Cave and Karst Programs

Geologic Resources Division
National Park Service
U.S. Department of the Interior

Inside Earth

Volume 8 Number 1 *Spring 2005*

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

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

Peg Palmer examines some calcified mud cracks along the Pink Trail in the Half Mile Hall Section of Wind Cave. Photo by Art Palmer, 2003.

Table of Contents:

Featured Articles:

Integrating Cave and Karst Inventory Methods with GIS, Wind Cave National Park, Walz & Spoelman 2
Coyote Cave Hits a Mile, Marc Ohms 5

Park Updates (Listed alphabetically):

Carlsbad Caverns National Park; Dale Pate 6
Grand Canyon Parashant, Kyle Voles 7
Hawaii Volcanoes National Park, Jadelyn Moniz Nakamura 7
Jewel Cave National Monument; Mike Wiles, Rene Ohms, & Peggy Renwick 8
Wind Cave National Park; Rod Horrocks & Marc Ohms 9

Feature Article:

Integrating Cave and Karst Inventory Methods with GIS, 2003-2004 Cave and Karst Inventory Project, Wind Cave National Park

By Jason Walz and Seth Spoelman

Abstract

Exploration and documentation of Wind Cave has been ongoing for more than a century, but many of the small caves and karst features within Wind Cave National Park have never been properly inventoried. These features are important because they provide clues that help unravel the complexities of the large karst drainage system of which Wind Cave is only a part. They also provide habitat for wildlife, and may contain paleontological resources or have cultural significance. The National Park Service considers all caves significant, which makes having locational and inventory data on these resources an important management consideration. For these reasons a two-person ridge walking crew was hired during the 2004 summer season to find and document as many new caves, rock shelters, and other karst features as possible; integrate all the existing karst data into a GIS format; and to establish updated methods and protocols to conduct future cave and karst inventories in Wind Cave National Park.

Background

Documentation of backcountry cave and karst resources in Wind Cave National Park began in the 1970's. In 1994, the Park submitted nominations for eight of its caves to be listed as significant resources, as part of a national effort tied to the Federal Cave Resources Protection Act (Nepstad, 1994). By that point, the National Park Service had made the decision that all caves on NPS lands should be managed as significant resources making systematic inventory of backcountry cave and karst features more of a priority. Originally, each cave received its own file folder, which included a photocopied topographic map showing its approximate location, written descriptions, trip reports, photographs, photocopies of survey notes, and a completed copy of the drafted cave map. In recent years, UTM coordinates were added to these files as the use of GPS progressed. By the time this funded project was started, the Park's Physical Science staff had documented 26 caves, 5 rock shelters, and 75 other karst features within Park boundaries (Ohms, 2003).

In 2003, two MS Word documents were created to consolidate and standardize all of the available cave and karst information into a digital format. For caves and rock shelters, standard documentation includes a written description and location, a history log, a photograph of the entrance, a drafted map, and UTM coordinates. The second record for springs, sinks, blowholes, and other features receives the same documentation without a drafted map or a history log. These two documents remain the current template for documentation of cave and karst resources within Wind Cave National Park.

Planning

Because Wind Cave National Park is over 11,331 hectares (28,000 acres), planning was necessary to prioritize which areas of the park should be studied thoroughly. We theorized that the potential for finding large caves is related to the type of bedrock, proximity to a contact with an overlying insoluble rock layer, proximity to a surface drainage, and slope. This can be thought of as a conceptual model of "karst feature potential" that has a history of success in karst systems all over the world. In Wind Cave National Park, karst features are most often found within the Madison Limestone. Other potential cave bearing formations include the Minnekahta Limestone, Minnelusa Formation, and the Spearfish Formation. Drainages are ideal places to investigate because they are often associated with the steepest slopes and the best exposures of bedrock, where cave openings can be more easily identified. Drainages are also important because they are the surface component of a karst system, and connections between streams and the subsurface are important to understanding the karst system as a whole. Geological contacts between limestone and less soluble overburden are ideal places to find large caves because the soluble rock layer, limestone, allows for cave development, while the overlying less soluble layer protects caves from subsequent erosion or filling. Though there are several known exceptions to these patterns in Wind Cave National Park, this conceptual model was used as a starting point to plan the most effective ridge walking routes possible.

An ArcGIS project was created with layers representing generalized geology, surface drainages, and areas with a slope greater than 30°. Elevation contours and a digital orthophoto of the park were combined with these layers for reference in field investigation. A Shapefile was placed into this project that combined all existing locational data, including older Shapefiles, dBase tables, text tables, or pencil dots on photocopied topographic maps. This file became a master document containing the entire Cave and Karst Inventory, and helped evaluate the pattern of spatial distribution of known and new features, and to prevent duplication of effort. Prior to the start of each day in the field, an updated map, including all the points added to the master file and a record of all previous routes taken in a given area, could be quickly produced. A sample field map is shown including all these layers except the file containing cave and karst feature locations (Fig. 1).

The actual routes taken in the field were chosen using these maps to balance the need for thorough documentation with a desire to efficiently cover a large area of the park. These are somewhat contradictory aims, so there was a certain amount of compromise. For example, it is likely that where karst features have already been documented, more are likely to be found nearby. On the other hand, without a previous record of ridge walking routes, areas with a high density of karst features might simply have already been thoroughly searched, and areas without known karst features may not have been searched at all. Thankfully some duplication of effort could be avoided by referring to more senior employees of the park who have done extensive ridge walking and can recall which areas were covered previously. A general plan was made to concentrate on high potential areas that had not been covered adequately by previous ridge walking. An effort was also made to search areas where there was no record of any ridge walking, areas of interest to the Resource Management Division, and some areas where karst features were unlikely.

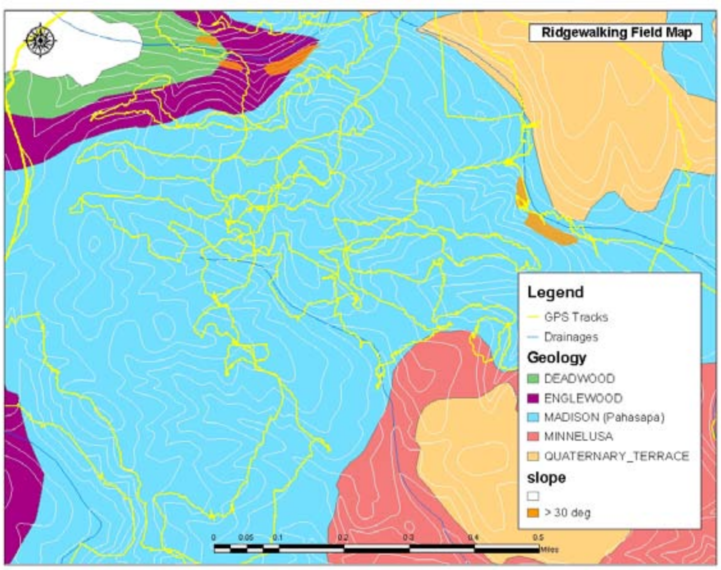


Figure 1, Ridgewalking field map showing a portion of Wind Cave National Park.

Field Methods

GPS Hardware

After field testing, the Trimble GeoExplorer 3 was chosen due to its data logging capabilities and the convenience of the Pathfinder Office software that accompanies it. The Garmin III Plus was not used for data logging, but was occasionally used for navigational purposes because it can display simple topographic maps and Shapefiles.

Trimble GeoExplorer 3 Settings

The Trimble unit was set to the default coordinate setting for all logged features, which is latitude and longitude, WGS 84 datum. The GPS precision setting was set as high as possible so that the data collected would be of the best quality. Unfortunately, due to weather and time constraints on field exploration, and the steep cliff-side or valley locations of some karst features, occasionally the precision setting had to be lowered so that data could be acquired even when conditions were not favorable. When logging point features, as many as 100 points were averaged to compensate for any inaccuracies due to topography or unfavorable satellite alignment. In some cases, no GPS location could be acquired in the field and an approximate location had to be added to the database manually by editing the Shapefile in ArcGIS.

A data dictionary was created using Pathfinder Office software for this project to record karst feature locations and the areas searched by the ridge walking crew. A new karst feature point could only be stored after a minimum of 25 GPS entries have been averaged, and twenty-four attributes have been entered. The attributes were chosen because they were already in use, and part of an Excel database. While most attributes require a qualitative entry indicating whether something is present or has been completed, some of the entries require entry of text manually or from a drop-down list.

A track of the route being followed was also recorded through the data dictionary. The Trimble unit was set to create the track by logging a point whenever the GPS unit detected movement of 3 meters. Attributes for the time and date at which the tracks were recorded generated automatically. Tracks were logged at all times while ridge walking to identify where the crew had searched, identify what areas might have been missed, and to calculate the total distance covered by the crew.

Field Notes and Survey

In addition to GPS data collection, standard written and photographic documentation were performed at each location. Written documentation included a general description of the location as well as more detailed documentation of the same attributes contained in the GPS data dictionary. If “yes” was selected for a given feature under “packrat,” for example, the written description denoted whether a live animal was sighted, whether scat was present, and whether the accumulated scat and debris constituted a midden. At least one photograph was taken of the entrance for each entry, and if it qualified as either a cave or a rock shelter, a survey was completed. The survey was conducted with a Suunto compass and clinometer and a Leica laser rangefinder. A finished map of the field survey was created using Adobe Illustrator 10 (Fig. 2) and was transferred with all the other field notes into a MS word document.

Data Management

Trimble Pathfinder Office software provided the link between field data collection and the ArcGIS software. A Pathfinder project was created that contained default pathways for data storage, and settings for data import and export. After using Pathfinder to transfer the collected data from the Trimble unit to the PC, all data was differentially corrected to increase precision using the base stations at Jewel Cave National Monument or Whitney, Wyoming. The corrected files were exported using custom settings that translate the collected data from WGS 84 datum to NAD 83 and project it to the UTM coordinate system that is used at Wind Cave National Park for all GIS data.

Using the GIS system, as new cave and karst features continue to be discovered, the master file will continue to expand accordingly. Once the files representing a given day's fieldwork were successfully imported to Shapefile format, they could then be edited using ArcGIS. Each day's point file was checked for accuracy against the air photo, the contours, and relative positions of other collected features. In the event that a GPS location was unobtainable, some points were digitized at this time, relative to other known features. To prevent rediscovering previously known karst features that lack precise GPS documentation, less accurate data from previous ridge walking was integrated into the master file. The attribute "GPS type" connects a given point to its accuracy and a brief description of how it came to be. All the locations denoting the value "Geox3" were taken with the Trimble unit starting with the 2004 inventory and are the most accurate. The attribute value "Magel" denotes that the position was acquired with a Magellan GPS unit in the 1980's, during selective availability. These points were moved collectively for integration into the current system, as there seemed to be a systematic error of about 9.1 meters between old and new GPS points. Most now seem sufficient to navigate to within 18 meters of the location. The attribute value "garm3" denotes that the position was acquired with a Garmin3 device.

Most of these locations have proven to be accurate, but registration errors can be found since different techniques were used in data transfer. The value "AP" means that the point was placed by hand relative to the air photo, and/or other known features. These points possess the most dubious data quality of all, and these locations should be field checked. The value "FC" applies to any of the above which have either been checked in the field against points logged with the Trimble unit and found to be nearly identical, or to points that appear to be within 15 meters of their true location due to the relative locations of nearby features as seen on the map. By consolidating all the records into one master file, the ridge walking crew was able to search Wind Cave National Park with the best available data.

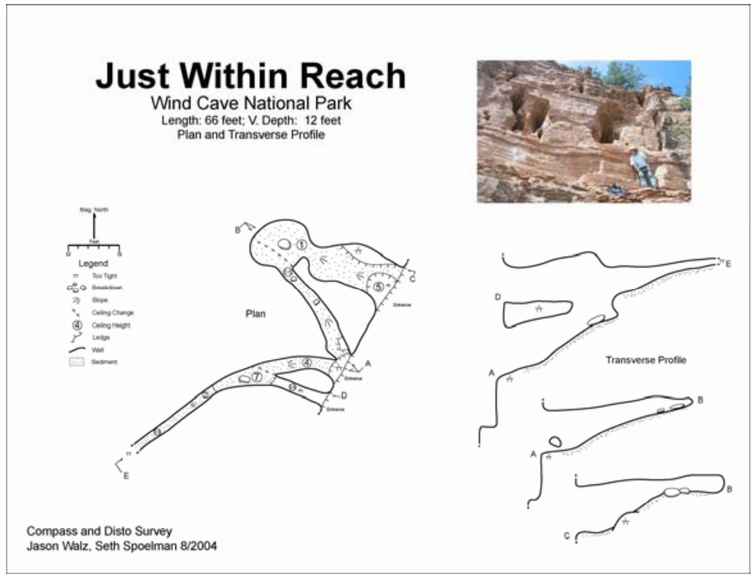


Figure 2. Map of Just Within Reach Cave in the Minnekahta Limestone in Wind Cave National Park.

Conclusions

The Cave and Karst Inventory Project was very successful. The two-person ridge walking crew, with the help of volunteers and other park employees, hiked more than 240 km (150 miles) within Wind Cave National Park. They searched 1,780 hectares (15% of the park) and found 152 new karst features, including 17 caves, 21 rock shelters, 6 sinks, 5 springs, and 106 other small features, which almost doubled the Karst Inventory Database. This new data was integrated into the park's GIS system, making it readily available to park management for decision making purposes.

Attribute analysis shows that almost all of the sites found over the summer have been recently used by wildlife. The majority of the creatures using these small karst features are packrats, porcupines, and spiders. Evidence of insects, bats, birds, raccoons, coyote, elk, deer, and even bison were also found at several locations. It appears that much of the wildlife within the park venture in or near these small karst features at some point in their life cycle.

No recent disturbance by people was found at any of the sites, however, at two sites, historic disturbance was discovered. A rock shelter was found with incised scratches and two sets of initials that are presumed to be historical graffiti. Secondly, a cave was discovered that contains a metal barrel apparatus that appears to be a historic still that may date to the early 20th century, when nearby homesteads were occupied. Most of the karst features that were found are small, but even the more extensive sites showed no human impact and it appears that keeping their locations secret is sufficient to protect them.

Using GIS for documentation of karst resources makes organization, visualization and integration of additional data a simple process. The Physical Science staff can now complete advanced analysis of this data. As expected, the data reflects an obvious clustering of karst features in areas that meet several of the criteria of the "karst feature potential" model. However, one of the criteria, proximity to a contact with an overlying insoluble rock layer, has not proven to be a significant criteria for developing karst potential models for the park. More specifically, most karst features were found along surface drainages or other steep areas where the Madison Limestone is exposed at the surface irregardless of the proximity to a contact with the Minnelusa Formation.

The GIS data also reflects that karst features can be found in areas that are not Madison Limestone bedrock, which is the main cave forming strata in the Black Hills area. In these areas the steepness of the slope and the proximity to a drainage seem to be the prevailing factors. A few karst features, including one cave, were found along drainages within the Minnelusa Formation. Even though the Minnelusa mostly consists of sandstones and shales, there are limestone layers within it that provide strata for karst development. In addition, a few karst features, including two caves, were found along steep areas within the Minnekahta Limestone. The Minnekahta Limestone is an unlikely place, because it is thinly bedded and brittle. Unexpectedly, the longest cave discovered during this inventory project was found within this formation (Fig. 2).

Cave feature inventory, much like cave exploration, is never truly finished. Even in areas that have been ridge walked, an unnoticed karst feature may still be found, perhaps even another long cave. In the future, systematic inventory using the best data available and the most current GIS technology is possible, as areas that have not been investigated are clearly indicated.

Acknowledgements

This project was supervised by Marc Ohms and advised by Rod Horrocks and Bill Koncerak. This paper was reviewed by Rod Horrocks, Marc Ohms, Rene Ohms, and Jim Pizarowitz. Individuals from EPMT, wildlife, and volunteer field crews helped locate and map unknown karst features including: Kali Pace, Chris Amidon, Ajax (B. Dalman), Eric Lassance, Eric Maichak, Duane Weber, and Jova Siegel.

Bibliography

Nepstad, James A. 1994. "Significant Cave Nomination Worksheet." Unpublished report, Physical Science files, Wind Cave National Park. 3 p.

Ohms, Marc 2003. "Cave and Karst features of Wind Cave National Park". Unpublished report, Physical Science files, Wind Cave National Park.

Additional Reading

Horrocks, Rodney D. 2005. "History of Cave & Karst Resource Management in Wind Cave National Park". Cave & Karst Resource Management Plan. Draft version, Physical Science files, Wind Cave National Park. 11 p.

Coyote Cave Hits a Mile!

By Marc Ohms

The earliest report of this cave, which is found in Wind Cave National Park, was by a seasonal park ranger named Tom Miller on July 5th, 1974. The cave is unusual because it is located within a thin limestone bed less than six-feet thick within the Minnelusa Formation (which is primarily composed of sandstone). Tom referred to the cave as Blo-Suk Cave after the strong airflow. It was later learned that Bob Kobza also knew of the cave but had never filed a report with the park. Over the following year, park rangers surveyed 600 feet. Exploration continued in the 1980's as park rangers Jim Pisarowicz, Jim Nepstad, Karen Rosga, and Darren Ressler pushed and dug further into the cave following the air. During this time the caves name was changed to Highland Creek Cave, which the park considered to be more appropriate. These surveys brought the cave's length to 1,114 feet to a tight place nobody would fit through (later named the Vice). At this time the name was changed to Coyote Cave as the former name hinted at its location. A gate was installed in 1990 approximately 100 feet into the cave.

In 1992 cavers visited the cave and Mike Wiles squeezed beyond the Vice and pushed 500 feet of belly crawl before turning around. In 1997 Greg Stock, Merrilee Proffitt, and Joel Despain squeezed through the Vice and continued beyond where Mike Wiles had turned back five years before. They discovered a large walking passage they named the Bison Borehole (a bison vertebra was discovered in this passage) and many leads. Two years later, in 1999, Merrilee and Joel returned with Rene Rogers to survey the passage found earlier. They surveyed 860 feet on the first trip and 1,100 feet on a second, bringing Coyote Cave to 3,200 feet long. Another trip by the thin trio in 2000 added another 1000 ft of survey to the cave's length.

In the summer of 2004 Marc and Rene Ohms, Seth Spoelman, Jason Walz, and Ajax Dalman went to Coyote Cave to on two trips trying to push the cave beyond the one mile mark. However, none of the males could fit through the sub-seven inch Vice so they were confined to surveying leads on the near side. They managed to survey enough to bring the length to 5,077 feet, just 203 feet shy of a mile.

On May 25th Rene Ohms led Ajax Dalman and Larry Shaffer into Coyote Cave and surveyed 288 feet, which brought the total length of the cave to 1.02 miles long. It became the seventh cave in the state to pass the one mile mark and is now the sixth longest cave in the state, passing Black Hills Caverns. The cave has a fairly strong barometric airflow and plenty of leads to indicate that there is plenty more to discover.

Cavers Larry Shaffer, Rene Ohms, and Ajax (B. Dalman) stand in front of the entrance of Coyote Cave on the trip that the cave's survey passed the one-mile mark. Photo by Marc Ohms. Wind Cave National Park.

Park Updates (Listed alphabetically):

CARLSBAD CAVERNS NATIONAL PARK

Submitted by Dale Pate, Supervisory Physical Scientist

DEAD BATS AT THE NATURAL ENTRANCE – Interpretation rangers, when opening the natural entrance route for Carlsbad Cavern on the morning of April 5, 2005, found 106 dead Mexican free-tailed bats along the trail in the entrance area. Visitors reported observing gusts of wind throwing the bats against the rocks the evening before.

Carlsbad Caverns Staff examine the 106 dead bats found at the cave entrance on 4/6/2005. Carlsbad Caverns National Park, NM.

STRUCTURE REMOVAL IN CARLSBAD CAVERN - With the help of funding from the NPS Cooperative Conservation Initiative and the work of dedicated volunteers, we have started the long process of removing or replacing old, deteriorating structures off the paved trail areas of Carlsbad Cavern. Approved through the compliance process in 2004, 19 structures (not including the more complex wooden bridges in Left Hand Tunnel) were identified and evaluated for removal or replacement with materials that would be less susceptible to deterioration. Wooden and galvanized steel ladders have been shedding materials that have the potential to negatively affect invertebrate populations and leave oxidized metal in the cave.

Five of these identified metal structures were removed from the cave recently. These included: (1) a chain-link fence bridge along the route to Lake of the Clouds which was not replaced; (2-4) three galvanized pipe ladders along the route to Lake of the Clouds that were lying on the ground to facilitate travel on a slope which were replaced with a handline and; (5) an "erector set" bridge in Right-Hand Fork which was not replaced.

This removal effort was led by Paul Burger. Special thanks to Jay Snow, Abby Snow, Mike Oakley, Isabelle Oakley, and Jessie Bebb for volunteering on their days off to remove these structures and to Angel Hernandez and Noel Carrasco from the park's maintenance staff for cutting the longer metal pieces up and removing them from the cave by hanging them on the bottom of the elevators.

NEW CAVES – Since the last Inside Earth newsletter report two more caves have been documented in the park's backcountry bringing the total number in the park to 111.

SAVE OUR CAVE DAY 2005 – April 27 found about 15 employees from various divisions helping to keep Carlsbad Cavern and the Visitor Center in better shape. This annual event accomplished a number of tasks including the following: the removal of about 20 gallons of emery chips (paved trail material), broken concrete pieces, and other debris from areas adjacent to the trail in the Big Room; the removal of about ½ gallon of lint, dust, and trash from areas along the paved trail in the Big Room and Main Corridor, the continued restoration by removing mud and red clay from a pool near Cave Man Junction in the Big Room, the cutting up into small pieces and removal of metal structures that had been moved to the back portions of the Underground Concessions area from a Left-Hand Tunnel project, and the cleaning and dusting of displays the main lobby and in the Library in the Visitor Center. Many thanks to all participants.

GRAND CANYON-PARASHANT NATIONAL MONUMENT

Submitted By Kyle Voyles

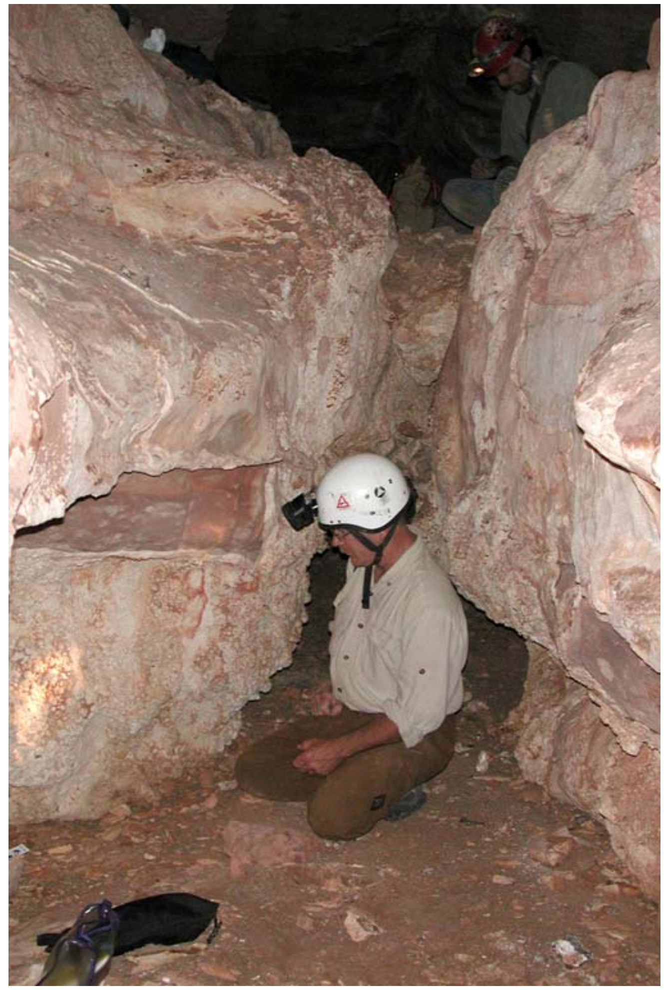
The Grand Canyon-Parashant National Monument is fairly new, only 4-years old. In that time we have conducted a two year Paleo study with Jim Mead from Northern Arizona University (NAU). We inventoried 12 caves and numerous shelters and had several significant discoveries concerning the Paleo climate of the area using radiocarbon dating. Included in the findings were a 24,000 year old vole that is extinct in the region and a ~24,000 year old Douglas Fir which in no longer found anywhere in the geographical region.

One of our caves contained several feet of guano and indicated over 1,200 years of bat use, but no recent or current use. There seems to be little bat use in nearby caves as well.

Starting about 3-years ago, I placed 10 Temp/RH HOBO data loggers in caves throughout the monument and Arizona Strip in order to compare cave temps and relative humidity. This data is used to help with the management and study of bat use in our caves.

Since the creation of the Monument in 2001, we have discovered and surveyed ~ 60 caves on and around the monument, bringing the total to 137. There are many more to be discovered and surveyed.

We have recently started a spring inventory on the monument. Most of the springs are believed to be perched aquifers, but there are numerous caves that take in large amounts of water and may act as large recharge points. To date, there have been no dye tracing conducted to determine resurgence points, but we think there is a direct connection to several of our springs and/or the local or possibly regional aquifers.



Jim Mead and Kyle Voyles conduct a paleontological inventory in Grand Wash Cave, Grand Canyon-Parashant National Monument.

At the same time, we are starting to rewrite and update the cave management plan. Several of our caves have been receiving heavy use, so we have also implemented LAC policies for several caves and are monitoring the current use and impacts.

Starting in May, we will begin a salamander study in our caves and caves throughout the Colorado plateau, working with JJ Wynne and Rick Toomey.

HAWAII VOLCANOES NATIONAL PARK

Submitted by Jadelyn Moniz Nakamura

Cave Resources – An Integrated Approach to Land Management

Due to the nature of its lava flows, Hawaii Volcanoes has numerous caves. They range in size from large lava tubes to small lava blisters. In the pre-Contact period, Hawaiians used caves as shelter/habitation sites, for burial. and for water collection. In an arid area like HAVO water collection in caves may have meant life or death for pre-contact Native Hawaiians. Spectacular examples of pre-Contact use of caves can be found at Hawaii Volcanoes including petroglyphs, hearths, living and sleeping terraces, water collection areas and workshop areas. Invaluable artifacts can also still be found in the most remote and little known caves.

In addition to cultural resources, some caves contain spectacular geologic formations as well as rare cave adapted invertebrate species. Caves support living ecosystems. The roots of native trees, in particular *ohia* are vital for the survival of planthoppers, for example. Other species including cave crickets, spiders, and water treaders also depend on this unique and relatively stable ecosystem below ground. Hawaii Volcanoes is unique in having the first ever documented endemic cave species for the Hawaiian Islands (Kipuka Puaulu a.k.a Bird Park Cave).

Because of their rich and sensitive resources, most HAVO caves remain closed to the public. The only caves currently open to the public are Thurston Lava Tube (light and dark sections), Pua Poo (open to a maximum of 12 individuals on the Interpretive Divisions weekly tour), and Bird Park Cave (no advertisement-safety questionable). Entry into other HAVO caves is on a permit system only. Currently, there are 4-5 active research projects associated with HAVO caves.

Further cave openings will depend on the status of the inventory and monitoring program. Due to the sheer number of caves at Hawaii Volcanoes management must be careful to target those resources considered most significant or at risk for permanent damage. Currently, over 200 cave entrances are listed in the HAVO Cave Database. However, inventory of these caves remains spotty at best. Although the cave program was started in 1995 it has faced numerous challenges including lack of sufficient staff, funding, and competing and sometimes clashing scientific and public interest. Despite this a number of projects have been completed and several new projects are slated for the current and next fiscal year. In the coming months we will highlight a few of these projects. Stay tuned!

JEWEL CAVE NATIONAL MONUMENT

Submitted by Mike Wiles, Rene Ohms, & Peggy Renwick

Airflow Study

Three anemometers are currently installed in the cave as part of the ongoing airflow study run by Dr. Andreas Pflitsch. One anemometer collects data on the cave's barometric airflow just inside the Natural Entrance. These data are then compared to the airflow measured by an anemometer near Hurricane Corner, which leads to the eastern part of the cave, and another in Hell's Half Acre, in the western part of the cave. This last anemometer collects data year-round, but the other two are along seasonal tour routes, so they must be removed in the summer. Airflow is also measured at Wind Cave, and at other small caves with barometric airflow in the southern Black Hills. Dr. Pflitsch visits Jewel Cave every few months, often accompanied by a student who assists him.

Bat Count

In January, the annual hibernating bat count was conducted in the Historic Area of the cave. A total of 1,555 bats were counted, 212 more than last year. One bat was suspected to be an Eastern pipistrelle; this would be the first record of this species within the Monument. Brad Phillips from the U.S. Forest Service, local bat consultant Joel Tigner, and Dan Foster of Wind Cave National Park came to help count.

Cave and Karst Management Plan

The Cave and Karst Management Plan and Environmental Assessment are currently being reviewed by the Midwest Regional Office. Once Region's comments are addressed, the document will go out for public review for 30 days. The Park will also host a third public meeting at the NSS Convention in Huntsville, Alabama.

Cave Maps

Much of the cave survey from the last 5 years has been pencil-drafted, but not yet added to the final Mylar quads. Cave Management Intern Peggy Renwick has been updating some of those quadrangles. Approximately 125 of the cave's 132 surveyed miles currently appear on the final map.

Lint Tarps

Peggy Renwick and Rene Ohms recently finished cleaning the lint tarps on the Scenic Tour route. The nylon tarps are suspended under each platform and stairway along the tour, to catch lint, hair, and other debris left behind by park visitors. The 79 tarps are detached, laundered, and re-attached each year. Many tarps were in need of design alterations, so this year the cleaning/replacement process included re-measuring dimensions in preparation for later alterations.

Recent Exploration

There have been three camp trips since October 2004, bringing the total length of the cave to 132.35 miles. In October, Mike Wiles, Rene Ohms, Peggy Renwick, and Jason Walz went on a four-day camp trip, and in January they were joined by Stan Allison for another four days, and two survey teams could explore simultaneously. In February, Mike, Jason, Rene, Peggy and Kelly Mathis went on a brief three-day camp trip.

Unusual spar stalactites and stalagmites discovered in Jewel Cave on the January exploration trip. Jewel Cave National Monument, SD.

Camp trips take place in the southeastern reaches of the cave, but since January 2005, there have been several day trips to the western half of the cave, primarily to "mop up" the area beyond the Thrill of Victory. Larry Shaffer and Matt Busch have assisted in these efforts.

Gypsum flowers discovered in Jewel Cave on the January exploration trip. Jewel Cave National Monument, SD.

WIND CAVE NATIONAL PARK

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

Since it has been eight months since we last wrote an update for Inside Earth, a lot has happened in Cave Resource Management at Wind Cave National Park. Some of the highlights that have occurred in the park are:

Projects:
The park completed a project to stop contaminated runoff coming off of the parking lot from entering Wind Cave. This was accomplished by replacing the asphalt lot with concrete. This project was a result of dye tracing work conducted by Jim Nepstad, Dena Venezky, Calvin Alexander, and Marsha Davis. The concrete has mitigated the effect of dripping gasoline and antifreeze "melting" the asphalt and releasing hydrocarbons which were then washed into the cave in as little as 6 hours. With the concrete lot, it is no longer necessary to conduct annual chip sealing of cracks in the asphalt, another major hydrocarbon source. In addition, special culverts in the new lot capture hillside runoff above the lot and redirect it into Wind Cave Canyon in an attempt to restore natural drainage patterns. All runoff directly off of the new concrete lot is now captured and funneled through an oil and grease separator before being released further down Wind Cave Canyon.

This years Black Hills Cave Restoration Camp cleaned dust, hair, and lint along the Natural Entrance Tour Route between the Post Office and the Natural Entrance. Although this stretch had been cleaned during the 2000 camp, a total of 17 plastic trash bags half filled with debris were removed by a crew of 5 volunteers. This crew, who were from Nebraska, Colorado, and South Dakota, donated a total of 80 hours.

We recently completed a project to document all of the flagged routes used by cavers in Wind Cave. In the process, we extended the Pink Trail from the Chimera Room up to the Snake Pit Entrance. Using COMPASS and ArcView 9.0, we have added all six trails into the park's GIS.

A cooperative agreement has just been signed between Wind Cave National Park and the University of Northern Colorado so they can study the impact that our tours have on the microbial community in Wind Cave during a two-year study.

Graduate student, Bjoern Zindler, from Ruhr University in Bochum Germany, recently visited the park and presented the results of his Masters Thesis on the microclimatic conditions in the Natural Entrance extended area of Wind Cave. Bjoern is a student of Dr. Andreas Pflitsch.

Jason Walz recently completed a six month seasonal position for WICA physical sciences. During his stint he completed a paper on the recent Cave and Karst Inventory of the park (see feature article in this issue). He also updated all of the quadrangle maps with the previous years worth of survey and documented all of the flagged trail routes in Wind Cave.

NCRC Course:
Marc Ohms recently taught a two-day NCRC cave search and rescue training class for park staff. The second day was a mock search and rescue of an injured patient from the half way point on the Wild Cave Tour in Wind Cave. It took the team two hours to haul the patient to the surface. The practice went remarkably smooth.

Meetings:
We are in the process of planning for the upcoming Karst Interest Group (KIG) Workshop in September. Hosted by the USGS, Wind Cave will be one of the stops on the Southern Black Hills Karst Hydrology Fieldtrip that will be held on September 12th.

The Superintendent and Physical Science Specialist attended a NPS meeting in Lakewood, Colorado that was hosted by Ron Kerbo and Louise Hose. This National Cave and Karst Research Institute meeting discussed what the relationship between the NPS and NCKRI should be.

Survey & Cartography:
We are in the process of putting the finishing touches on an update of all of the new Wind Cave quadrangles. These Mylar-based maps have now been updated to the current survey date. This marks the first time in nearly 20 years that Wind Cave has had all of the existing survey drafted onto quad sheets.

We recently completed a new map of the tour routes in Wind Cave. This digital map has separate levels that can be turned on and off to create different theme maps at any desired scale. The individual layers include cave restoration sites, environmental monitoring sites, research sites, light fixtures, and infrastructure. These new maps are being heavily used by the park.

The Coyote Cave survey just passed the one mile mark. It is the second cave in the park to pass a mile in length and the seventh cave in the Black Hills. There are numerous leads left in this difficult cave (See the extended article featured in this issue).

Since the last reported length of Wind Cave in Inside Earth, volunteer cavers have increased the surveyed length of the cave by 4.64 miles, establishing the current length of 116.75 miles. On January 10, the Wind Cave survey passed the fifth longest cave to become the new fifth longest cave in the world. The Park's press release on this milestone generated a surprising amount of attention as it was picked up by newspapers, radio stations, and magazines across the country.

Seth Spoelman and Rene Ohms in the entrance passage of Coyote Cave, Wind Cave National Park. Photo by Marc Ohms. Wind Cave National Park, SD.