also found it difficult to survey many of the side leads in Wind Cave because early surveyors had bypassed leads to maximize the lengths of their shots. This meant that these either needed to be re-surveyed or redundant shots would have to be created to get a station at the lead. These shots would then have to be excluded from the length of the cave. Excluding shots is technically not a problem, but it made things messy, especially with the map. These issues combined with the quality of many of the sketches, which were not drawn to scale, often had no interior passage detail, and only showed the major side leads, led to the realization that a bunch of Wind Cave needed to be resurveyed. There were two choices, either stop the new exploration project altogether and concentrate on resurveying nearly half of the cave, do both projects simultaneously. In order to keep volunteers interested in the survey project and to continue to learn more about the resources that needed managing, it was decided to do both projects at once. The Wind Cave Resurvey Project was born.

After analyzing this issue more in depth, we determined that most of the surveys in question were done before survey standards were enacted by the first cave management position in 1985. Looking at just those surveys, we realized that we had 183 surveys, or 37.07 miles of survey, that predated cave management in the park. We decided that we needed to prioritize what we resurveyed, starting with the most serious data problems first and then move on to sketching problems later. Marc began the process by identifying the surveys that had the most serious loop closure errors. In 2004, he put out a list of 151 surveys that we would concentrate on. Although, these included surveys from several sections of the cave, the majority were in the Historic Section. Not surprisingly, the oldest surveys had the most problems. In fact, it seemed that the survey quality improved with each decade from the 1950s to the 1970s, except for the 1959 NSS Expedition to Wind Cave, which produced three miles of fairly good quality data.

The first significant improvements in the data were realized in 1978, when John Scheltens created survey standards for his volunteer survey group in a document he called the "Operations Manual". These standards required distance measurements to be within a tenth of a foot and compass declinations to be set at zero. He also discouraged steep shots with vertical angles over 40 degrees (Scheltens, 1978). Although, this Operations Manual was not adopted by the Park, it undoubtedly had a positive influence on later Park survey standards. By the 1980's, there began to be improvements in the quality of the sketching too. In 1991, Jim Nepstad created cave survey standards for all surveyors working in Wind Cave. In those standards, he established loop closure errors of <1% for loops longer than 500 feet. For loops under 500 feet in length, a <2% closure error was set. Although these standards required that surveyors who failed to meet these closures were to be banned from reading instruments in the cave, to our knowledge this never happened; possibly because it was realized that loop closure errors may not be just the fault of the instrument person. These standards also required sketchers to sketch to scale and to maintain angles of plotted shots on their sketches to within 10 degrees of their actual angles (Nepstad, 1991). These standards led to real improvements in the

Roger Harris, Duff McCafferty, and Rod Horrocks resurveying the AV survey along the eastern edge of Wind Cave in 2009. Photo by Ken Geu

quality of the Wind Cave survey data.

By the end of 2000, we realized that we were still seeing new loop closure errors, even among the most experienced survey groups. We hypothesized that the culprits were the steep angle shots. So, we decided to implement a mandatory foresight and backsight for each shot with an inclination over 30 degrees. At the same time, we created a Sketchers Evaluation Form to help sketchers improve their sketch. By 2002, we were still seeing high levels of loop closure errors, so a few trip leaders started doing backsights on all of their shots. We finally decided to make it official in 2005 and require backsights on every survey shot that was not a dead-end shot (Horrocks, 2011). New loop closures errors have dropped dramatically since that policy change.

Since he started working with the Wind Cave survey data, Marc has been using the COMPASS software to analyze loop closure errors. Once he identifies a problem loop, he starts by verifying the computer data against the original survey notes to find potential data entry errors. Tie-ins with other surveys are double-checked to be sure that the tie-in entered was the same as the one recorded. This has been found to be a significant source for errors. Then magnetic declination is set to the correct setting using NOAA's calculator, via their website. Back in the day, it was common practice to set the compass to the magnetic declination. This created two problems. One, the source used to determine declination was USGS topographic maps. Since the maps were generally many years old, the correct declination was out of date. Secondly, since survey standards were non-existent at the time, some cavers set their compasses and some did not. This is not a problem in itself, the problem lies in the fact that many did not record if they set or did not set their compass. Currently COMPASS recognizes 2,351 loops in the Wind Cave survey. Of these, 315 are deemed as bad, which is 14% of the total. This represents an 11% reduction in the percentage of bad loops over the previous 12 years, while adding 1,451 new loops to the data set!

We have been asked, "Why it is so important that we have accurate survey data?". It has been illustrated to us time and again that having accurate survey data is critical in managing Wind Cave and the infrastructure above it. One illustration of this happened in 2002, when a survey team led by Rene Ohms observed a waterfall in a dome near the Natural Entrance during a rainstorm. By using a cave radio, it was determined that the top of the dome was only six-feet below the sidewalk going out to the Walk-In Entrance. It wasn't long after this discovery that Maintenance put out a request to dig a trench alongside that same sidewalk. Knowing the dome was there allowed us to potentially avert damaging the cave or creating a safety hazard for our employees by digging a trench over the top of this shallow dome. This one example demonstrated not only why having accurate data is critical but why we continue to survey Wind Cave. Although, we have realized since we started at the park that having good quality sketch is important to cave maps, it wasn't until we started the latest update to our digital cave map that the full importance of that data was realized. Although Wind Cave surveyors sketch at 20 feet to the inch, only the walls and most important features were used on all previous Wind Cave maps. Essentially, we were collecting higher resolution data than we could use on the 50 feet to an inch cave quadrangles. On the newest digital map, we are digitizing all of the interior passage detail from the in-cave sketches. Without sketches that are drawn to scale and sketches that have interior detail, there is nothing to add to the new digital map. Unfortunately, both of these situations exist in most of the pre-cave management survey data (37.07 miles of sketch).

In 2000, the first year of the Wind Cave Resurvey Project, 0.48 miles of problem surveys were resurveyed. Since that time, the amount resurveyed each year has fluctuated. The most productive year was in 2005 when 3,535 feet were resurveyed, with the least productive year in 2004, when 1,109 feet was resurveyed. However, overall, during the 12 years since the project started, we have averaged about 2,463 feet or 0.46 miles of resurvey a year. This was accomplished by resurveying 89 partial or complete surveys, most of which are in the Historic Section of the cave. During this same time period, we averaged 4.3 miles of new survey per year throughout the whole cave, in addition to the resurvey totals. To date, 5.59 miles have been resurveyed under the Wind Cave Resurvey Project. This represents about 15% of the 37.07 miles of pre-cave management survey that exists in the Wind Cave survey database. At the current rate, it will take 67.5 more years to resurvey the whole 37.07 miles. We obviously need to find a better way to attack this behemoth. One tactic that we have pursued, unfortunately unsuccessfully thus far, is obtaining a funding source and hiring a team to tackle this problem for a couple of years. Even though we haven't been able to secure funding thus far, we will continue to search for ways to bring all of the Wind Cave survey data up to current cave management standards.

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White Nose Syndrome Update

Submitted By Kevin Castle

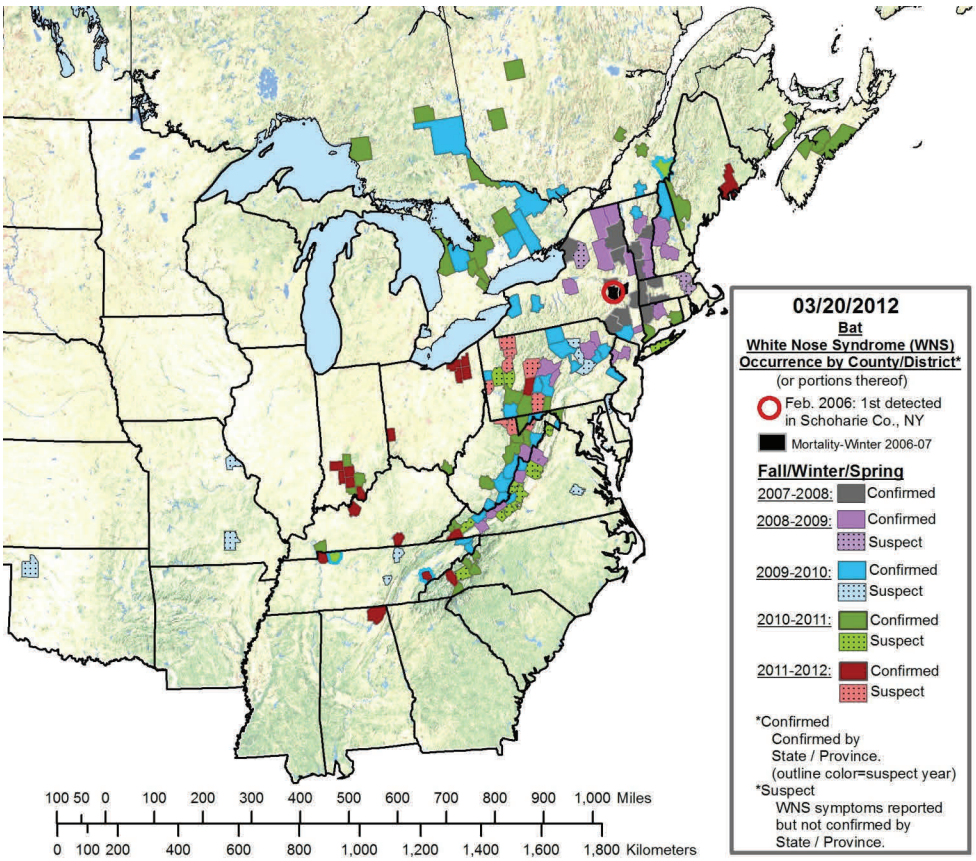
WNS Overview, A National Perspective

White-nose syndrome (WNS) is a disease of cave-hibernating bats caused by a fungus, *Geomyces destructans*. The disease was first observed in four caves near Albany, New York, in the winter of 2006 –2007. Since 2007, white-nose syndrome has spread into 16 additional states and 4 Canadian Provinces, and has devastated populations of bats in its path. Overall declines of hibernating colonies at the most closely monitored New York sites reached 75% within two to three years of initial detection, and declines have approached 100% in some areas. As of March 2012, WNS has been detected in 6 species of hibernating bats, and *G. destructans* has been found on 3 additional species without apparently causing disease.

More than half of the species of insectivorous bats that occur in the U.S. rely on hibernation as their primary strategy for surviving the winter, when insect prey is not available. Four endangered species and subspecies of bats in the U.S. rely on undisturbed caves or mines for successful hibernation, and all four of these species (Indiana, Gray, Virginia big-eared and Ozark big-eared bats) hibernate/reside within the WNS affected area. Although the potential for the cold-adapted fungus to continue spreading is currently unknown, the implications of it undermining the survival strategy of so many bat species are enormous. We are just beginning to appreciate the roles bats play in North American ecosystems, and the impact of WNS on bat populations. We need to further understand its potential to influence ecosystem function, for example through cascading effects on bat prey abundance.

Species of bats with WNS: Big brown bat *(Eptesicus fuscus)*, Eastern small-footed bat *(Myotis leibii)*, Indiana bat *(Myotis sodalis* = **endangered),** Little brown bat *(Myotis lucifugus),* Northern long-eared bat *(Myotis septentrionalis)*, Tricolored bat *(Perimyotis subflavus)*

Species of bats with *G. destructans* only: Cave bat *(Myotis velifer)*, Gray bat *(Myotis grisescens* = **endangered**), Southeastern bat *(Myotis austroriparius)*



Map by: Cal Butchkoski, PA Game Commission

WNS and the National Park Service

WNS or *G. destructans* have been found in 7 NPS units. Those that have announced this to the public at this time are:

- Acadia National Park (WNS)
- Delaware Water Gap National Recreation Area (WNS)
- Great Smoky Mountains National Park (WNS)
- New River Gorge National River (WNS)
- Ozark National Scenic Riverways (*Gd*)
- Russell Cave National Monument (WNS)

Since spring 2009, the NPS Wildlife Health Branch (WHB) has led an NPS WNS working group made up of cave and bat ecologists, regional biologists, and park superintendents. The primary objectives of the working group are to disseminate information among parks and regions and to coordinate NPS WNS response and management activities nationwide. A number of NPS biologists have helped with WNS national planning efforts through their input to various National Plan working groups. In addition, the NRSS Associate Director is a member of the WNS National Plan Executive Committee, and NPS Wildlife Veterinarians are members of the WNS National Plan Steering and Coordination Committees.

Little brown bat; close-up of nose with fungus, New York, Oct. 2008. Photo by Ryan von Linden/New York Department of Environmental Conservation

A September 2010 Deputy Director's guidance memorandum recommended that parks across the country work to minimize the risk of WNS impacting NPS resources. The primary recommendations were that field-based staffs continue to make WNS management decisions based on the best science available and in accordance with the NPS mission, policies, and park enabling legislation, and that efforts be made to limit the human-assisted spread of WNS into or out of NPS units. In response to the memorandum, parks have written or updated Cave Management Plans or have used the Superintendent's Compendium to take a number of actions to help manage WNS:

- In parks where cave visitation is allowed, access to caves requires a permit or tour ticket. In parks where visitors can be screened prior to cave entry and gear can be decontaminated or disallowed as necessary, such as NPS tour caves, NPS caves remain open. Where those precautions cannot be implemented, caves have been closed.
- Many NPS units have focused efforts on educating visitors, partners, and neighbors about cave ecosystems, bats, and the potentially devastating impacts of WNS. For example, Mammoth Cave National Park has developed a WNS information booth, educational posters, and a video that provide information to over 450,000 cave visitors per year, and Great Smoky Mountains National Park, which does not offer cave tours, has produced a WNS podcast that is available online.

Parks across the country have been supporting WNS research by monitoring bat populations, conducting disease surveillance, sharing existing data, and providing research sites and research assistance.

According to the NPS Office of Public Health, WNS does not appear to pose a threat to human health since the fungus that causes WNS, only grows at temperatures well below human body temperature. However, WNS can cause sick bats to exhibit unusual behavior, such as flying outdoors or at hibernaculum entrances at all times of day and in all types of weather, so bats may be encountered in unusual settings. NPS visitors and employees are being reminded to not handle any wildlife they encounter, including bats.

Kevin Castle is a Veterinary Medical Officer in the Wildlife Health Branch of the Natural Resources Science and Stewardship office's Biological Resources Management Division in Ft. Collins, CO. He is currently the WNS lead for the National Park Service. Photo by ©Ralph Arwood

For more information about white-nose syndrome in the National Park Service, visit http://www.nature.nps.gov/biology/wildlifehealth/White_Nose_Syndrome.cfm

For more information about white-nose syndrome, including non-NPS closures and decontamination protocols, visit http://www.fws.gov/whitenosesyndrome or http://www.nwhc.usgs.gov/disease_information/white-nose_syndrome/index.jsp

Park Updates

Buffalo National River

Submitted by Chuck Bitting

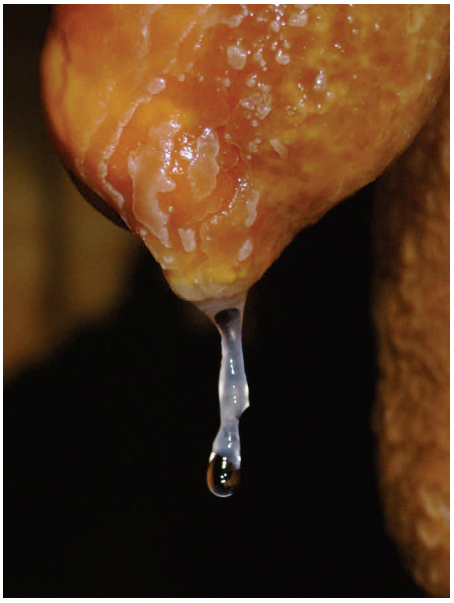
Since White Nose Syndrome (WNS) reached the Ozarks, nearly all of the 360 caves at Buffalo National River have been administratively closed. We continue to monitor a select group of caves for bats exhibiting signs of WNS. To date, we have not detected the disease. A balmy winter is winding down. The bat hibernacula surveys showed that bats had moved to the coldest sections of the caves instead of their usual roost sites. We are paying special attention to the Gray bat (*Myotis grisescens*), Indiana Bat (*Myotis sodalis*), Ozark Big-eared bat (*Corynorhinus townsendii ingens*), Small-footed bat (*Myotis leibii*) and Northern long-eared bat (*Myotis septentrionalis*) during these surveys. We also find substantial numbers of Tri-colored bats (*Perimyotis subflavus*) along with smaller populations of Little Brown bats (*Myotis lucifugus*) and Big Brown bats (*Eptesicus fuscus*). Overall, bat populations appear to be stable. Hopefully the southern latitudes will prove fruitless for *Geomyces destructans* and WNS, allowing remnant populations of bats to develop resistance and repopulate the northeast.

Carlsbad Caverns National Park

Submitted by Stan Allison

Park Staffing Changes

Since the last issue of Inside Earth, the Carlsbad Caverns National Park Cave Resources Office has lost two positions. In the Fall of 2010 Park Hydrologist/Geologist Paul Burger moved to Alaska as the Hydrologist for the Alaska Region of the National Park Service. Paul worked at the Park for over 10 years and was the driving force behind many major projects such as the Cavern Protection Plan and the Cave Management Plan. In addition to his duties involving geology and hydrology, Paul drafted many miles of Carlsbad Cavern, Spider Cave and Lechuguilla Cave while at the Park and coordinated the Lechuguilla Cave cartography project. Paul's excellent caving skills were extremely beneficial when it came time to maintaining the Lake of the White Roses data logger at the end of Lechuguilla Cave. Thanks for your many contributions to the caves & karst of Carlsbad Caverns National Park,



2cm long, mucus-like biothem actively dripping. Lechuguilla Cave, Coral Sea area. Photo by Scott Linn.

Paul!

In addition Jason Walz, former Cave Technician became the Cave Specialist for the Lincoln National Forest in June 2011. Jason had only worked at the Park for one year, but had already contributed much to the Cave Lighting Project due to his experience at Wind Cave National Park. We wish Jason the best at his new position with the Forest Service. Unfortunately, there are no plans to fill either the Hydrologist/Geologist or Cave Technician positions in the near future.

Lechuguilla Cave Exploration, Survey & Cartography

8 survey and exploration expeditions took place in Lechuguilla Cave in 2011 resulting in over 2.5 miles of new cave surveyed and many loop closure errors solved. Currently Lechuguilla Cave has 133.3 miles of surveyed passages. The most significant discovery in Lechuguilla in 2011 wasn't measured in miles but in centimeters, 2 cm to be exact. Scott Linn, Rich Sundquist and Steve Maynard discovered a biothem with mucus-like texture in the Coral Sea area of the Far East that was actively dripping. Only 4 Lechuguilla survey and exploration expeditions have been approved for 2012 due to the decrease in Cave Resources Office personnel. Derek Bristol, Peter Bosted, Max Wisshak and Rod Horrocks were the most active cartographers in 2011. The Park continues to maintain a data logger recording the water level at Lake of the White Roses where Lechuguilla Cave intersects the Capitan Aquifer. The water table is continuing it's steady decline with minor upward jumps. Current water levels are now 18.4 feet below the 1989 discovery level.

Carlsbad Cavern Exploration, Survey & Cartography

Cave Research Foundation (CRF) members Scott House, Ed Klausner and crew have been busy resurveying and drafting the paved tour routes in Carlsbad Cavern. Scott has nearly completed his resurvey of the Main Corridor and Scenic of Carlsbad Cavern that he began in 2010 and is nearing completion of a detailed digital map of the area. Ed Klausner has made good progress on his Big Room resurvey that he began in 2011 and is also making good progress on his detailed digital map of the Big Room.

Spider Cave Exploration, Survey & Cartography

Paul Burger has drafted a complete map of Spider Cave's 3.8 miles of survey. Chris Amidon has led several trips to continue survey and exploration work in the cave.

Carlsbad Cavern Restoration

CRF continues their excellent work in performing various restoration projects led by William and Tammy Tucker.

Cave Research Activities

Some of the active cave related research occurring in the Park includes the following studies. Greg Stock and Joel Despain are continuing their study dating calcite shelfstone related to pools in the Western Branch of Lechuguilla Cave to determine paeleoclimate information.

Dave Decker, Victor Polyak, Zachary LaPointe and Yemane Asmerom have initiated a study to date cave spar and cave mammillaries to determine landscape evolution of the Guadalupe Mountains during Jurassic to early Paleogene.

Art and Peg Palmer are continuing their studies of cave geology by focusing on the weathering of cave bedrock and chemical evolution of the weathered material. This helps to evaluate the nature of water flow and air chemistry after they have undergone their major phases of development.

Victor Polyak and Yemane Asmerom are continuing their study of Holocene and Pleistocene climate based on uranium-series dating of speleothems. Victor recently came up with a new sampling method that greatly reduces the sampling impact of speleothem dating for paeleoclimate studies. Instead of sampling an entire broken stalagmite and hoping that it would have been formed in the study dates, they are now drilling a small diameter hole and collecting 10-50mg of rock powder in the tops and bottoms of broken stalagmites to determine if the stalagmite is in the appropriate date range for their study or not.

Diana Northup, Leslie Melim, Michael Spilde, Penny Boston and Michael Queen continue work on their study to investigate whether microorganisms help form pool finger, chenille spar and other pool precipitates and to develop a classification system of pool precipitates.

Andreas Pflitsch continues making regular trips to the Park to work on his cave climatology studies. Preliminary results indicate that Carlsbad Cavern and Spider Cave have an airflow connection resulting in a large system and that Lechuguilla Cave, Big Manhole Cave and other BLM blowholes are also connected by airflow in an even larger system. Airflow in Carlsbad Cavern has proven to be quite complex with thermally driven airflow at floor levels and barometric and thermally driven airflow at ceiling levels.

Grand Canyon National Park

Submitted by Steven E. Rice

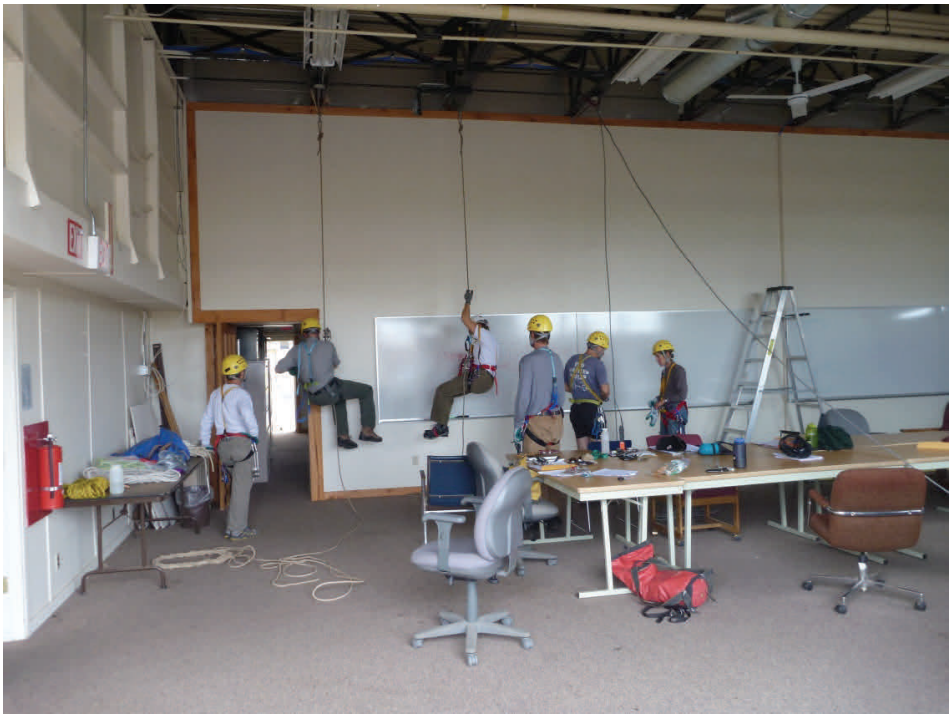
Program Management and Development

The Grand Canyon Cave Management Program continues to expand and has made great strides recently. An agreement with Utah State University resulted in the development of an MS Access-based cave inventory and monitoring database. A separate agreement with the Museum of Northern Arizona is currently digitizing the complete cave archive files, populating the database with this information, and archiving all of the historic information and maps in the GRCA museum collections. This database is a great leap forward towards the compilation and understanding of the scope of cave resources at GRCA and will assist in directing future research needs.

Two technical assistance requests were recently completed at the Park, one to conduct a single rope technique (SRT) course and another to conduct an overview assessment of the Cave Resources program and to provide input into the development of a Cave Management Plan. Stan Allison (CAVE) led the SRT course for several GRCA resource specialists including biologists, archaeologists, geologists, and protection rangers to provide the background skills to assist in future inventory and assessment work at the mostly technical-entry caves at GRCA. Dale Pate (CAVE/WASO) conducted two Park visits to get an overview of the program and developed a recommendations document to Park Management to push for the developments that would be most beneficial to the program.

GRCA is currently in the process of updating its Backcountry Management Plan (BMP), and cave resources will be addressed more thoroughly than in previous iterations. A complimentary document to the BMP will be the development of a long-needed Cave Management Plan (CMP), where cave-related management objectives will be discussed in much greater detail than will be mentioned in the BMP. The protection of cave resources was recently added to the list of Park priority objectives for the 2012-2016 timeframe.

Establishing trails in a section with delicate gypsum grass. NPS Photo



Indoor section of 2011 SRT training for GRCA resource staff. NPS Photo

Inventory/Exploration/Survey

Inventory and exploration in GRCA continues and remains a large part of the Cave Management Program's objectives. Inventories were conducted on over 20 caves in the last year, and exploration efforts led to the discovery of 10 more confirmed caves and several more leads, bringing the total for the Park to over 400 confirmed caves, still representing a fraction of the likely total amount.

Survey projects exist at several larger caves, and one completed project made quite a splash at the 2011 NSS convention. Leandras Cave is just over 8 miles, making it the largest cave in Arizona. The massive passage sizes in the cave make it by volume one of the largest caves west of the Rocky Mountains. The map of Leandras Cave, drafted by Bob Richards, won Best In Show in the cartography salon at the NSS convention as well. Survey was completed on Abyss River Cave as well with the assistance and expertise of other NPS cave resource staff Stan Allison (CAVE) and Andy Armstrong (TICA). Stan and Andy were the lead sketchers on the project and Andy will be drafting the map, hopefully for presentation at the 2012 NSS convention. Abyss River Cave was mapped to just over 7,000ft over three days in often unpleasant wet and cold conditions. The survey data from this cave adds important information to the complex karst system draining the North Rim of the canyon.

Survey work continues at a few other caves, and may begin at a few other locations in the near future. Cave inventories are continuing as well, and the program hopes to complete inventories on 30 more caves in 2012.

Research

Four of the seven major cave spring systems below the North Rim have been instrumented recently to monitor spring discharge timing and water temperature fluctuations. Two more are planned for 2012, with the remaining one unlikely to ever be done due to access difficulties. These instruments will provide valuable information on the nature of the deep and complex karst system that connects the sinkholes and fractures on the North Rim to the large springs thousands of feet below.

GRCA received a grant to install infrared visitation sensors at a number of locations to track unpermitted visitation to caves. These sensors will provide information to management decisions in the upcoming backcountry and cave management plans, and will direct the potential of opening limited recreational caving in the Park in the future.

Victor Polyak of University of New Mexico will be soon publishing a final paper on the radiometric dating of mammilary speleothems in GRCA caves and how the dates relate to water level declines in caves associated with the downcutting of Grand Canyon.

Hans Bodenhamer, who developed a Visitor Impact Mapping (VIM) protocol for quantifying human-caused cave resource injury, completed an assessment of 11 GRCA caves with his Bigfork High School (Bigfork, MT) Cave Club in 2011, and produced an extensive and useful report for future cave management at these locations. The group is returning in April 2012 to complete more VIM assessments including a number of locations containing sensitive archaeological resources at risk of vandalism or theft.

Outreach

GRCA cave resources have been on display in a number of television and print outlets over the past year. National Geographic Wild filmed a segment on 40,000 year old Shasta Ground Sloth dung deposits at a Western Grand Canyon cave, and a Japanese film crew completed a television program with the Cave Resources Manager Steve Rice investigating caves' role in the hydrogeology of the Colorado Plateau and the relation of certain speleothems to the timing of canyon incision. A BBC production company will be filming a segment on Ice Age fauna at a GRCA cave in May 2012.

The 2011 VIM project with the Bigfork High School Cave Club created substantial interest in Park caves and with cave resource protection in general. The project was highlighted on the Inside NPS website, and was picked up by local newspapers both in Arizona and Montana. The press from the 2011 project facilitated the acquisition of financial support for the 2012 project and future outreach will hopefully make this an annual event.

Presentations on cave resources and the Cave Management Program at GRCA have recently been given at a number of conferences and interpretive seminars.

Grand Canyon-Parashant NM

New isopod (cf. Brackenridgia sp.) from Grand Canyon – Parashant National Monument.. Image courtesy of Jut Wynne, NAU.

New millipede (Pratherodesmus nov sp.) from Grand Canyon – Parashant National Monument. Image courtesy of Jut Wynne, NAU.

Submitted by Eathan McIntyre

Cave Ecological Inventory

As part of the work done by Jut Wynne (Baseline Inventory and Documentation of Cave and Karst Resources on the Grand Canyon – Parashant National Monument, Ecological Inventory of 15 Caves, Grand Wash Cave Bait Survey, Bat Hibernaculum and Microclimate Study, CPCESU partner: Northern Arizona University), several new-to-science macroinvertebrate taxa have been identified, or are in the process of formal identification. This includes the first record of a cave-adapted centipede for Arizona, three pseudoscorpions, a cave-adapted millipede which represents the 3rd new species of Pratherodesmus, a new genus described by Wynne and others in 2009, and a new species of cave-adapted isopod, believed to belong to the genus Brackenridgia. These represent only a few of the species that are a range extension or new-to-science found in PARA caves each time they are surveyed.

Publication:

Shear, W.A., S.J. Taylor, J.J. Wynne and J.K. Krejca, 2009. Cave millipeds of the United States. VIII. New genera and species of polydesmidan millipeds from caves in the southwestern United States (Diplopoda, Polydesmida, Polydesmidae and Macrosternodesmidae), Zootaxa, 2151: 47–65. URL: http://www.mapress.com/zootaxa/2009/f/zt02151p065.pdf

Great Basin National Park

Submitted by Gretchen Baker

There were three cave-related articles in the winter edition of *The Midden*. These articles discussed the age of Lehman Cave, a stalagmite collected from the cave to infer long-term climate patterns, and a new fly species found in the dark zone of Lehman, Root and Lehman Annex Caves.

To read the entire articles, download a PDF copy at http://www.nps.gov/grba/parknews/upload/2011wintersmall.pdf.

Jewel Cave National Monument

Submitted by Rene Ohms

On January 19, 2012, Jewel Cave National Monument teamed up with the South Dakota National Guard Civil Support Team (CST) to host a mock rescue. The CST specializes in incidents involving the release of harmful radiological, biological, or chemical agents. The mock scenario involved the release of a radiological agent along the Scenic Tour Route at Jewel Cave. All responders were required to enter the cave in PPE appropriate for the identified agent, which included full Tyvek suits, rubber gloves, and masks. As part of the scenario, one of the responders also was "injured," and needed to be hauled out of the cave in a Ferno litter. The exercise brought together resources from the Paha Sapa Grotto, Black Hills National Forest, SD National Guard, and Custer County Sheriff's Office.

The park has continued the rescue preplanning work that was begun last year by Anmar Mirza and John Punches. Preplan documents for the Hub Loop, Wild Caving Tour, and the black & blue taped trail from the Target Room to Cloud Nine will be finalized this fiscal year.

The annual Black Hills Cave Restoration Camp will be held at Wind Cave and Jewel Cave from August 27-31, 2012. Anyone interested in attending should contact Kelly Mathis at (Kelly_C_Mathis@nps.gov) by August 3.

Multiple survey trips have brought the total surveyed length of Jewel Cave to 160.39 miles.

Lava Beds National Monument

Shawn Thomas submitted an article on changes to the winter bat surveys at Lave Beds National Monument from 2010 to 2012 including the use of GIS and field sheet and coordination with the Klamath Network Inventory & Monitoring Program. Katrina Smith submitted an article on a survey of bighorn sheep paleontological remains in caves that was prompted by the return of a skull illegally collected from one of the park's caves.

Mammoth Cave National Park

Submitted by Rick Toomey

Research remains vigorous at Mammoth Cave in spite of the threat of WNS. We have several studies on-going seeking to better understand our bat populations before WNS arrives. A three-year study on Rafinesque big-eared bats by Joe Johnson (University of Kentucky) is finishing up this year. He has been studying their foraging and roosting behavior. His telemetry studies have resulted in finding not only several new roosts, but in some cases new caves on the park.

Drs. Luke Dodd and Mike Lacki are in the second year of a study of how bat foraging relates to prescribed burns on the park. This study has provided vast amounts of data on bat foraging (using acoustic monitoring), insect abundance through the year, and herbivory in burned and unburned areas. This study also included an airborne LIDAR flight of the park to characterize the canopy. A part of this study has also included spring and fall harp-trapping at one of the parks hibernation roosts to examine bat weight and condition going into and coming out of hibernation. That data set should be very valuable for comparison with WNS sites.

In addition, Steve Thomas (CUPN) has coordinated this year's count of Rafinesque big-eared bats in their hibernation sites. Steve and Rick Toomey (MCICSL) have been coordinating WNS monitoring at MACA sites. These have been mainly entrance checks, but they also include acoustic monitoring at roosts and some limited internal checks in major roosts.

Dr. Tom Byl (USGS and Tennessee State University) has a set of students doing valuable water quality studies on the park. They have been studying the effectiveness of our storm water filters for removing contaminants before they enter the cave. They have also been tracing water through the vadose zone to examine changes as it moves from the filters into the cave.

The threat of WNS has altered several aspects of research at Mammoth Cave. We are enforcing rigorous decontamination protocols with our researchers. We are also requiring decontamination of footwear after walking tours. This has led to questions as to whether Lysol solution coming off walk-over mats could be contaminating the cave. Dr. Byl and his students have been looking at that question as well. They have found some quaternary ammonium compounds in storm water at the park, but they have found that the filters do a good job of removing them. They have also found some alteration of soil bacteria near the mats.

Rick Olson and Rick Toomey have been installing a detailed cave micro-climate study network in the Historic section of Mammoth Cave. The network is being used to understand energy and mass flows in the entrance area to examine condensation that threatens historic saltpeter mining infrastructure and to examine restoring a historic bat roost. Portions of the data will also be used for a display in the new Visitor Center exhibits.

A renovated Visitor Center with new exhibits is scheduled to open at Mammoth Cave this coming fall. The exhibit topics include geology, hydrology and cave formation, cave biology, cave archaeology, cave exploration, the history of the park, the Green River, and the parks surface ecology.

The Mammoth Cave International Center for Science and Learning (MCICSL) has scheduled the 10th Mammoth Cave Research Symposium for this coming fall. It will occur October 9-10, 2012. It is co-sponsored by MCICSL, MACA, the Hoffman Environmental Research Institute at Western Kentucky University, and the Cave Research Foundation. For more information, contact Rick Toomey.

Oregon Caves National Monument

Submitted by Elizabeth Hale, John Roth, and Emily Ring

Recent Studies and Findings

At the 2011 National Cave and Karst Management Symposium, Physical Science Technician Emily Ring presented "How Resilient Are Caves to Change?". This ongoing study compares chloride and total organic carbon (TOC) of water entering Oregon Caves during a recent wet cycle with a dataset from an extended drought in the early 1990s. Though counterintuitive, increased drought in the comparative study appears to increase nutrients going into the cave. This study may shed light on whether changing climates and fire suppression threaten endemics with extinction by changing nutrient flow or by reducing moist cave surfaces.

Also at the 2011 National Cave and Karst Management Symposium, GIS Specialist

Elizabeth Hale presented a paper on Seasonal Variation of Carbon Dioxide in Oregon Caves. Ten years of carbon dioxide (CO_2) data show seasonally high levels of CO2 occur in Oregon Caves between May and November. At its peak, cave CO2 is approximately six times greater than what occurs on the surface. Likely reasons for the CO2 changes include seasonal changes in airflow, degassing of cave waters, and, though likely less significant, the number of people in the caves.

In 2010 Dr. Stewart Peck described a leioidid beetle in Zootaxa. The beetle is a troglobitic species only known from Oregon Caves. Also soon to be published in Zootaxa, Dr. Sean Schoville identified two species of Oregon Caves grylloblattid. These are in one of the smallest and most recently described of all insect orders. Their studies add to the six previous species known only from Oregon Caves.

A study of cave scallops by geosciences volunteers Séverine Furst (France) and Heather Neis in the summer of 2011 yielded some unexpected results, such as paleo-flow in the lower cave being the opposite of the flow of the present-day underground River Styx. Plugging of exit springs may have temporarily caused backflows during or shortly after major floods.

A study of cave sediments by geosciences volunteer Ove Meisel (Germany) in fall 2010 characterized sediments from different sites in the cave with an aim toward answering questions about their distribution and origin. Well-rounded quartz and diorite pebbles at a few sites suggest that they were washed in after a lengthy rounding by long streams on the surface. The presence of glacial loess only in the older parts of the Caves supports this. Generally, most of the sediment had angular and sub angular grains, suggesting flood events as the main sediment-transport mechanism, but with short transport distances (otherwise they would be more rounded).

In its first year of implementation in 2011, white-nose syndrome screening for all visitors to Oregon Caves resulted in 221 actions (0.5% of cave visitors) based on visitors arriving to the park wearing or carrying items that had been used in a cave or mine east of the Rocky Mountains or in Europe. Over 70% of the actions were to decontaminate footwear or accessory items such as glasses; 20% of actions were to exchange the item for one that had not been used in a cave or mine within the area of concern. Nearly 20% of the actions resulted because of item exposure to a European cave or mine. Less than 5% were from Canada. More than half of the time the cave or mine visit in a white-nose affected region was within the past year.

Cave Cleanup and Restoration

Drawing on local volunteers and regional caver-volunteers, Oregon Caves has seen its annual President's Day Weekend (February), National Park Service Volunteer Day (April), and National Public Lands Day (September) cave restoration events well attended. Participants typically spend the day cleaning lint and trash in the cave with brushes, tweezers, and spray bottles. For some this is a new experience and a new way of seeing the cave, unlike anything they have done before! Others have found themselves captivated by the cave environment and keep showing up for these events – again and again!

At the ninth annual President's Day Weekend event in 2012, volunteers removed copious amounts of lint from Paradise Lost, restored a pool, and got rid of some old, obnoxious red cement. Download the event write-up: www.nps.gov/orca/supportyourpark/upload/2012_Pres_Day_Weekend_Report.pdf.

Projects

The Oregon Caves infrared "bat cam" went online in fall 2011, along with visitor center web cam for viewing surface conditions. Look for roosting bats at www.nps.gov/orca/photosmultimedia/webcam.htm.

Three real-time environmental monitoring stations were installed in summer 2010. Live data from the cave can be ac-

Left: Siskiyou grylloblattid spotted on a Monument trail in winter next to a Sharpie for scale. Right: The pale grylloblattid is currently only known from Oregon Caves. Note the longer antennae. NPS Photo.

cessed through the network on office computers. Sensors measure stream depth, wind speed and direction, barometric pressure, and air and water temperature. Future projects are proposed to create a live data display for the visitor center or post data online.

Volunteer Hester Mallonée entered a new phase in the long-term rimstone restoration project, an effort to repair Oregon Caves' largest rimstone formation, once the site of the cave tour path cut through its center. Thanks to careful artistry and color matching of cements with dry pigment, it is difficult to distinguish between restored and undamaged natural sections of the formation. This project received funding in 2011 from the Pacific West Region Volunteers-in-Parks program.

Monitoring

Oregon Caves added stream gauging to its suite of monitoring activities in 2011. Following up on stream gauging activities in 2010, Physical Science Technician Emily Ring improved the reliability of the procedure to measure stream discharge in the low-flow River Styx. The cave stream is monitored weekly when it can be accessed without disturbing hibernating bats, approximately April to November.

We look forward to 2012 as the first year of the Klamath Inventory & Monitoring Network Cave Monitoring Protocol is implemented at Oregon Caves and Lava Beds. The protocol includes monitoring winter bat hibernation, seasonal cave pools, invertebrates, climate, and scat as a proxy for organic input and small mammal activity.

In Other News

Permanent exhibits have been funded for over half a million dollars for the Oregon Caves Visitor Center, which will include a 3D cave and a cave-like walk-thru that will appeal to both adults and children.

The NPS Geologic Resources Division published the Oregon Caves Geologic Resource Inventory Report in 2011. This report contains a significant and broad overview of the park's geologic resources and context. Access the report: www.nature.nps.gov/geology/inventory/publications/reports/orca_gri_rpt_view.pdf.

Ozark National Scenic Riverways

Submitted by Scott House

The Ozark National Scenic Riverways has over 400 caves within its authorized boundaries. Ninety percent of these are on NPS fee-title land with the rest on state and private inholdings. Cave management priorities have recently been focused on trying to prevent and detect the spread of White Nose Syndrome (WNS). Despite a shortage of staff and funding, cave management in the park is being accomplished by the volunteer and contracted help of the Cave Research Foundation (CRF) working with NPS staff.

DNA signatures of WNS were detected in the Ozark Riverways in 2010. All caves not developed for public use have been closed since that time and a WNS Plan was written and approved. Research and monitoring visits are allowed under strict guidelines. The park's interpretive cave, Round Spring Cavern, remains open to the public for interpretive lantern tours during the summer months.

A regular cave monitoring program was begun in OZAR in 1999. Since the detection of WNS signs much time and energy has been spent on monitoring the potential spread of the disease in the park. In FY2011, more than 150 visits were taken to OZAR caves for regular monitoring, with heightened emphasis on bats. So far in FY2012, nearly 80 visits have been taken. At certain critical hibernacula, personnel of the Missouri Department of Conservation are involved as well. Thus far, there has been no sign of the disease spreading.

In addition to WNS, monitoring trips look at other cave life, particularly amphibians, which indicate some decline in numbers. Monitoring also looks at human usage, keeping a particular watch for ARPA violations, any of which are instantly directed to law enforcement rangers.

A three year project, beginning in the summer of 2009, is underway to evaluate potential park habitat to determine the scope and dimensions of summer/fall bat use. Investigations at various hibernacula and a small forest pond were performed to identify if any variation existed in bat species composition and abundance over time. In addition, detectors have been placed at several known bat caves in order to develop qualitative information on bat diversity. Bat trapping and identification have verified and extended the results. These projects are being directed by Dr. Lynn Robbins of Missouri State University through a cooperative agreement.

Despite the cave closure order, a portion of the general public continues to visit caves, although visitation has dropped

Surveying in Alphen Hollow Cave. Photo by Josh Hafner

Missouri State University researchers assemble a harp trap for surveying bats. Photo by Ed Klausner

considerably. Most of these visits are to the outer regions of smaller caves. Due to the geography of the park (long and slender) it is not possible to close roads or to sign every cave. Further, the bulk of OZAR caves are located along rivers, which see high recreational use. However, we are continuing to sign those priority caves which are incurring visitation. Fifteen NPS caves within the park have gates; one priority is the continual maintenance required to keep the gates functional.

Baseline cave survey and inventory continues under the restrictions of the WNS plan. New discoveries continue to be made, mostly in very wet stream caves. Bealert Blowing Spring has been surveyed for 4,000 feet with passages continuing. This is a pristine cave, completely undocumented until recent surveying. Sluiceway Cave, now finished at 2400 feet, provides habitat for the grotto salamander, the Salem crayfish, and the southern cave fish. Another stream cave, Alphen Hollow Cave, is nearly 2500 feet long with several continuations not yet surveyed. The survey and inventory of these newly-discovered caves is important to the proper management of these resources.

Data on park caves is contained in a database maintained by CRF in cooperation with the Missouri Speleological Survey. Outputs include run-time databases and data suitable for incorporation into the park's geographic information system.
Despite the challenges of high visitation and modest funding, OZAR continues to effectively manage their cave and karst resources.

Sequoia - Kings Canyon National Parks

Joel Despain, former cave specialist for the park, has taken a position with the U.S. Forest Service leaving the cave specialist position at the park vacant. It is hoped that the position will be backfilled this summer. Until the position is filled, questions and comments about the program should be directed to Annie Esperanza, annie_esperanza@nps.gov 559-565-3777.

Timpanogos Cave National Monument

Submitted by Cami McKinney

Middle Cave Lake Restoration

In 2011, Timpanogos Cave National Monument began a three year project to restore Middle Cave Lake. The majority of this 5 x 60 ft lake runs beneath a bridge that is crossed by approximately 70,000 visitors annually. Decades of accumulated debris has filled the lake floor with several feet of "muck". Debris included not only mud and lint, but blasting rubble from tour development in the 1930s.

Capitalizing on construction closures and utilizing both volunteers and employees from other departments, the project began in August and continued until early December. Work began with draining the lake, saving some water for cleaning purposes but planning for seasonal flows to restore lake levels in 2012. During the four months focused on this project, crews removed more than 3,000 lbs of debris from the lake. Care was taken to identify broken cave formations and cultural items.

Cave Management Plan

An interdisciplinary team at TICA has spent the last 2 years working to reach decisions on the Timpanogos Cave: Cave Management Plan. This plan will address environmental monitoring, bats and WNS, safety concerns, infrastructure, as well as create new policies regarding tour operations and cave impacts. The park has been asked to present the plan in the IMR Worksession in May 2012 with plans to release the environmental assessment for public comment in the summer.

Ground Water Study

Cami Lee, Dante Kleinman, Bonny Armstrong, Kyle Gochenour, and Aaron Stover with blast rubble debris. NPS Photo.

TICA is undertaking a project with the support of Ball State University to understand the scope and characteristics of the watershed that contributes to the many cave pools. With the high elevation of the cave and the proximity to NPS boundaries, it is hypothesized that the cave watershed extends into US Forest Service lands. USFS lands above the caves and on the slopes of Mount Timpanogos are subjected to recreational off-road vehicle use, snowmobiling, commercial ranching, and mining. Each of these activities presents a potential source of contamination to surface waters that may enter the cave ecosystem.

Wind Cave National Park

Submitted By Rod Horrocks and Marc Ohms

Groundwater Flow Study Completed

Scientists from the U.S. Geological Survey (USGS) and the National Park Service recently completed a four-year study looking at the flow, quality, and mixing of the park's groundwater. From 2007 to 2011, researchers collected a total of 100 samples from 60 sites which included stream sinks, cave drips, cave water bodies, springs, and wells. For more information, or to read the entire report, visit http://pubs.usgs.gov/sir/2011/5235/.

Projects

We recently completed the public scoping phase for an Environmental Assessment (EA) for a proposed airlock on the Walk-In Entrance to Wind Cave. We are writing the FONSI for that project, with construction set to begin in September. The airlock will be a two-door structure that will replace the deteriorating revolving door. This project will also return and repair the historic wooden door and metal bar gate that date to 1939 for display. We will also recreate the 1939 rock arch entrance around the outside door of the airlock, in an attempt to recreate a "cave-like" opening in the hillside that the CCC originally created. The original rock arch opening, which is now obscured by the revolving door, will be visible from inside the new airlock structure. Not only will the structure be large enough to hold a 40-person tour, but it will significantly reduce the amount of artificial air exchange between the cave and the surface atmosphere, returning levels to near natural conditions that existed before the Walk-In Entrance was blasted open. The airlock will also prevent unnatural access for woodrats, bats, and flood waters. Instead, flood water will enter the Natural Entrance through grates in the rock retaining wall surrounding the Natural Entrance. Once in the cave, those waters will be allowed to fall down the Warm Air Pit, not affecting the paved tour route and accompanying infrastructure. Finally, the airlock will give our visitors a place for their eyes to adjust to low-light conditions before they descend the steep entrance stairs. The public comment period on the draft alternatives in this EA ended on 3/8/12. The draft EA can still be seen at Parkplanning.nps.gov.

Along the same lines, our Maintenance Division just completed a project to rebuild the two airlocks on the Upper and Lower Elevator landings in Wind Cave. This involved removing the moldy wood rafters and plywood roofs of those structures and replacing them with stainless steel hollow tubes covered with stainless steel plates that were welded on and then topped with a rubber membrane. In order to improve the esthetics of those structures, the cinder block walls were covered with cement stucco that was colored with liquid pigment to match the surrounding cave colors. Before we completed the cement stucco project, we tried a synthetic stucco product called Synergy on the walls of the airlock. Although, this looked great and was easy to apply, it quickly grew black mold in the high humidity cave environment and had to be removed. Once again, it has been demonstrated to us that using high tech solutions in caves almost always fail.

Everett Brill characterizing stream cobbles in the flood deposits in the Cobble Hall area of Wind Cave. Photo by Rod Horrocks.

Research

Brian Fagnan, from the South Dakota Geological Survey, recently published a geology map of the park at a scale of 1:12,000. A digital version of this map is available at: http://www.sdgs.usd.edu/publications/index.html.

Dr. Art and Peg Palmer just finished a project to study tepee-like structures in the Pahasapa Limestone in an area of the cave known as the Walking Stick Maze. They found that the multi-colored bedrock in this area is a silicified, iron oxide-rich, soft, porous material. They are now working on a cooperative project with Jim Paces and John Stamm from the USGS to date and analyze calcite wall coatings in the Lower and Middle Levels of Wind Cave. It is hoped that this project will provide a history of the water table fluctuations in Wind Cave as well as the chemical and climatic environments at the time that those coatings were deposited.

South Dakota School of Mines and Technology student, Everett Brill, has begun his senior geology research project to study the cobbles in Wind Cave. He will be analyzing all known cobble sites located below Wind Cave Canyon to determine the source, flow rate, relationship, and potentially the age of those flood deposits.

Dr. Andreas Pflitsch is continuing his research on the barometric caves in the Black Hills. He is currently conducting more in-depth monitoring of the barometrically breathing well on the Lady C Ranch, located just SW of the park.

Starting in 2008 and ending in 2010, Dr. Hazel Barton sampled water from Calcite Lake within Wind Cave to examine the microfauna as a representative community of microorganisms living within this unique mixed aquifer. In addition to sampling water within Wind Cave, she also examined microbial communities in other sites in the Madison Aquifer including Beaver Creek Spring, Park Well #2 and the Streeter Well, which are located both within and outside of park boundaries. Her results represent the most comprehensive examination of a microbial community within a cave environment to date. Her results suggest that the microfauna of Calcite Lake represent a unique and highly diverse microbial community, with a biomass (cell numbers) far below any encountered in any other freshwater environment, including karst environments, aquifers or other studied bodies of water.

Search and Rescue

In the fall of 2011, Wind Cave National Park along with Jewel Cave National Monument hosted the week-long NCRC level 1 and 2 courses. The bulk of the courses were held at Wind Cave with the final mock rescue at Jewel Cave. There were a total of 8 level two students and 17 level one students that completed these courses.

Personnel

MaryBeth Wells has accepted a new position with us and will be joining the Park's Physical Science Branch of the Resource Management Division as a seasonal Physical Science Technician. She will be starting on 3/26/12 and will be working for the summer.

Cave Survey & Inventory

Since the last *Inside Earth*, cavers have increased the surveyed length of the cave by 3.27 miles; establishing the current length of 137.68 miles. The Ox Bel Ha cave survey in Mexico passed Wind Cave since the last issue of Inside Earth to move up to fourth longest cave in the world, dropping Wind Cave down to fifth place. Currently, the Sac Actun cave survey is only three miles behind Wind Cave and has the potential to pass the Wind Cave survey at any time, dropping Wind Cave down to sixth place.

We have begun a project to ridgewalk the newly acquired Casey property for cave and karst resources. This 5,555 acre parcel, located to the SE of the park, was recently purchased and added to the existing park boundaries. The park is currently determining how this new land will be managed and used by the public.

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