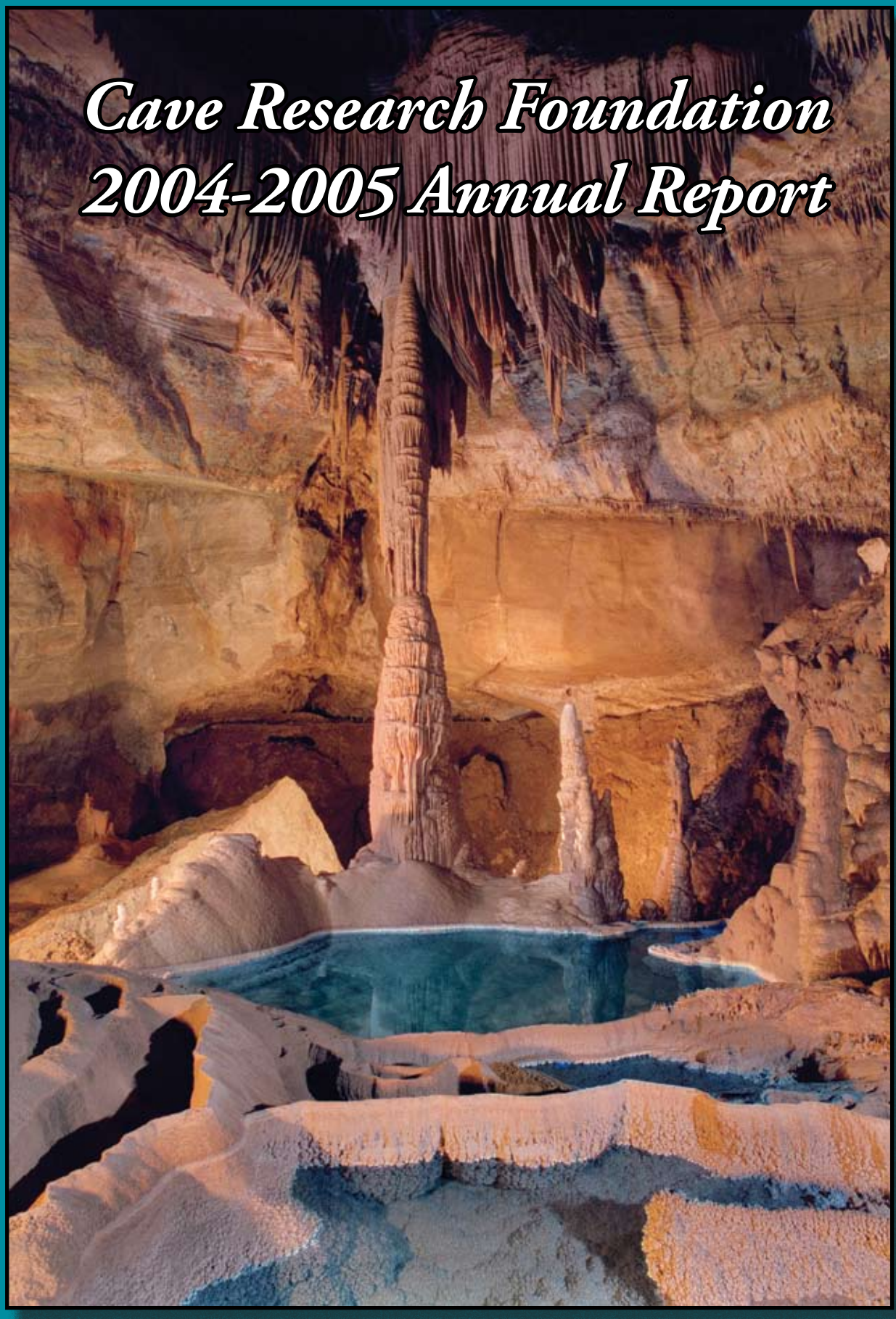
Cave Research Foundation 2004-2005 Annual Report



Cave Research Foundation 2004-2005 Annual Report

The Cave Research Foundation was formed in 1957 under the laws of the Commonwealth of Kentucky. It is a private, non-profit organization dedicated to facilitating research, management and interpretation of caves and karst resources, forming partnerships to study, protect and preserve cave resources and karst areas, and promoting the long-term conservation of caves and karst ecosystems.

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Front cover photo: Royal Palm Pool, by Dan Silvestri

This 60-foot column with pools is located in the Rimstone Riviera section of Gap Cave, Cumberland Gap National Historical Park. Captured by CRF Joint Venture cavers during the June 2005 Expedition, a print of this photograph was awarded the Best of Show Medal in the Traditional Color Print Category of the 2005 National Speleological Society salon.

Back cover photo: Elizabeth Winkler in the Hall of Mists in the Bedquilt section of Mammoth Cave, by Peter and Ann Bosted

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OPERATIONS AREAS

Eastern Operations Area
Dave West, Operations Manager
Mike Crockett, Project Manager, Cumberland Gap
Mammoth Cave National Park
Cumberland Gap National Historical Park

Lava Beds Operations Area
Janet Sowers, Operations Manager
Lava Beds National Monument

Ozarks Operations Area
Scott Huse, Operations Manager
Mark Twain National Forest
Ozark National Scenic Riverways

Sequoia/Kings Canyon & Mineral King Operations Area
John Tinsley, Operations Manager
Lava Beds National Monument

Southwest Operations Area
Barbe Barker, Operations Manager
Carlsbad Caverns National Park
Lincoln National Forest

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2004 CRF HIGHLIGHTS

The year 2004 was a banner one for the Cave Research Foundation. After many years of planning and hard work, the new Visitor's and Research Centers at Lava Beds National Monument were dedicated in June. Then in July the National Speleological Society awarded their prestigious Certificate of Merit to the Southwest Region Operations Area for the restoration project in Carlsbad Caverns National Park. Read more about these events in the articles on the following pages, reprinted from the CRF Quarterly Newsletter. The CRF Annual Meeting was held November 5-7th at the Hamilton Valley facility near Mammoth Cave National Park and was well-attended. Rick Toomey announced that he was retiring as CRF President, and Chris Groves was elected to fill the position.

The achievements of the CRF would not be possible without the efforts of the multitude of volunteers that comprise the organization. The reports in this volume outline many of the major CRF projects, and illustrate well the goals and ideals of the organization.

2004 CERTIFICATE OF MERIT

Ron Switzer, NPS, Mammoth Cave

2004 FELLOWS

Jim Kaufmann

2004 CRF FELLOWSHIPS AND GRANTS

Reiko Ishihara
$2,500 Grant
Department of Anthropology, University of California, Riverside
Aguateca Grieta (Chasm) Archeological Project: Contextualizing the Use of Sacred Landscape in the Political History of the Late Classic Maya Site of Aguateca, Guatamala.

Kathleen M. Muldoon
$1,500 Grant
Department of Anthropology, Washington University, St. Louis
Paleoecology of Ankilitelo, Southwestern Madagascar: Implications for Late Quaternary Megafaunal Extinctions.

Meta G. Pike
$1,000 Grant
Department of Anthropology, University of Tennessee
Prehistoric Plant Food Subsistence in Central Tennessee: A Macrobotanical Analysis of Desiccated Human Paleofeces from Big Bone Cave.

Linda L. Martin
$1,000 Grant
Department of Geography, University of Kentucky
Biogeomorphic Land Use Influence on Erosion in a Sensitive Fluviokarst Landscape, Kentucky River, Kentucky.

CRF & THE LAVA BEDS RESEARCH CENTER

Janet Sowers and Bill Devereaux

"On station!" is the cry from the darkness where a tiny point of light shines. "Thirty seven point five," calls the surveyor. "Three-seven-point-five," confirms the note taker as she writes down the measurement by the light of her headlamp. These surveyors are members of the Cave Research Foundation and they are creating a map of a cave. Sixty CRF members contributed 1078 volunteer hours on cave-related projects in the park last year, and many more since 1988 when CRF began operating at Lava Beds.

The Cave Research Foundation (CRF) is a non-profit organization dedicated to the research, protection, and interpretation of caves. Founded in Kentucky in 1957 to research and explore Mammoth Cave National Park, CRF now has operations at Carlsbad Caverns NP, Buffalo National River, Guadalupe Mountains, Ozark Scenic Riverway, Lava Beds National Monument, and Sequoia/ Kings Canyon National Park. CRF works closely with federal managers to conduct research that will be of benefit to the park, while CRF members enjoy the privilege of working in some of the nation's most fascinating caves. Most CRF members are experienced cavers and scientists who donate their time to these endeavors.

In 1988 a group of cavers and scientists joined together under the auspices of the CRF to help Lava Beds National Monument gather data needed to properly manage its caves. The CRF developed a cave mapping and inventory protocol and began collecting information on numbers, location, features and contents of the caves. Other CRF projects through the years have included bat survey, ice cave measurements, photomonitoring, cave minerals survey, a dust study, and study of ferns species at cave entrances.

Basic documentation of the caves through cave mapping and inventory continues today. With over 500 caves to date, and more being found each year, the work seems never-ending! When a cave is first found, a card is filled out that gives a name, location, brief description, and a sketch of the cave. Later a brass marker is installed at the entrance and precisely located with GPS. Still later, a survey crew may be sent out to make a detailed map of the cave. If the cave seems to have special features or contents, a detailed resource inventory is conducted to document its

The flat gray area in the foreground is the building site, and the front of the building will face in the direction of the photograph, toward the Tulelake basin.
Elizabeth Winkler photo

geology, biology, hydrology and cultural resources.

The beautiful computer simulation of Valentine Cave in the Visitor Center was created by CRF members. Using actual photographs of the cave, they assembled the pictures in the computer so that a person can "tour' the cave on the computer screen. The simultaneous narration describes the geology, ecology and history of the cave.

The Research Center being dedicated this June is a long-held dream for both CRF and the park. Built entirely with private donations from CRF members and friends, and designed *pro bono* by Minert Architects of San Jose, CA, it is a place for researchers to stay and work. Its lab, storage, work, and living spaces will provide an ideal setting to accomplish goals and work closely with monument staff. It is hoped that with this facility, Lava Beds will be able to attract more visiting scientists to conduct research that will further the understanding, protection, and enjoyment of this amazing park.

CRF RECEIVES NSS CERTIFICATE OF MERIT

Dale Pate

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

CRF members cleaning the Rookery in Lower Cave.
Dale Pate photo

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

Lower Cave First entered by Jim White around 1905, the Rookery in

Lower Cave is a flowstone-covered area with pools of water that at one time held thousands of cave pearls. It was obvious that over the years people had walked on the flowstone with muddy boots. Visitor tours to Lower Cave began on an irregular basis in the 1980s; and by the early 1990s, tours were given on a regular basis, five times a week. The trail through Lower Cave crossed the Rookery flowstone numerous times and with more and more people walking through the area, the flowstone was becoming a muddy mess. The CRF started restoring the Rookery and found that the flowstone under the mud was actually white and quite beautiful. The park soon realized that it would have to install raised walkways over the flowstone to stop the mud from being washed right back into the cleaned areas. With the installation of walkways, the CRF went back to re-cleaning the flowstone and have since restored most of the area. The restoration also yielded hundreds of cave pearls that had been hiding in the mud for all those years.

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

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

Stan Allison inspects the restored flowstone floor in the Rookery in the Lower Cave of Carlsbad Caverns.
Dale Pate photo

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

2005 CRF HIGHLIGHTS

2005 was another year of progress for the Cave Research Foundation. The Lava Beds Research Center opened for business, and hosted the first CRF expedition on President's Day weekend, 2005. The Central Kentucky Karst Coalition (CKKC) has partnered with CRF for survey outside Mammoth Cave National Park, and this year connected the 2.5-mile long Hoover Cave into the Mammoth System. Read more about these events in the articles on the following pages, reprinted from the CRF Quarterly Newsletter. The CRF Annual meeting was hosted by the Ozarks Operations Area and held in Cape Girardeau, Missouri, November 11-13th, and was well attended by members from all over the country.

These and other examples of the cooperative efforts of the CRF to explore, document and protect fragile cave resources are only possible through the extensive efforts of a large cadre of volunteers. Read on for more detailed descriptions of CRF projects and achievements.

2005 CERTIFICATE OF MERIT

Liz Wolff

2005 FELLOWS

Mike Crockett
Dan Doctor
Marek Cichanski

2005 CRF FELLOWSHIPS AND GRANTS

Benjamin Schwartz
$5,000 Fellowship
Department of Geological Sciences, Virginia Technological University
A multi-method approach to characterizing sinkhole hydrogeology and recharge mechanisms in agricultural settings.

Narlaila (Layla) Sitepu
$500 Grant
Department of Biology, Andalas University at Padang, West Sumatra, Indonesia
Composition and structure of communities of macrobenthos in some caves in the Padang Karst Region, West Sumatera Province, Indonesia

Valerio Vicario
$2,000 Grant
Department of Ecology and Evolutionary Biology, Yale University
Phylogeny and molecular dating of a morphologically diverse group of troglobiont Coleoptera.

Vionette DeChoudens-Sanchez
$500 Grant
Department of Geology, University of Kansas
Calcium carbonate speleogenesis: Elucidating the role of temperature, saturation, and solution composition (Mg/Ca) in speleothem mineralogy and crystal morphology.

THE LAVA BEDS RESEARCH CENTER IS OPEN FOR BUSINESS!

Janet Sowers

President's Day weekend 2005, we held the first CRF expedition based out of the new Lava Beds Research Center. The center is set on a knoll near the headquarters area within Lava Beds National Monument. Built entirely with private donations from CRF members and friends, and designed pro bono by Minert Architects of San Jose, CA, it is a place for researchers to stay and work. This weekend, the years of planning, fund raising, and working with architects and contractors finally came to fruition.

At about 1,700 square feet, the center accommodated our party of twelve well, with some of us occupying the bedrooms and others sleeping on the floor in the living room or work room. The kitchen is spacious and simply laid out. Banks of cabinets line both walls, and the window over the sink has a view of the sage covered hillside. The red granite countertops that David Kuhnel installed are very handsome. Thanks, David! At the Saturday night potluck there was ample counter space to lay out a scrumptious buffet dinner. Several of us brought donations of pots, pans, and serving bowls to leave as permanent equipment. We made a list of other things to bring next time.

The workroom has laminate counters on one side with built in shelves beneath, and storage closets on the opposite wall. We plan to install some big work tables, locking file drawers, and a map cabinet. On this trip we used the counters for our laptop computers and to spread out maps and paperwork. John Tinsley brought a copy machine. We plan to obtain a dedicated computer so that we can download and plot cave survey data after a day in the field. Instant gratification! A drafting table/light table is another planned addition.

The living/dining room is large enough for a meeting, small workshop, or just relaxing. High ceilings and the picture window facing the Tulelake basin give it an open feel. The monument staff had rounded up some furniture in the form of three couches, a small table, and some chairs. The planned addition of a rug over the linoleum floor, curtains, and a larger table will give it a more comfortable feel and dampen sounds.

CRF Lava Beds members (from left) Bill Devereaux, Janet Sowers, Peri Frantz, Bill Frantz and John Tinsley at the first CRF expedition at the new Lava Beds Research Center, February, 2005. Janet Sowers photo

We were very pleased with almost every aspect of the new center. It is comfortable and very functional. The research center is already booked by two other groups – a cave invertebrate study and a water quality study. The word is getting around. One simple benefit we

noticed was that when everyone on the expedition is housed in the same facility, communication and camaraderie is much easier.

On Saturday afternoon, after spending most of the day underground, we met with David Larson, the Chief of Resources Management, and discussed the status of the various cave-related projects, both those CRF is doing and projects the monument is either doing or planning. Later, three more staff arrived, including Chief of Interpretations Terry Harris, and we all sat down to a potluck dinner.

We reminisced with Terry, about the night ten or so years ago, when he first informed us that our old field house had been condemned and was slated to be burned down. That was the night the idea of building a research center was born. We thought Lava Beds should have a facility that would serve not only cave researchers but any researcher whose work would benefit the monument. Finally that dream has become a reality!

We wish to thank all those that supported the project with their time, resources, and good wishes. Come participate in an expedition and help us realize the potential of this wonderful new facility!

HOOVER CONNECTION

James Wells

At five minutes to midnight on March 19th, 2005, a group of cave explorers from the Cave Research Foundation (CRF) and Central Kentucky Karst Coalition (CKKC) connected the surveys of Hoover Cave to the Mammoth Cave system.

Hoover Cave was discovered in September, 2003, by Alan Canon and James Wells. An epic mapping trip the next day by Dick Market, James Wells, John Feil, and Seamus Decker took the survey from the entrance for 150 stations and 2500 feet through Athena Trail, consisting of various crawls and canyons, to a walking passage, Katie Jane Way. This passage appears to be the upstream continuation of Yahoo Avenue in Roppel Cave, part of the Mammoth Cave system. While not quite a large trunk passage, Katie Jane Way was just right for exploring and mapping, being mostly walking passage with very little breakdown.

Katie Jane Way was mapped for over seven thousand feet in three subsequent trips, but to the west ended in breakdown without connecting to Roppel-Mammoth. A side passage named Three-Bears Canyon was mapped by Bill Koerschner and Dick Market to a pit called Papa-Bear Pit. Dick Market led an aid climb up the far side of the pit which led to walking passage for a few hundred feet to a narrow, blowing crack.

In 2004, several planned Hoover trips were washed out due to rain. Instead, crews climbed and mapped leads in the area of Hobbit Trail and the S Survey in Roppel, as these areas were close to potential connection points such as Three Bears Canyon. One climb near Wildcat Dome led to 1180 feet of passage and a near-connection, but ended in breakdown.

On another front, a low crawl off Arlie Way was pushed by several crews to another near-connection, so close that crews in Hoover and Roppel were easily able to establish a sound connection through hammer taps during a September, 2004, Hoover photo-trip.

On March 19, 2005, a crew of Alan Canon, John Feil, Dick Market and James Wells went in with high hopes, this being the first mapping trip in Hoover in over a year. The cave was known to be within 100 feet of Roppel in the upper level beyond Papa-Bear Pit, and this was the primary objective.

At the beginning of Three-Bears Canyon, Alan and James started to map Three-Bears Canyon to the south while John and Dick went to look at the narrow, blowing crack past Papa-Bear Pit. The passage became narrow, but continued well enough, until Alan and James bagged the survey by design after 22 stations to go find the others, leaving a going lead.

At Papa-Bear Pit, James and Alan waited just a few minutes until John appeared at the top of the far drop. He and Dick had opened the blowing crack and descended to walking passage, which went 150 feet to the top of a drop into a large dome. This was very likely one of the big domes in Hobbit Trail East, in Roppel.

Okay, time for a little math. The 150-foot rope in Papa Bear Pit went down one side, wiggled around the floor, and then went back up the other side. If we cut off everything lying on the ground, leaving both sides of the pit rigged, would it be enough? Dick and John were not so sure. Should we pull a rope behind us, which would cut us off from any rescue? This was not the greatest habit.

We just had to make sure we had enough rope. Leaving just enough rope for the near (Hoover Entrance) side climb up the pit, Alan cut his rope, and he and Dick pulled it up after everyone was up the far side. Meanwhile John and James scurried along to start the survey. After we mapped down the climb below the crack and a few stations along, the riggers passed the mappers with a big bundle of rope. Surely that would be enough.

James and John arrived at the pit after nineteen stations to find the pit rigged. Dick was equipped, since he had been hanging out setting bolts at the lip of the drop. He got on rappel and descended. We listened.

"Guard Rail!"

A joke, no doubt, evocative of the 1972 connection where the crew came to a guard rail of a tourist trail. We knew there were no guard rails, nor real tourist trails, in this part of Roppel. "Come on Dick, stop fooling! Where are you?"

"Wildcat Dome!"

"Are you sure?"

"YES!!!"

Wildcat Dome, in the Hobbit Trail East area of Roppel Cave. We had found the connection!

After mapping a side passage to get a little more done, we all rapped down into Wildcat Dome and set about searching for a Roppel station. The old W17 from 1983 was located and tied in. At that, we added 360 miles to the Hoover Cave system, which is now estimated to be 362.5 miles long.

Although Hoover Cave now connects to the Mammoth Cave system, the entrance is a very long underground travel distance from Mammoth Cave National Park, and the entrance cannot reasonably be used to gain access to any parts of the cave system that are within the park.

To date, the Hoover Cave project participants have been: Gary Berdeaux, Jim Borden, Shanna Borden, Ann Bosted, Peter Bosted, Tom Brucker, Alan Canon, Jim Currens, Seamus Decker, John Feil, Bill Koerschner, Dick Market, Ryan Moran, Tony Pugh, Bill Stephens, Bill Walter, James Wells, and Peter Zabrok.

Dave West surveying a 90-foot pit in Great Onyx Cave, KY.
Peter and Ann Bosted photo

Operation Area Reports 2004

EASTERN OPERATIONS 2004

August 3, 2003 – August 7, 2004

Dave West

Ann Bosted admires a large column in Martin Cave, KY. Notice the inscription on the lower edge of the column: "Elmer Doyle, January." Peter and Ann Bosted photo

During this period, Eastern Operations at Mammoth Cave National Park fielded 108 parties, expending over 4,770 hours, in support of various projects as follows:

In Park

MCNP Cartography – 73 parties
Small Cave Inventory – 39 parties
Trails Revision – 4 parties
Cave Art Documentation - 1 party

Biosphere Reserve

Roppel Cave - 23 parties
Hamilton Valley - 2 parties
Hidden River Survey – 1 party
Stan's Well - 1 party
Diamond Caverns – 1 party
Pigthistle Cave - 1 party

Many trips supported multiple objectives. Work has continued on bringing the survey data and maps into the park's GIS system. Pat Kambesis

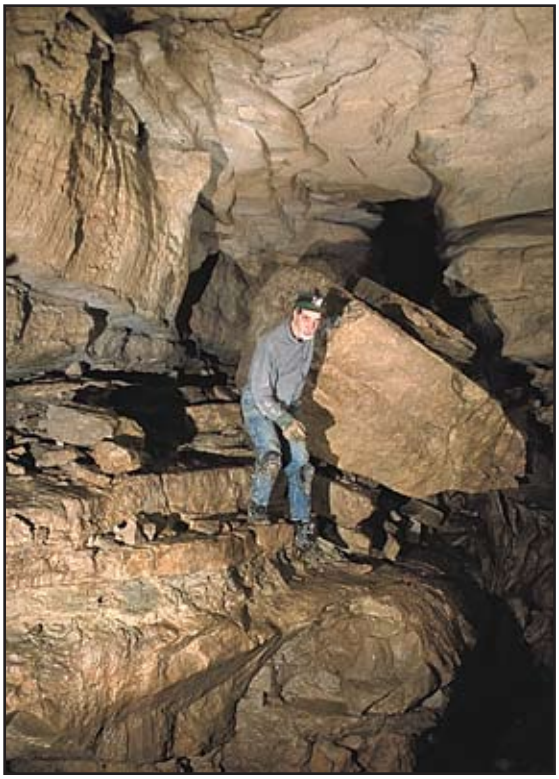
has taken responsibility for the Control Points project to assist with the GIS effort. Efforts are continuing to move the database into Walls, the currently preferred data reduction software for the Cartography project, as it more easily complements the increasing use of Adobe Illustrator in map production. Elizabeth Winkler continues to make progress on the Trip Report Database consolidation effort. A cartographer's meeting was held during the July expedition.

A major new project has begun in Great Onyx Cave to improve the map detail. Bob Gulden has taken on the cartography duties there. Sixteen parties were fielded here during the period. Many of the small cave efforts are geared in support of ongoing park-sponsored research.

A report from the Cumberland Gap Project is attached separately.

Mick Sutton and Sue Hagan surveying in Low Tech Dome, Roppel Cave, KY.
Peter and Ann Bosted photo

Richard Rubin descending the stone stair-steps in the Hall of the Mountain King in the Bedquilt section of Mammoth Cave.
Peter and Ann Bosted photo



Annual Report Supplement
August 7, 2004 - September 30, 2004

This supplement is for the purpose of aligning the Eastern Operations Annual report with the CRF and federal fiscal year that begins on October 1 and ends on September 30th. During this report period, Eastern Operations at Mammoth Cave National Park fielded 11 parties, expending over 350 hours, in support of various projects as follows:

In Park
MCNP Cartography – 9 parties
Small Cave Inventory – 3 parties

Biosphere Reserve
Roppel Cave - 2 parties

Some trips supported multiple objectives. This report includes only the September expedition.

LAVA BEDS OPERATIONS 2004

William C. Deveraux

Our project year begins October 1 and ends September 30 of each year. This allows us to make our annual report to the Lava Beds NM (LABE) staff for the Thanksgiving weekend annual meeting. The period also coincides with the weather patterns that dictate our research rhythms.

This report will detail the projects that I am responsible for, as well as detailed numbers from a spreadsheet that I use to keep track of people, projects, and expeditions. This coming year, I hope to expand the sheet back into previous years to quantify our work since 1990. I have expanded the sheet to track people who come here to work, and quantify the number of trips for which they have been present. I have numbers for 2000, 2001, 2002, 2003 and 2004.

Iris Heusler and James Wilson in Paradise Alley Cave. Peter and Ann Bosted photo

The year we call 2004 saw 23 people work on 10 different projects over 23 expeditions, while contributing 946 hours of work in the Monument. There were 74 person/trips compared to 60 the previous year. Those hours do not include the hours the people spend getting to and from LABE, drafting maps, working on *COMPASS* files, building or repairing equipment, writing reports, composing and responding to e-mails from each other or the LABE staff, or attending CRF Board meetings. Those hours also do not reflect the hours spent by Park staff (both permanent and seasonal), SCA's, and volunteers who went on trips with us to support our work. There were also local NSS cavers (principally from Shasta Area Grotto) who gave us materials and assistance. The success of this project belongs to people who care about this Monument and the caves herein. There were at least two trips that were mainly dedicated to planning for the new Research Center. I do not have all the time recorded for John Tinsley or Janet Sowers in that regard. We have begun logging the travel time and offsite hours on time sheets and in the journal. I do not have totals yet built into the matrix that I keep.

The projects that I worked on this last year were Ice Level Monitoring, GPS Location and Monument Installation, General Inventory, and Cave Reconnaissance Inventory (which includes the cave entrance photography 'project'). I also completed a file review of the cave files for the fourth year in a row.

Ice Level Monitoring

This project has been going on since the 1970's under the guidance of Mike Sims. I have been helping him since about 1988 when it became a CRF project. I have now taken on the job of Principal Investigator, with Mike assisting me in the final report writing for the year. This last year we made 7 measurements in 7 caves during 2 expeditions. We use a digital thermometer that measures in 1/10ths of a degree. We measure with a fiberglass tape the distance from a stainless steel screw mounted in the cave wall to the surface of the water and to the ice surface in 1/100th of a foot. We record the date, measurements and brief remarks on quality of the ice, dead critters, or conditions of the room at each measuring station. Between the two Labor Day expeditions, the ice floors in Merrill, Frozen River, Big Painted, Caldwell, Cox, and Crystal have declined or disappeared, while the floor in Skull has risen. Heppe and Captain Jack's are still iceless. In Merrill the hole has gotten bigger. Ice is now only on two sides of the hole. The catwalk has been moved, and the Park has reopened the cave to visitor traffic. The two ice rivers have largely disappeared. In Frozen River, the floor and pool are gone. The distance to the pin dropped another .49' in one year. One new tool created this year was a spreadsheet and graphs by David Haskel showing the trends in ice levels and water going back to 1990. I hope to have an update for the Thanksgiving meeting.

GPS Location and Monument Installation

This project has been going on since the fall of 1994. Each cave or 'feature' that is recorded in the files or database receives a LABE number by lava flow and sequential number. The staff marks a brass monument, and then we go install it at the cave entrance. The location is written and drawn on the Reconnaissance Card. The cave monument becomes the site for the GPS location session. We record three different sessions at a point two meters above the brass monument. We use a tripod for the sub-meter antenna that is connected to the Magellan 'rover' unit. We have the base station running simultaneously with the rover unit. The file name on the rover session is labeled one, two and three for the cave name. Later, the three files are compared with the base station to get a differential location. The software makes a scatter plot, and a printout is viewed to see if the diagram is tight enough to make the location within a 1 cm circle. If the answer is yes, then we declare it good. If not, we go back and start over. When the UTM coordinates of the three sessions are accepted, then the Monument staff put the location into the GIS system. One of the new wrinkles in both GIS data gathering and cave mapping here, is to tie the brass monument and the GPS location one meter above it to the published cave map. Many cave maps are dated from the 1930's to last year. They obviously don't have the monument or GPS location on them. We are trying to do that as we go. This year we did no new GPS fixes. We installed 5 new monuments.

Cave Reconnaissance Inventory

This project also started long before CRF became a player at Lava Beds NM. What we did in 1988 was define the project, create standards, adopt a card/form and train our people to use the form, and work with the Monument staff to apply it. Many of the other projects

Toinette Hartshorne in Crystal Ice Cave.
Peter and Ann Bosted photo

use the 'card' as a starting point for their work. It is the most basic document that must be completed when a cave is found, recorded, studied, or marked. Mike Sims created the project, invented the form, and trained most of us (both CRF and park staff) in its use. The form is a joint form called LABE, CRF 5/93. The 'card' comes in two forms. The two-sided card is 5"x7". The one-sided version is 8 ½" x 11". We found that the card version often did not get the flip side filled out. So the single sheet with both card sides on the front meant that all the data got filled in the first time to the cave. The 'short' inventory consists of 19 specific items in 4 categories that the field researcher looks for in the cave during their first visit. They can circle the Yes or No symbol, and make remarks to the side of the entry. They look for bats, pictographs, access problems, formations, ice, etc. The card is a living document. It is filled out in pencil, and is updated as new information comes to light. This year we made 5 new cards, and fixed 13 older ones. There were not as many cards and maps made as last year when there were two people on staff to make them, so some of the burden has fallen back to us.

One component of the Cave Reconnaissance project that saw considerable activity this year was the entrance photo piece. The idea is to take a digital photo of each cave entrance with at least one person at the entrance pin, the 'meter' sticks for scale, and the cave number written in large black letters on a white board. The location of the photo is at the brass monument with one stick placed on it so you can see where it is. The location of the camera operator is noted on the recon card so that it can be replicated later if needed.

This year we printed 34 photos, and photographed 40 entrances. There are only 3 caves in the Loop Flow left to be photographed.

We completed no General Inventory this year.

Unofficial Projects

I completed the third annual cave file review. This is an unofficial project

that I have taken on. We reviewed 506 file folders during one trip. This year I had the help of Josh Bailey. This project came out of an agreement early in CRF's relationship with the Monument. We agreed that certain items must be in the file folders, with corresponding consistency of information being recorded on forms, in surveys, on maps, and annotated on photos. There are a total of at least 10 items that I look for in every folder. There is an annotated cave printout from the database that I use to record notes of missing items. I also make notations in red pen in the Book of Caves as we update material. As maps get made, recon cards get completed, GPS and monuments get validated and installed, and entrance photos get taken, printed and inserted into files. The list of shortfalls gets shorter each year. This year's file review took about half the time of previous ones. It also allows us to focus on priorities that are mutually agreed upon when we arrive to work in the Monument.

Another unofficial project is the security check we make of the gates at Upper Post Office and Lower Post Office. We check the gates for signs of molestation or tampering, and report the results to Terry Harris after the trip. This year the gates showed no sign of tampering. This is both good and unusual. I hope the trend continues.

No report would be complete without credit given to some of the CRF JV's who make the projects happen. Dr. Janet Sowers is the overall PI who makes the projects stay on track and keeps me focused. David and Anna Kuhnel have been with me on many of the trips and made my progress possible. Dr. Bill Broekel and his family have stepped forward and taken on a lot of mapping and recon duties this year. He has established a CRF/USFS MOA with the Modoc National Forest to map the caves on their property, and ones which lie outside the Monument. Iris Heusler is Co-PI for the mapping project. One of her chief missions is to eliminate the backlog of maps that are overdue. She has reduced the number, with more soon to arrive at Lava Beds to be put in the flat drawers. David Haskel created the ice level spreadsheet analysis document. Bill and Peri Frantz have pretty well completed their virtual cave tour for the new Visitor Center that recently opened. Last, but not least, Dr. John Tinsley has been essential this year in getting the Research Center project moving along. He has attended meetings, made phone calls, and written countless e-mails to us, Superintendent Dorman, and the contractor to make the building happen.

The Research Center broke ground, and is well on the way towards being operational and habitable. That will happen this coming year.

Kelly Fuhrman in Crystal Ice Cave.
Peter and Ann Bosted photo

CUMBERLAND GAP PROJECT

October 1, 2004

Mike Crockett

Passage in Gap Cave
Kenneth Storey photo

This is an interim progress report of the Cave Research Foundation Cumberland Gap Project.

Images of newly discovered passage just became available from the September 2004 CRF Expedition into Gap Cave.

Interpreting the geomorphology and passage features in this area will be a challenge. The images begin to relate the scale. The survey of the passage, trending northeast, is advancing from Virginia into Kentucky.

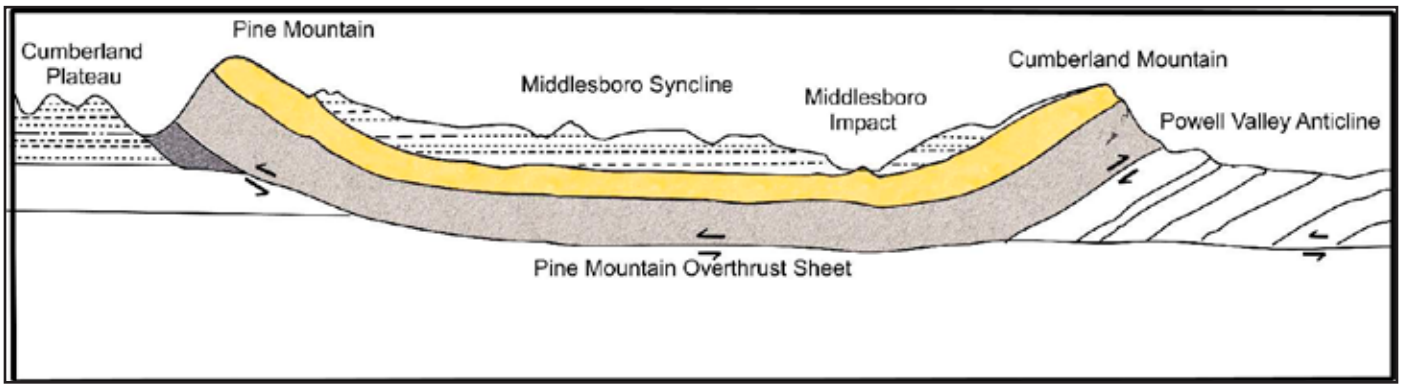
The Pine Mountain Overthrust Fault Sheet is tilted at about 40 degrees and bears the stream passage (Gap Creek) and the remnant paleo stream passages.

The newly found passage is bedded in the relatively flat Cudjos Cave Underthrust Fault Sheet. This sheet is a repeat of the Pine Mountain Overthrust Fault Sheet, about 300 feet thick and containing members of Newman (Greenbriar) Limestone.

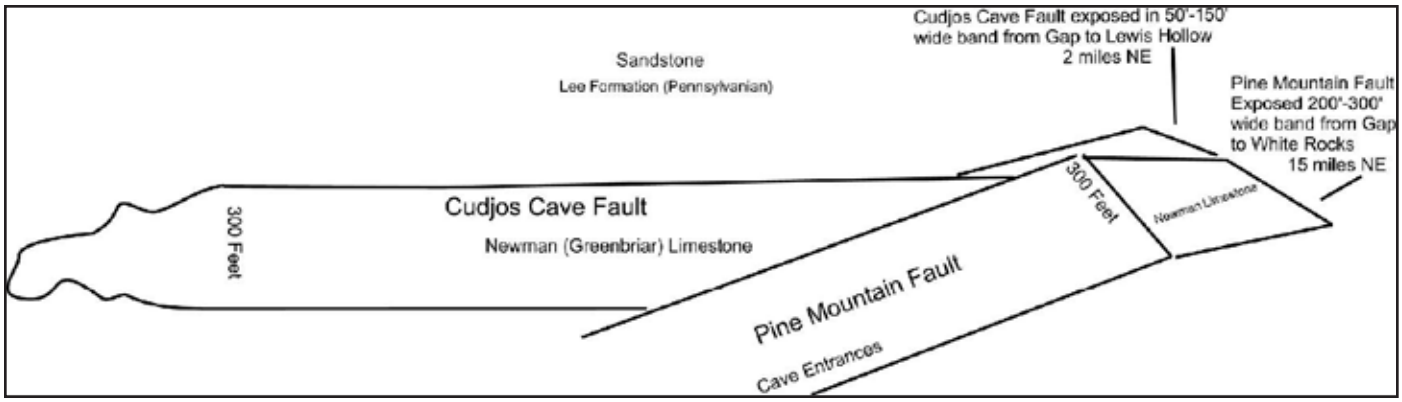
The Cudjos Cave Underthrust Fault Sheet is about 2000 feet wide and two miles long running from the Gap to Lewis Hollow. The Cudjos sheet seems to be highly disconformed in some small areas, but the majority of the sheet observed so far, which is a small percentage of the total sheet, appears to be intact. It is not fully understood how this sheet became a flat rider over the Pine Mountain Overthrust Fault Sheet. This phenomenon is observed in Cumberland and Pine Mountain only at Cumberland Gap.

The Big Salt Passages appear to be in the flat Cujos sheet. The stream level passages are in the tilted Pine Mountain sheet.

The newly found passage is about



North – South cross section of Pine Mountain Overthrust Fault Sheet
Mike Crockett graphic



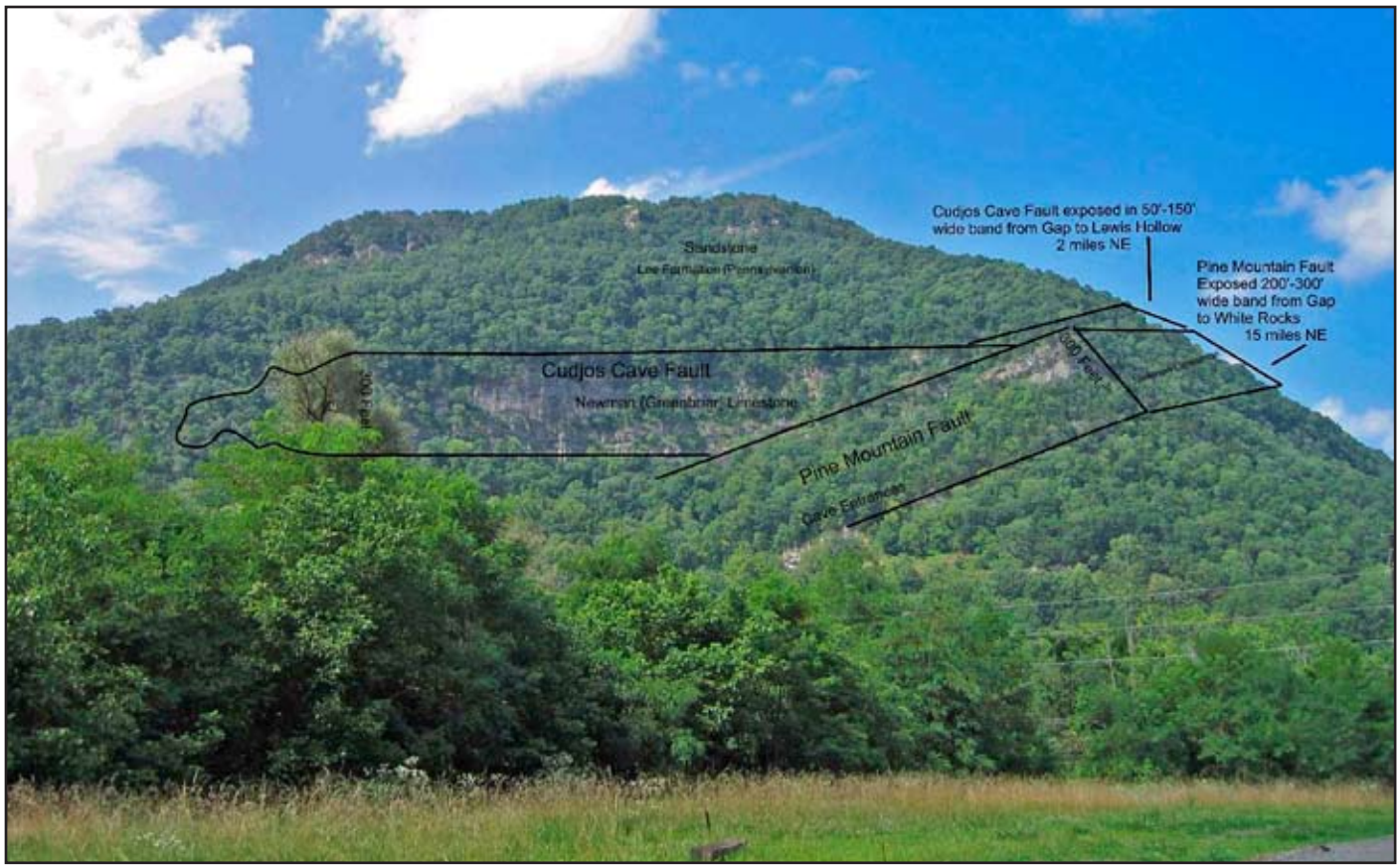
North – South Cross Section at Cumberland Gap showing Cudjos Cave Underthrust Fault Sheet and Pine Mountain Overthrust Fault Sheet. Mike Crockett graphic

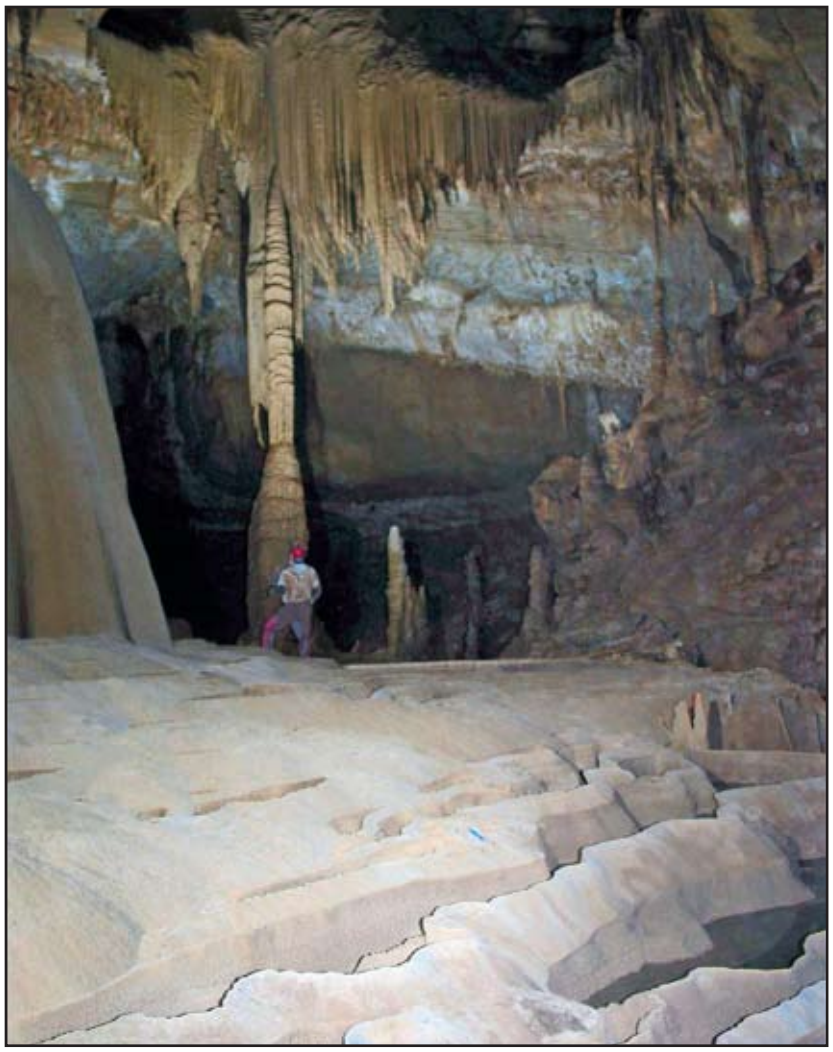
275-300 feet above the stream level, north and trending northeast.

Additional general graphics and schematics are being developed, as supplements to the map, to illustrate the relationship of the Cudjos and Pine Mountain sheets. Certainly more study is needed to understand the fault sheets and the formation of Gap Cave within them.

When the most recent data is added to the working map by Project Cartographer Bob Gulden it should begin to reveal the potential for a high connection route to Big Salt in the Cudjos Cave Underthrust Fault Sheet. This is difficult to assess since the passage could end abruptly in one of the disconformed areas. Large rooms, not yet surveyed, have been entered in the Big Salt end of the cave; these rooms

Cumberland Gap with fault sheets shown. Mike Crockett photo & graphic





are likely in the Cudjos sheet.

Meanwhile the survey will continue into the dozens of leads remaining on the working map. A camping trip to the upstream end of the survey is possible in January or February 2005. Addressing the challenging logistics of low impact cave camping while limiting overhead for cavers will help push the survey as travel time from the entrances increases. Camping may help reduce caver fatigue and reduce injury risks while increasing production but must always be compared to other methods.

Overall progress of the survey has been slowed by requirements to navigate passages with minimal impact and various surface distractions not to be detailed here. Project goals continue to be long term. Multidisciplinary objectives related to biology and hydrology add even more overhead.

An update to the faunal survey by Jonathan Mays is available as a spreadsheet. This is a work in progress. Additional resources must be developed to support documentation and, if necessary, collection efforts related to this survey.

Sixty-three cavers have invested nearly 3000 hours in the Project. A detailed spreadsheet in support of the volunteer effort is being finalized.

Lincoln Memorial University has agreed to enter into a written facilities use agreement that will insure availability of the Cumberland Mountain Research Center for Project activities.

This interim report does not replace the expedition report normally filed. It serves as a general update in executive summary style.

Left: Passage in Gap Cave
Below: Complex cracked flowstone in Gap Cave
Kenneth Storey photos

OZARKS OPERATIONS 2004

Cave Inventory, Mapping and Management

Scott House

As in the past, CRF Ozarks had a very productive year, working on a variety of projects.

Buffalo National River

CRF began coordinating an effort in Fitton Cave back in 1985. A map was produced in 1990 showing much of the surveyed cave. Our major goal at Fitton Cave is to create a new map series showing all the presently surveyed passages. Protocols and standards for the new series have been worked out and a dataset has been produced that makes us relatively happy. Three expeditions with ten survey parties this year have yielded about several thousand feet of survey, managed to correct a number of survey errors, and re-sketched a large part of the West Crystal and Roundhouse Rooms. Expeditions have operated out of the NPS facility at Steel Creek.

A project testing new low-cost temperature loggers in Fitton Cave has been completed by Pete Lindsley (see separate report).

Three additional survey parties were sent to work on smaller caves in the Park.

Mark Twain National Forest

The Mark Twain National Forest consists of 1.7 million acres of land, mostly in southern Missouri. Work by the Foundation on the Forest has been ongoing since 1986. There are approximately 480 known caves on MTNF land.

Over fifty CRF trips were taken on the Mark Twain in 2004.

In the 1990's most of the Foundation's work was on an area known as the Eleven Point - Doniphan District. However the past few years' field efforts have mostly been in other districts. Still, one trip was taken to do biologic inventory in the Eleven Point area. Another was taken to relocate and identify caves in an area bordering the Ozark Riverways. Two small new caves were found as well. Three trips were taken on the Salem/Potosi District to revisit one bat cave during different seasons and map another cave.

On the Rolla/Houston District, several trips were taken to Pittman Cave, a fairly large stream cave on the Gasconade River. The trips did mapping, biologic inventory and photographic work. Several more trips were taken to caves on Mark Twain National Forest land south of Rolla, near Lane Spring and in a nearby extensive upland sinkhole area. A new map was begun of Merrell Cave and a biological/management trip was taken to a cave which had been held for many years as a special permit. Several trips were also taken to relocate and locate new caves in a rugged area southwest of Fort Leonard Wood. Lastly, trips were taken to a private cave that the Forest is attempting to acquire.

Six trips were taken to the Willow Springs District along the North Fork River. Some of these were to conduct a biological inventory of Still Spring Cave, the largest on Mark Twain land. Three more were taken to caves directly on the North Fork River. A new survey of Sloan Cave was also begun.

Six parties were fielded in the

Cassville District; two of these were surveys of a pair of vertically-developed caves. Other trips focused on biological and use evaluations.

Numerous parties were fielded on the Ava District of the Forest. Some of these were standard public use evaluations. Others were in support of attempts to find additional habitat that might support the Tumbling Creek Cave Snail, an endangered species found only in Tom Aley's Ozark Underground Lab. Several FS caves were mapped and detailed inventories of most were done.

Numerous reports and cave maps were finished this year.

These efforts were supported by funding from Mark Twain National Forest; additional support for the cave snail hunt came from the Missouri Department of Conservation and Ozark Underground Laboratory.

Ozark National Scenic Riverways

The Ozark National Scenic Riverways consists of approximately 80,000 acres along the Current and Jacks Fork Rivers in southeast Missouri. A long term CRF project here has increased the number of known caves from 80 in 1980 to over 320 today, over 200 of which have also been surveyed. Survey and inventory continue on Riverways lands as time permits. A few smaller caves were surveyed in 2004, and a new map was begun of Branson Cave, a fairly sizable permit cave.

Mick Sutton and Scott House continue to participate in the OZARK Cave Management Team.

CRF was contracted in October 2003 to take over certain cave management services of the NPS in the Riverways. This arrangement was found to be very beneficial to the park and was continued into the next fiscal year. Scott House was employed approximately half time over the year, with others such as George Bilbrey being either employed or having expenses paid for performing certain types of management work. This allows cave specialists to be in the park throughout the year and to apply manpower to issues that need resolving. This is a big step forward for CRF in our relations with the park. The duties range from writing management plans, to performing biotic surveys, to installing cave signs, and so forth. The funding also allows us to help attract volunteer groups to the park.

A major development was the establishment of the Powder Mill Research Center. Acting on a CRF proposal, the NPS designated a housing unit at Powder Mill as a research bunkhouse. Space in a garage below the housing was designated for storage of cave gear and other volunteer and research materials. The long disused old Powder Mill visitor center was turned into work quarters for cave management and other researchers. This development has enabled CRF and other volunteer and/or research groups to greatly increase their time spent on projects. New upper-level management in the park is responsible for getting this improvement through the bureaucracy.

An additional contract was issued to CRF for the building of additional cave gates. CRF member Jim Kaufmann did virtually all of the work, aided by occasional hired help, volunteers and NPS staff. Cave gates were built on seven caves, primarily to protect or restore endangered species habitat. Another older gate was reinforced.

Pioneer Forest

Pioneer Forest is a privately-held forest of approximately 180,000 acres

in the Lower Ozarks. CRF has been involved in survey and inventory of caves (of which there are about 100) located on these lands. In addition, we have been providing services to the forest in the form of data and cave management. Specifically, we have integrated additional data into the database and provided that information to Pioneer Forest. CRF also provides support to volunteers from the Missouri Speleological Survey, especially the Meramec Valley Grotto of the NSS, to do a great deal of work on the Forest.

Missouri Department of Conservation

CRF continues to map and help inventory caves owned by the Missouri Department of Conservation (MDC), an agency that manages state forest lands and wildlife. We also continue to provide services to the Department in the form of cooperative data management and consultation.

Powder Mill Creek Cave is a large, transitional cave (phreatic passages currently being modified by ground water movement) located in the Lower Ozarks area less than a mile from the Current River. While within the legislated boundaries of the Ozark Riverways, it is actually owned and managed by the Department of Conservation. The cave is closed except for research purposes and harbors an increasing number of Indiana bats in the winter. CRF has been surveying the cave for the past fifteen years and it is now over 8 miles in length. Grueling trips to the end of the survey now take upwards of fifteen hours and involve more than a mile of watercrawl one way. Three trips in the summer of 2004 resulted in additional footage surveyed and several leads finished. It is anticipated that the survey will be completed in 2005. Doug Baker heads up this project.

The MDC provided funds for CRF to build additional cave gates. One was completed on a privately-owned cave that houses one of the larger groups of Indiana bats in the state. MDC also provided funds for the aforementioned cave snail project.

Missouri Department of Natural Resources: Geologic Survey and Resource Assessment Division

CRF continues to work with the Department of Natural Resources/ GSRAD and the Missouri Speleological Survey (MSS) on cooperative cave files. CRF continues to work with the MSS and DGLS on updating the computer database of state caves. Presently those files exist in FileMaker Pro format where output of data can be created in a variety of formats. Scott House heads up this project and is in charge of modifying and coordinating the state cave database. Additional help is provided by such CRF members as Michael Carter, Jon Beard, Ben Miller, Andy Free, Mick Sutton, Leonard Butts and Joel Laws.

State Parks Division

CRF continues its new survey of Fisher Cave, a large show cave in Meramec State Park. Partially surveyed several times previously, Fisher is a well-decorated, historic cave that is shown to visitors by lantern light. The two parties fielded in 2004 surveyed most of the huge Hugh Dill Room and attempted, not quite successfully, to cross the dreaded pit at the end of the Pit Crawl.

Missouri Speleological Survey

The MSS works to collect all cave info

in the state. We cooperate fully:
-Maps and reports are turned in to the MSS and are archived by the Missouri Department of Natural Resources.
-We are leading the way by facilitating the development of the state cave database.
-CRF members continue to create the bulk of the cave maps finished in the state.

Personnel and Management

We continue to attract a select group of people, many of whom are considerably younger than the rest of us. Ozark cavers are generally very pleased with the level of CRF interaction with agencies and caving groups. Occasional government funding of our various projects has given us the funding stability to perform work that we would otherwise not be able to do. Additional funding from the Ozark Riverways and Mark Twain National Forest enabled us to double the number of man-hours in the field this year.

Statistical summary of work:

Trips/parties:	98
People/days:	313
Man/hours in field:	2590
Survey footage:	8100
Mileage driven:	33960

At rates of $12/hour, $35 per diem for subsistence, and $0.32/mile our field work alone thus far in the year has a value of over $54,000! This does not count time driving to expeditions, drafting and management work, data entry, cleaning gear, equipment costs, etc.

Ozarks Operation Area
Operations Manager - Scott House
Assistant Operations Manager - Pete Lindsley
Reporter and Ecologist - Mick Sutton
Geologist - Bob Osburn
Powder Mill Project - Doug Baker
Lower Ozarks Contact - George Bilbrey
Pulaski County Contact – Andy Free
Cave Gater – Jim Kaufmann

SEQUOIA-KINGS CANYON OPERATIONS 2004

John Tinsley

The CRF operations at Sequoia and Kings Canyon National Parks are in transition, but again maintained a productive record in 2004. We look forward to the 2005 field season as a new chapter is dawning at Lilburn. The following contributions briefly summarize the principal research activities that we conducted.

Cartography by Jed Mosenfelder

Jed Mosenfelder has succeeded Peter Bosted as the Lilburn Cave Cartographer on site. In order to familiarize himself better with the cave, he developed a new lead list. In 2004, 1325 feet of survey was tallied, 1111 feet of which is new passage. This brings the total length of the cave to 20.66 miles. One particularly challenging lead heading away from the Blue Passage was pushed by Shannon Mathey, Natalie Uomini, and Nicholas Barth. The party leader, Joel Despain, was unable to fit past a previously known constriction, and could only instruct them from afar in the fine art of cave surveying. An exciting, muddy but blowing lead heading off the map remains in this area, but will have to be pushed by comparably small and gutsy

cavers. Other areas where significant new passage was explored include the Schreiber Complex, Black Stalactite area, three separate high areas above River Pit Avenue, and the seldom-visited Alto Stream.

Sedimentology of Redwood Canyon Karst by John Tinsley

It was the third consecutive cool and dry winter and spring; the cool weather kept the rate of snowmelt at low levels and thus the amplitudes of peak runoff were low. The sediment samplers in the cave recorded but a 6-inch rise at the Lake Room and no signal at all at White Rapids this past year. Thus, sediment transport throughout the cave evidently was at minimal levels. The winter of 2004-2005 apparently constitutes a "mild" El Nino, according to some prognosticators, so it will be interesting to note in 2005 if any changes in patterns of sediment accumulation or dispersal will be occur. We know from studies of Lilburn Cave since 1969 that the so-called "El Nino" or southern oscillation makes for unusually wet winters at our latitude in California. Thus, 1968-1969, 1982-1983, and 1996-1997 winters are especially significant from a karstic sedimentological perspective for Lilburn Cave. It remains to be seen what impacts this winter's runoff will present.

Cave Restoration by Bill Frantz

From 1996-2004, a narrow 25-foot long passage situated underneath the Jefferson Memorial (Lilburn Cave's signature speleothem) is now as clean as Bill and his restoration crews can make it. The next principal target for restoration will be selected from several candidate sites. The restoration trips are quite popular, especially on the second or third day of expeditions, for the trips tend to be relatively short, folks are generally lightly laden (unless schlepping water), and the trips always go to well-decorated areas.

Cave Management

This program at Sequoia and Kings Canyon National Parks has contracted with cave biologists for surveys of key park caves, including Lilburn Cave. The field phases of this contract have been completed, and a report should be forthcoming in 2005. We look forward to hearing of several new finds in Lilburn and in other park caves. Speleobiology has been a somewhat neglected pursuit for several years, and it is good to see this discipline receiving important play in the cave management's activities at SEKI.

Jed Mosenfelder in the Canyonlands area of Lilburn Cave, CA. Peter and Ann Bosted photo

Mineral King Mapping and Inventory

Coordinated by Roger Mortimer and Jeff Cheraz, this project got a major boost this year when Joel Despain and Shane Fryer led a major assault on the Timber Gap caves. Nineteen joint venturers showed up at various times during the Labor Day weekend to map the main level of Empire Mine Cave, to continue to advance the mapping of Jordan Cave, to map other nearby small caves, and to conduct ridge walking in an effort to extend and document our growing knowledge of this relatively little-visited but impressive karst area.

Shane Fryer crawling in the Outback section of Lilburn Cave, CA.
Peter and Ann Bosted photo

Administrative Perspectives

A new Supervisory District Ranger for the Kings River District will be in place during the first quarter of calendar year 2005. The former District Ranger, Kinsey Shilling, took a position at Ozark National Scenic Riverways. Scott House will be interacting with Ranger Shilling for the ONR portions of the Missouri operations. We will miss Kinsey's helpful and supportive hands at SEKI, and look forward to working closely with his soon-to-be-named successor.

We are reconstituting the Lilburn Cave project, with all PIs being required to submit new proposals for the year 2005 and beyond. We look forward to productive studies of the karst, as we commence a new study described below.

New Proposals to be submitted and/or commencing in 2005:

Nutrient Loading and Sediment Yield under Pre- and Post-burn Conditions, Redwood Canyon Karst Area, Kings Canyon National Park by Daniel K. Doctor

Dr. Daniel Doctor is a US Geological Survey Mendenhall Postdoctoral Fellow and the PI of a $144,000.00 grant awarded this past summer to the USGS by the National Park Service. The study will measure impacts of controlled burns on nutrient loading and sediment yield in the Redwood Canyon karst. As conditions permit during the next several years, the NPS is planning to re-introduce fire to Redwood Canyon's ecology after nearly a century of fire suppression has resulted in extremely high fuel loads. Dr. John Tinsley will continue his sediment monitoring studies as a cooperator under the terms of this grant. Sediment and water sampling devices and data loggers will be procured and installed above and below the karst in Redwood Canyon in order to track suspended load and various chemical parameters as Doctor

seeks to model the chemical impacts of burning on the karst and Tinsley seeks to record the impact of burning on cave and karst sediment yields. The sampling equipment will remain with the cave management program following this three year study, enabling the NPS to conduct similar studies in other SEKI karst areas. We are optimistic that this study will spur a new era of interest in Redwood Canyon and its karst. As many of SEKI's karsts lie in mixed coniferous and deciduous forests at elevations less than 6000 feet, the results of the Redwood Canyon study should be transferable to other park areas.

Cave Passage Locating and Documentation in Sequoia and Kings Canyon National Parks, California by Mark Scott

This project proposes to remove dirt, loose rock and other materials blocking access to continuing cave passages. All work will adhere to the provisions in the Park Cave Management Plan and its Environmental Assessment, including the use of hand tools only, documentation of a site before work begins and a cessation of all activities if any resources of concern (such as bones) are discovered. This work is part of a long-term program to find, document and study park caves.

Structural Geology of the Redwood Mountain Pendant, Sequoia and Kings Canyon National Parks, California
Principal Investigator: Dr. Marek Cichanski, De Anza College, Cupertino, CA

The purpose of this project is to elucidate the structural history of the metamorphic rocks in the Redwood Canyon karst area. Like most such metamorphic rocks in the Sierra Nevada, the rocks in and around Redwood Canyon have undergone extensive deformation. In studying the structural geology of these rocks, I plan to map and describe in detail the types of metamorphic rocks present, and to measure and describe the geometries of (and relationships between) the structures that have affected these rocks. I will do this in order to determine the various phases of deformation that have affected the rocks, and how this deformational history fits into the tectonic history of the Sierra Nevada.

White bacon near Alto Stream, Lilburn Cave, CA.
Peter and Ann Bosted photo

SOUTHWEST REGION 2004

Guadalupe Escarpment & Fort Stanton Range, 11/2003 - 10/2004

Barbe Barker

CRF Southwest has had a very productive year thus far, working on a variety of areas and projects.

Carlsbad Caverns National Park

At this year's annual National Speleological Society Convention, members of the Guadalupe Area CRF were awarded a Certificate of Merit for our dedication to conservation and restoration projects at Carlsbad Caverns National Park. This was a huge compliment and honor for our group to receive. A copy of the Nomination Letter signed by all four members of the Cave Resource Office is attached to this report.

Five Expeditions were held at CCNP this last year during the usual 3 and 4 day holiday weekends and also one week long restoration field camp. The breakdown of survey and restoration projects is determined and planned according to the expertise of the group on each expedition.

Survey has continued in Lower Cave with ongoing projects headed by the approved sketchers of the Park. We continue to check tie-in and loop closures and inevitably find virgin passage. Within five years or so, the re-survey of CCNP will be complete.

Scientific & Geology Inventory is done on every survey trip as well as one area that is dedicated to Scientific & Geology Inventory.

Restoration projects in Lake of the Clouds, The Guadalupe Room, New Mexico Room, The Dome Room, The Rookery and Longfellow's Bathtub have kept many people busy and coming back to work on "their" projects. As reflected in the Nomination for the Certificate of Merit, these are all long term projects and will require years of work in the future.

Our relationship with the Park and all Cave Resource staff continues to be very good. They have a lot of faith in what we do and we work very hard to live up to their expectations.

Fort Stanton Cave

CRF was awarded $25,000 in Challenge Cost Share Funds by the BLM, Roswell Field Office. We spent approximately $12,500 for rescue equipment and have been actively working on a Cave Rescue Plan for the five significant caves within the District. A second award of $12,500 is tied to a Task Order for Restoration and Conservation to be administered over the next 3 years. The BLM has appointed CRF as lead cooperator in regard to all future Ft. Stanton Cave/Snowy River projects. They remain very clear that they will not enter into cave politics within or outside of CRF.

Bill Murry is the Acting Recreation/ Cave Specialist within the Roswell Field Office and we have an excellent relationship with him. I continue to work with Bill Murry and Paul Happel with regard to administrative items as well as long term planning for Fort Stanton Cave. Frank Everitt was named the CRF Operations Manager for the BLM, RFO. Frank has 41 years of caving experience

in Fort Stanton Cave and has been a Volunteer Cave Specialist for the BLM for 32 years. He lives in Roswell and meets regularly with the BLM.

A meeting was held in September, 2004, with Rickard Toomey, Barbe Barker, John and Dorothy Corcoran and Frank Everitt attending. The purpose of the meeting was to discuss issues regarding CRF's plans for future work in Ft. Stanton Cave. John Corcoran has agreed to participate on a management team which would also include survey, scientific and exploration experts. Rick Toomey has agreed to establish and head a scientific committee that will review and make recommendations on proposed scientific projects in the Snowy River Section of FSC. Efforts are still being made for permission to send one trip through the administratively closed Priority 7 passage so that critical survey information can be verified and items left by the last expedition can be removed. If allowed, the team would include the BLM/RFO's Safety Officer and 5 cavers selected for their strength in accomplishing the trip goals, as well as caving.

The CRF Gate Building Team, headed up by Project Manager Jim Cox, laid the foundation and built approximately 1/3 of the Roaring Hills Gate. This first gate section was installed October 9, 2004. The rest of the gate is being built while the cave is closed for the winter and will be installed April 15, 2005. Depending on the studies done, as well as proposals presented, a dig will begin in Don Sawyer Memorial Hall. This will hopefully intersect with Mud Turtle Passage in Snowy River and science and survey can resume in this world class passage.

Current projects within Fort Stanton Cave include restoration, photo monitoring, gate building, cave rescue training, writing a Cave Rescue Plan, guide training, leading trips, conservation and restoration training of groups.

Current projects at Torgac Cave include restoration, photo monitoring, impact mapping and leading the 6 trips allowed per year.

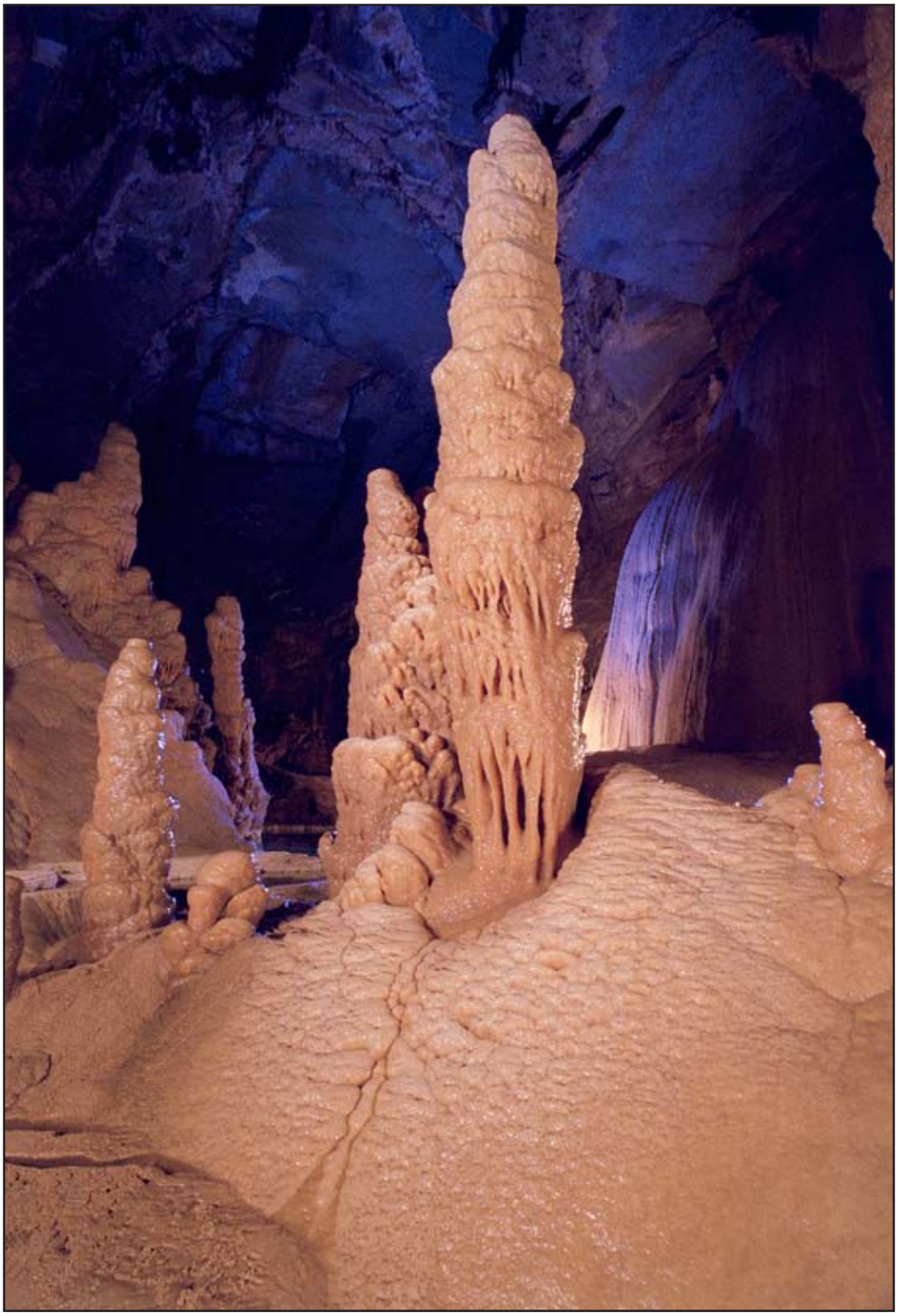
Summary:

Things are great at CCNP with the NPS. Everything is stable and running smoothly. We were very honored that the NSS awarded a Certificate of Merit for a CRF activity.

We are working very hard for the BLM Roswell Field Office. They are very appreciative and we look forward to a productive winter of planning and a busy 2005 season of caving.

CRF Southwest Area:

Area Manager: Barbe Barker
CCNP Survey Manager: Kevin Glover
Personnel Manager: Sherry McClure
BLM, RFO, Operations Manager: Frank J. Everitt
Project Manager, Gate Building: Jim Cox



Midnight at the Oasis by Dan Silvestri and Jack Engle
Speleothems and flowstone group in Rimstone Riviera section of Gap Cave, Cumberland Gap National Historical Park. Captured by CRF Joint Venture cavers during the June 2005 Expedition.

Operation Area Reports 2005

EASTERN OPERATIONS 2005

October 1, 2004 – September 30, 2005

Dave West

During this period, Eastern Operations at Mammoth Cave National Park fielded 157 parties, expending over 6,141 hours, in support of various projects as follows:

In Park

MCNP Cartography – 91 parties
Small Cave Inventory – 28 parties
Cave Art Documentation - 8 parties
Photo Documentation - 7 parties
Gate Project - 5 parties
Biology - 1 party
Sediment Study - 1 party
Safety Video - 1 party
Names w/o Faces - 1 party

Biosphere Reserve

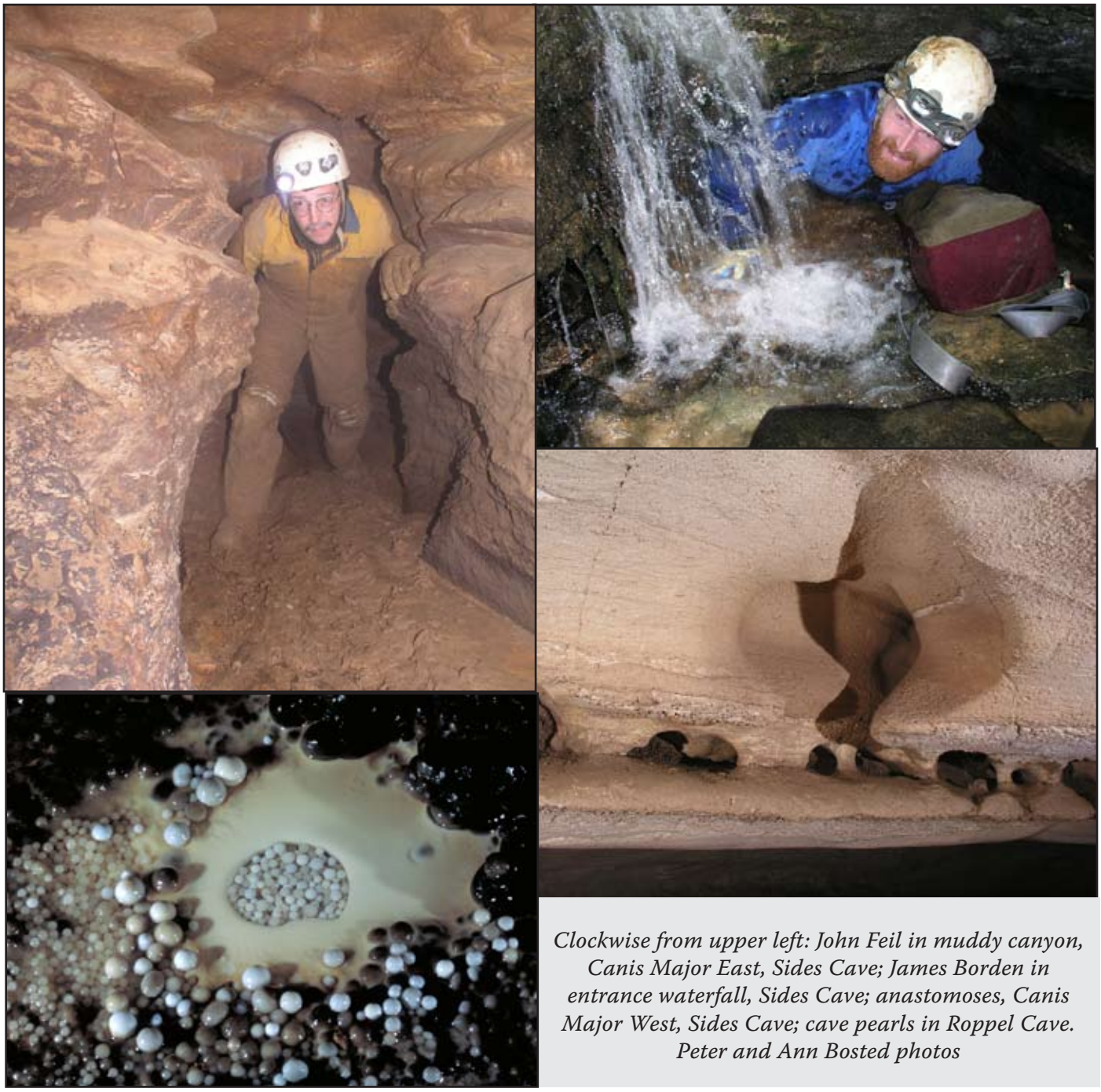
Roppel Cave - 26 parties
Hamilton Valley - 1 party
Hidden River Survey – 3 parties
Stan's Well - 4 parties
Pigthistle Cave - 1 party
Side's Cave - 2 parties

Charles Fox films crawling cavers in Mammoth Cave for the new CRF Safety Video. Peter and Ann Bosted photo

Many trips supported multiple objectives. Aaron Addison has completed the Control Points project to assist with the GIS effort. Efforts are continuing to move the database into *Walls*, the currently preferred data reduction software for the Cartography project, as it more easily complements the increasing use of *Adobe Illustrator* in map production. Elizabeth Winkler continues to make progress on the Trip Report Database consolidation effort. Michael Carter has taken the lead on the photo documentation to support cartography. Dave West coordinated the effort to gate Cathedral and Wildcat Hollow Caves for the park to protect the Rafinesque bats using these caves. Charles Fox is putting together a Safety Video for use as a training tool by CRF and the park. Charles Swedlund's Names without Faces project wrapped up with the removal of remaining material from the cave. Many of the small cave efforts are geared in support of ongoing park-sponsored research. Overall, CRF Eastern Operations contributed over 12,600 hours to Mammoth Cave National Park during this period.

Outside the park, support for the CKKC survey in Roppel Cave has continued. Work also continues in the caves owned by Hamilton Valley neighbor and CRF member Stan Sides.

Much work remains in Hidden River Cave, site of the ACCA Museum in Horse Cave, KY. Pigthistle Cave was apparently misidentified and the team may have surveyed an entirely different cave.



Clockwise from upper left: John Feil in muddy canyon, Canis Major East, Sides Cave; James Borden in entrance waterfall, Sides Cave; anastomoses, Canis Major West, Sides Cave; cave pearls in Roppel Cave. Peter and Ann Bosted photos

CUMBERLAND GAP PROJECT

October 1, 2005

Mike Crockett

Mapping and related research by the Cave Research Foundation continues in Cumberland Gap National Historical Park, Middlesboro, Kentucky. During

Flowstone Shoe Blues by Kenneth Storey

CRF Joint Venture caver Karen Caldwell changes footwear to comply with impact standards in Gap Cave, Cumberland Gap National Historical Park. Captured by CRF Joint Venture cavers during the April 2005 Expedition.

2005 CRF has surveyed nearly 3 miles of passage in Gap Cave bringing the overall surveyed length of the cave to over 7 miles.

Newly discovered passage in Gap Cave includes the Rimstone Riviera. This section of cave is highly decorated. Concerns about impact to the Rimstone Riviera and other areas led to a rewrite of the General Agreement between CRF and the National Park Service. Cavers are required to have annual training related to low-impact and conservation. Cavers are taught, or reminded of, ways to cave even more softly.

The new General Agreement prohibits the use of carbide in the caves of Cumberland Gap. Everything taken in, including all human waste, must be taken out. Sketchers must be certified by the National Park Service. The size of survey teams regulated. All three views are required for all survey and the optimal scale is 20 feet per inch. Permitting and reporting requirements were also increased.

The most significant change in procedure was the addition of a detailed Cave Inventory to the survey process. The process originally proposed by the NPS has been modified by CRF Joint Venture cavers. More than 120 specific cave features are noted in 7 categories including geology, hydrology, cultural, and formations. This information is georeferenced by the survey. Ways to make the Cave Inventory more useful for cave science are being developed.

Rafted Calcite by Cheryl Pratt

Gap Cave.

Facing page:
Cave Images Poster by Kenneth Storey

This poster by Kenneth Storey is based on an award winning design by the artist. Ken's wife Lisa is depicted at Yellow Mountain, Gap Cave, Cumberland Gap National Historical Park. The poster is in use at the permanent cave images exhibit in the park visitor center.

Cave Research Foundation

Cumberland Gap Project

In cooperation with
Cumberland Gap National Historical Park
Cumberland Mountain Research Center and Lincoln Memorial University

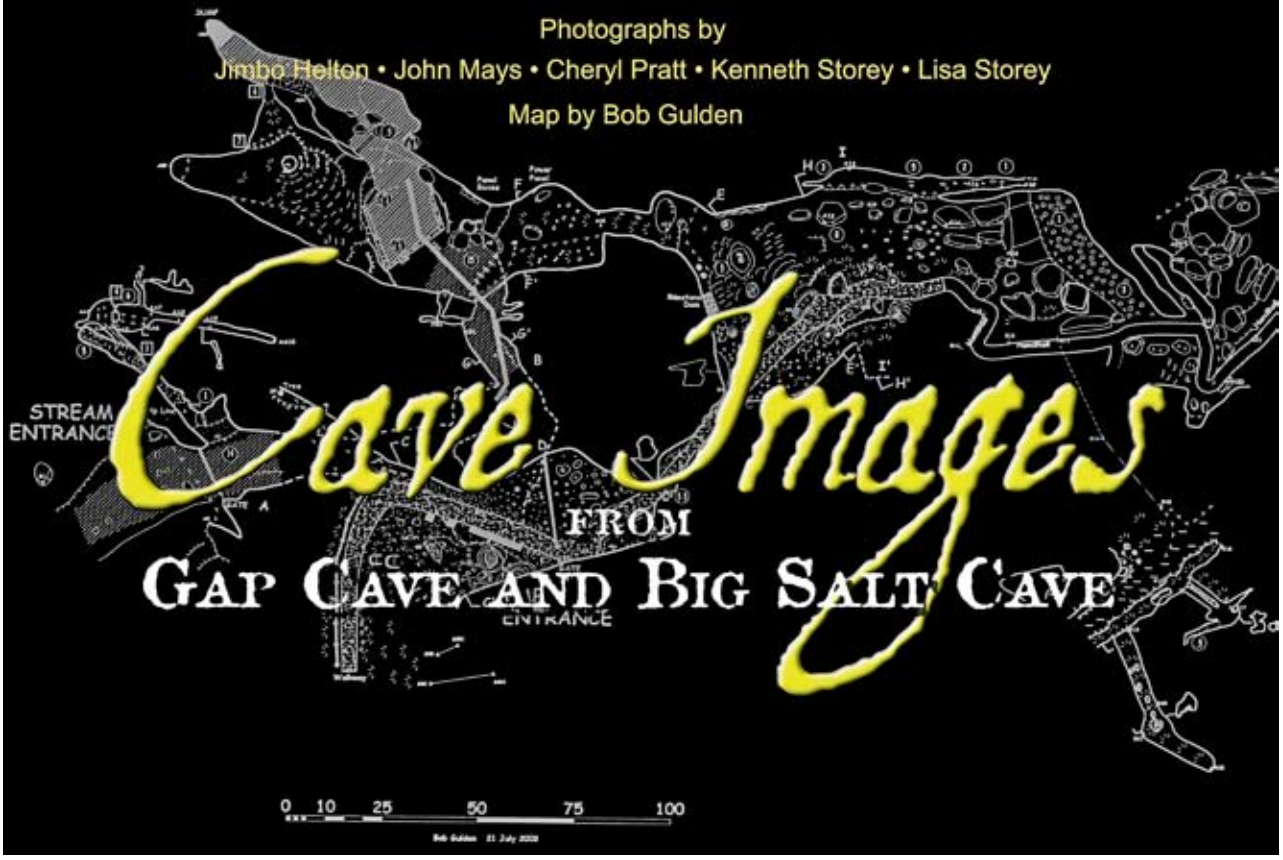
Photographs by
Jimbo Helton • John Mays • Cheryl Pratt • Kenneth Storey • Lisa Storey

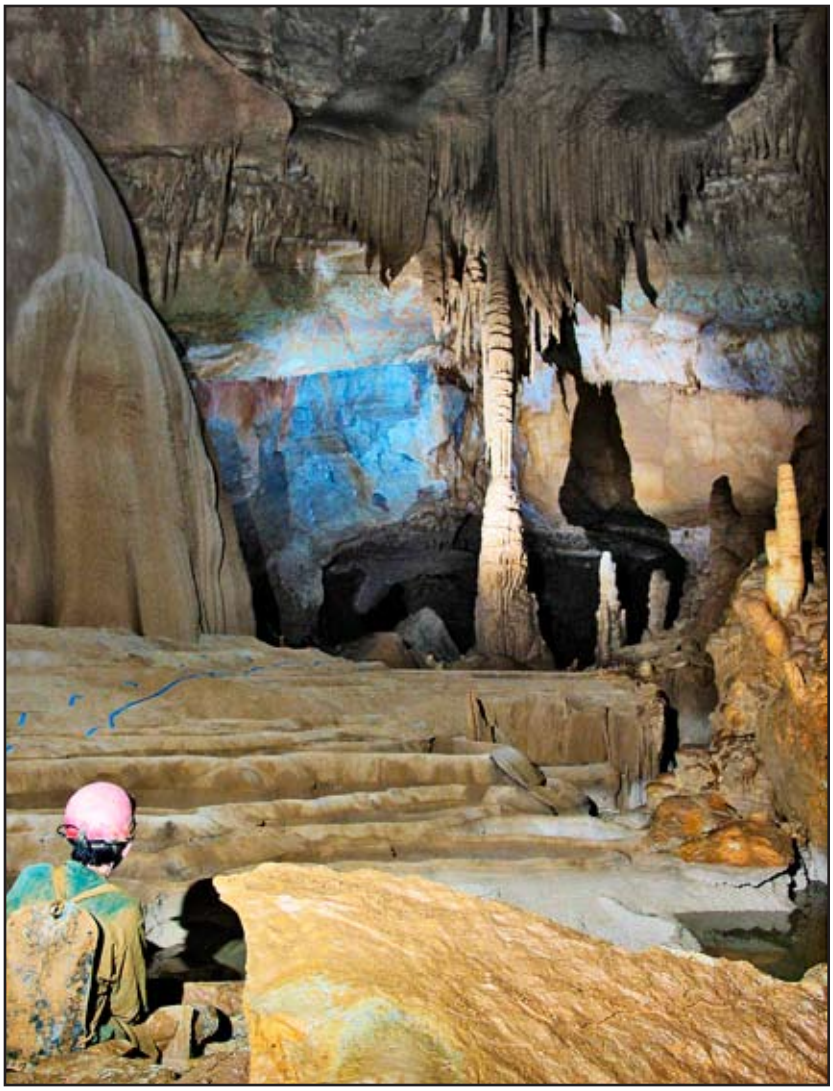
Map by Bob Gulden

Cave Images

FROM

Gap Cave and Big Salt Cave





The accomplishments, developments, discoveries, and changes of the past year have laid the foundation for more elaborate cave science in the caves of Cumberland Gap. The need for resources, particularly cavers and cave scientists, is increasing. Equipment, instruments, and processing needs will rise also. Gap Cave, guarded by public ownership, protected by a near wilderness setting, and formed in a unique way is proving to have the potential to be an accessible karst laboratory of efficient scale. 2005 will be remembered as a year of transition but it was just as much a year of opportunity and accomplishment at Cumberland Gap.

Alternate View by Kenneth Storey

CRF Joint Venture caver Richard Hand surveys a complex area of the Rimstone Riviera, Gap Cave. Captured by CRF Joint Venture cavers during the April 2005 Expedition.

Wilderness Road by Mike Crockett

CRF Joint Venture cavers Dan Henry, Brien Chartier, Otis Farmer, and Rich Lounsbury leave the Wilderness Road on the way to Gap Cave. This team traveled 3 hours to the upstream end of the survey and pushed forward setting 30 stations during a 12-hour trip. Captured during the October 2005 Expedition.

LAVA BEDS OPERATIONS 2005

November 7, 2005

Janet M. Sowers

This report is on the activities of the Lava Beds Project for the year, November 2004 to November 2005. We include reports on five projects: Cave Reconnaissance Inventory, Cave Location and Monumenting, Cave Mapping, Ice Level Monitoring, Cave Rescue support, and the Valentine Cave Virtual Cave Tour. We also report on cave rescue training, the completion of the Lava Beds Research Center and first expeditions using the new center.

The year 29 people worked on 10 different projects in over 26 expeditions while contributing 1,209 hours of work in the Monument. Additional hours were logged by those facilitating the construction of the research center, drafting the management plan for the center, and drafting cave maps.

CRF Projects

Below are brief summaries of CRF's projects listed with the National Park Service. The attached report by field operations manager Bill Devereaux provides more detail on the status of each project, as well as some additional activities.

Cave Reconnaissance Inventory. Led by Bill Devereaux, the purpose of this project is to provide reconnaissance-level documentation of every cave, no matter how small. Data include a sketch map and profile of the cave and a checklist of contents and features. This year we documented nine new caves.

Cave Location and Monumenting. Led by Bill Devereaux, in this project we install a brass marker at the cave entrance and locate it with GPS. Each cave or 'feature' that is recorded in the files or database receives a LABE number by lava flow and sequential number. That number is stamped on the marker. The cave entrance is photographed.

This year we did 8 new GPS fixes and we installed 16 new monuments, compared to 5 the year before. There are only two 'stamped' monuments left to install. The newly discovered caves of the last several years have not been numbered, and therefore have not had monuments made for them. This year we also photographed 3 cave entrances.

Cave Mapping. Led by Iris Heussler and Janet Sowers, we continue to work on our backlog of drafting, but also did a few new cave surveys. Bill Broeckel also continued to survey small caves.

After a 2004 incident in which two fifth graders got lost for two days in an unmapped side passage of Catacombs Cave, we took on the project of resurveying this large cave. Liz Wolff headed the team that conducted a re-survey of the cave. The survey was completed and a pencil draft prepared by October. John Tinsley is now computer-drafting the final map in *Illustrator.*

Bill Broeckel completed a report entitled "Modoc National Forest CRF Project: 2004-2005 Report #4 - Gooseberry Cave Area." It was submitted September 1, 2005. The principal product of this project last year was the Gooseberry Cave map, which showed that three caves (Gooseberry, Elvis the

Pelvis Grotto, and Bounda) connect into one cave (Gooseberry Cave). Total length of the Gooseberry system is 408 feet. The map won a ribbon at the 2005 NSS Convention Cartography Salon.

Bill Broeckel also named and documented another cave (Double Agent Cave) in this report, and drafted an original map of it. Length was 68 feet. The report gives nomination documents for 3 other caves for which I used existing maps (Trench Bench, The Defector, and Glaesers 116. Cindy Heazlit did the map of Glaesers 116.

Bill also discovered, documented, and mapped Rope Bridge Cave (23 feet long) early in 2005.

Ice Level Monitoring. In eight caves that contain permanent ice, we are monitoring the height of the ice floor. Since 1988 Bill Devereaux and crew have taken these measurements twice a year. We measure with a fiberglass tape the distance from a stainless steel screw mounted in the cave wall to the surface of the water and to the ice surface in 1/100th of a foot. David Haskell recently compiled all the ice level data into an *Excel* spreadsheet with graphs so that we can begin examining and analyzing the data.

Valentine Virtual Cave Tour. Touring Valentine Cave without having to actually enter it is the objective of this computer-simulation project conducted by Bill and Peri Frantz. Completed in June of 2004, the simulation is now installed at the new Visitor Center. Visitors can manipulate the joystick to move through the cave, turn around, choose passages, or zoom in on objects of interest. Meanwhile, an electronic tour guide (Peri's voice) describes the geology, biology, and history at each station.

Other CRF Activities

Cave Rescue: CRF Lava Beds also provides support to the monument for cave rescue. This includes helping with actual rescue situations, and providing training for monument staff. For the second year, Cindy Heazlit, with the help of Jansen Cardy and Bill Devereaux, conducted a cave rescue seminar for monument staff. This year's class, held in July, was expanded to be a 2-day seminar involving multiple agencies. There were approximately 20 students. The mock rescue for the class took place in Catacombs Cave, which has the most cave rescue incidents of any cave within the park. The class also tested out the new CRF rescue map. This scenario was a search and recovery effort for a patient with C-spine injuries, and was run entirely by the students. This was the deepest and most complex mock rescue in recent years.

Research Center: Our biggest news is that the Lava Beds Research Center is finally complete and in operation!! The first expedition was held in February of 2005. This October we held a Gala Dinner to honor the significant donors. The center has seen lots of use already in its first year. Scientists who have checked into the center so far include invertebrate biologists, botanists, wildlife biologists, bat researchers, and of course cave researchers! We look forward to hosting the CRF Board for its annual meeting next fall.

LAVA BEDS OPERATIONS 2005
Selected Projects
William C. Deveraux

Our project year begins October 1 and ends September 30 of each year. This allows us to make our annual report to the Lava Beds NM (LABE) staff for the Thanksgiving weekend annual meeting. The period also coincides with the weather patterns that dictate our research rhythms.

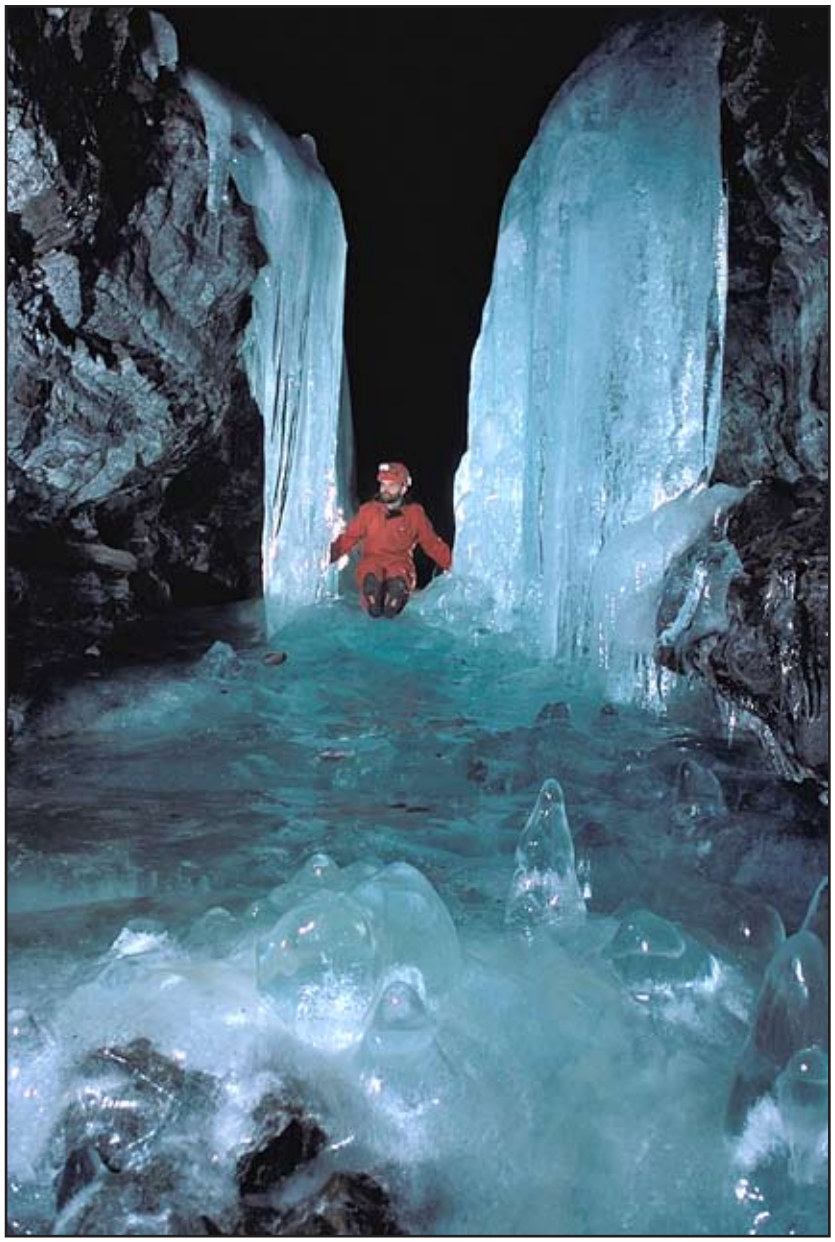
This report will detail the projects for which I am responsible or worked on this year, plus detailed numbers from a spreadsheet that I use to keep track of people, projects, and expeditions. This year, I expanded the sheet back to 1990. I expanded the sheet to track people who came here to work, and quantified the number of trips for which they were present. I have numbers for 1990-2005.

The year we call 2005 saw 29 people work on 10 different projects over 26 expeditions while contributing 1209 hours of work in the Monument. There were 78 person/trips compared to 74 the year before. Those hours do not include the hours the people spend getting to and from LABE, drafting maps, working on COMPASS files, building or repairing equipment, writing reports, composing and responding to e-mails from each other or the LABE staff, or attending CRF Board meetings. Those hours do not reflect the hours from Park staff (both permanent and seasonal), SCA's, and volunteers who went on trips with us to support our work. There were also local NSS cavers (principally from Shasta Area Grotto) who gave us materials and assistance. The success of this project belongs to people who care about this Monument and the caves herein. There were several trips that were mainly dedicated to planning, technical oversight, and site visits for the new Research Center. I do not have all the time recorded for John Tinsley, Janet Sowers, or others in that regard. We have begun to log travel and offsite hours on time sheets and in the journal. I do not have totals built into the matrix that I keep.

The projects that I worked on this last year were Ice Level Monitoring, GPS Location and Monument Installation, General Inventory, and Cave Reconnaissance Inventory (which includes the cave entrance photography 'project'). I completed a partial file review of the cave files by updating the Book of Caves.

Ice Level Monitoring

This project has been going on since the 1970's under the guidance of Mike Sims. I have been helping him since about 1988 when it became a CRF project. I have now taken on the job of Principal Investigator, with Mike assisting me in the final report writing for the year. This last year we made 13 measurements in 9 caves during 4 expeditions. We use a digital thermometer that measures in 1/10ths of a degree. We measure with a fiberglass tape the distance from a stainless steel screw mounted in the cave wall to the surface of the water and to the ice surface in 1/100th of a foot. We record the date, measurements and brief remarks on quality of the ice, dead critters, or conditions of the room at each measuring station. Between the two Labor Day expeditions, the ice floors in Merrill, Frozen River, Big Painted,



James Wilson in Crystal Ice Cave.
Peter and Ann Bosted photo

Caldwell, Cox, and Crystal have declined or disappeared, while the floor in Skull has risen. Heppe returned after being water/iceless for exactly six years. As of September, the 'new' pool is 20'x24'. Captain Jack's is still iceless. We put two pins in Upper Ice Cave. In Merrill the hole has gotten bigger; ice is now only on two sides of the hole. The catwalk has been moved, and the Park has opened the cave to visitor traffic. The two ice rivers have largely disappeared. In Frozen River, the floor and pool are gone. The pin is directly above the breakdown now. The spreadsheet and graphs created by David Haskel show the trends in ice levels and water going back to 1990. I hope to have an update for the Thanksgiving meeting.

GPS Location and Monument Installation

This project has been going on since the fall of 1994. Each cave or 'feature' that is recorded in the files or database receives a LABE number by lava flow and sequential number. The staff marks a brass monument, and then we go install it at the cave entrance. The location is written and drawn on the Reconnaissance Card. The cave monument becomes the site for the GPS location session. We record three different sessions at a point two meters above the brass monument. We use a tripod for the sub-meter antenna that is connected to the Magellan 'rover' unit. We have the base station running simultaneously with the rover unit. The file name on the rover session is labeled one, two, and three for the cave name. Later, the three files are compared with the base station to get a differential location. The software makes a scatter plot, and a printout is viewed to see if the diagram is tight enough to make the location within a 1 cm circle. If the answer is yes, then we declare it good. If not, we go back and start over. When the UTM coordinates of the three sessions are accepted, then the Monument staff put the location into the GIS system. One of the new wrinkles in both GIS data gathering and

cave mapping here, is to tie the brass monument and the GPS location one meter above it to the published cave map. Many cave maps are dated from the 1930's to last year. They obviously don't have the monument or GPS location on them. We are trying to do that as we go. This year we did 8 new GPS fixes. We installed 16 new monuments, compared to 5 the year before. There are only two 'stamped' monuments left to install. The newly discovered caves of the last several years have not been numbered, and therefore have not had monuments made for them. GPS locations for those caves have been made by the handheld Garmin units, and not by the Magellan/3-session protocols with printed sheets placed in the file folders.

Iris Heusler in Crystal Ice Cave. Peter and Ann Bosted photo

Cave Reconnaissance Inventory

This project also started long before CRF became a player at Lava Beds NM. What we did in 1988 was define the project, create standards, adopt a card/form and train our people to use the form, and work with the Monument staff to apply it. Many of the other projects use the 'card' as a starting point for their work. It is the most basic document that must be completed when a cave is found, recorded, studied, or marked. Mike Sims created the project, invented the form, and trained most of us (both CRF and park staff) in its use. The form is a joint form called LABE, CRF 5/93. The 'card' comes in two forms. The two-sided card is 5"x7". The one-sided version is 8 ½" x 11". We found that the card version often did not get the flip side filled out. So the single sheet with both card sides on the front meant that all the data got filled in the first time to the cave. The 'short' inventory consists of 19 specific items in 4 categories that the field researcher looks for in the cave during their first visit. They can circle the Yes or No symbol, and make remarks to the side of the entry. They look for bats, pictographs, access problems, formations, ice, etc. The card is a living document. It is filled out in pencil, and is updated as new information comes to light. This year we made 9 new cards, and fixed 15 older ones.

One component of the Cave Reconnaissance project that saw considerable activity this year was the entrance photo piece. The idea is to take a digital photo of each cave entrance with at least one person at the entrance pin, the 'meter' sticks for scale, and the cave number written in large black letters on a white board. The location of the photo is at the brass monument with one stick placed on it so you can see where it is.

The location of the camera operator is noted on the recon card so that it can be replicated later if needed.

This year we photographed 3 entrances. That completes the Loop Flow.

Dan Clardy in Hopkins Chocolate Cave.
Peter and Ann Bosted photo

General Inventory

We completed no general inventory this year.

Unofficial Projects

The cave file review project came out of an agreement early in CRF's relationship with the Monument. We agreed that certain items must be in the file folders, with corresponding consistency of information recorded on forms, in surveys, on maps, and annotated on photos. There are a total of at least 10 items that I look for in every folder. There is an annotated cave printout from the database that I use to record notes of missing items. I also make notations in red pen in the Book of Caves as we update material. As maps get made, recon cards get completed, GPS and monuments get validated and installed, and entrance photos get taken, printed and inserted into files. The list of shortfalls gets shorter each year. I spent one weekend updating the Book of Caves with this last year's information.

Another unofficial project is the security check we make of the gates at Upper Post Office and Lower Post Office. We check the gates for signs of molestation or tampering, and report the results to Terry Harris after the trip. This year the gates showed no sign of tampering. This is both good and unusual. I hope the trend continues. Bats are intensively using the lower entrance gate, based on evidence of mothwings and guano deposits at the nearside of the gate. The upper gate shows no such traffic.

No report would be complete with credit given to some of the CRF JV's who make the projects happen. Dr. Janet Sowers is the overall PI who makes the

projects stay on track and keeps me focused. David and Anna Kuhnel have been with me on many of the trips and made my progress possible. Dr. Bill Broeckel and his family have stepped forward and taken on a lot of mapping and recon duties this year. He has established a CRF/USFS MOA with the Modoc National Forest to map the caves on their property, and which lie outside the Monument. Iris Heusler is Co-PI for the mapping project. One of her chief missions is to eliminate the backlog of maps that are overdue. She has reduced the number, with more soon to arrive at Lava Beds to be put in the flat drawers. David Haskel created the ice level spreadsheet analysis document. Bill and Peri Frantz have pretty well completed their virtual cave tour for the new Visitor Center that recently opened. Last, but not least, Dr. John Tinsley has been essential this year to get the Research Center project completed. He attended meetings, made phone calls, and wrote countless e-mails to us, Superintendent Dorman, and the contractor to make the building happen.

The Research Center is built, and is operational and habitable. In February 2005, we occupied it for the first time. We, and other researchers across several disciplines and organizations, have used it throughout the spring and summer. They have expressed surprise and delight at the utility of the facility. This reflects well on the vision, determination, persistence, and teamwork by the CRF volunteers and the Monument staff to bring the building into existence and operation. The lab has actually been used as a lab already, and the meeting room has been used for meetings and classes for groups not associated with CRF or caving. Minor access or operational problems will be fixed or solved as time goes along.

The other major accomplishment is the remapping effort in Catacombs Cave. In a nutshell, the re-survey took 8 days in-cave, by 14 people, who worked 305.75 hours, to map 8435.9 feet of passage. Liz Wolff led the effort, and is drafting the map. The effort also took many offsite work hours by her, and with the cooperation of Iris Haussler, John Tinsley, Janet Sowers, and Bruce Rogers.

Lastly, three of us taught and supported the cave rescue seminar for two days in July. Cindy Heazlit led the team, and acted as principle instructor with Jansen Cardy as assistant instructor. Again, the teamwork between CRF volunteers and the Monument senior staff made the class possible. The success of the class lies in the confidence and work by the students who learned the basics, and then demonstrated true competence in the field (in Catacombs Cave) by safely recovering one of their fellow employees from deep in the cave. New CRF volunteer Jansen Cardy took over 200 photos of the class and recovery. They truly tell the story of who did the work.

SEQUOIA-KINGS CANYON OPERATIONS 2005

John Tinsley

The year 2005 has been a watershed year for CRF studies at Lilburn Cave in Kings Canyon National Park and in the Mineral King area of Sequoia National Park. Tinsley decided to reconstitute the entire project this year, so all PIs were required to submit new proposals to NPS. This action was triggered by changes in the project reporting practices wrought by the National Park Service. We chose to seize the opportunity to take stock of the project and evaluate and promote new research prospects and opportunities. Scientifically, I don't think we've ever been stronger than at present. Still, we are a small project, and therefore fragile. The advent of Dan Doctor's funded hydrologic study of controlled burns and their effects on nutrient loading and sediment yield in the Redwood Canyon karst has resulted in much-needed upgrades to the radio system, the solar array, the batteries at the cabin, and other infrastructure in support of this new research. The cartographic study of Lilburn Cave proceeds well under the direction of Jed Mosenfelder, mainly emphasizing quadrangle checking and mopping up lots of small leads. A new study of the structural geology and petrology of the Redwood Canyon karst was initiated by Dr. Marek Cichanski (Professor of Geology, DeAnza College, Cupertino, CA). He spent a week in Redwood Canyon this past summer, mapping and sampling, then spent the fall packing out his myriad rocks and related samples. Tinsley's sedimentology project rested this year, as he had the luxury of riding on the back of Doctor's proposal (of which Tinsley was the principal co-author). Tinsley will renew his in-cave sediment monitoring studies in 2006. We also have pending proposals from Mark Scott for exploration of entrances and passage stabilization (digging?) and from Bill Frantz for the continuation of his cave restoration efforts in Lilburn Cave. At Mineral King, there were two expeditions devoted to the mapping

Charlie Holtz climbing in the Alto Stream passage, Lilburn Cave, CA.
Peter and Ann Bosted photo

and inventory of Empire Mine Cave, a remarkable (and dangerously unstable) cave located at about 10000 feet above the entrance to Mineral King Valley. Much of the survey work is completed, and Joel Despain is drawing up the map. Roger Mortimer is nearly finished with the White Chief Cave map, and other small caves of the area are also gradually getting mapped. Bill Farr has terminated his cave diving project, doubtless much to Carol Vesely's relief. However, there are stout prospects regarding a new dive project employing new, compact re-breather technology pending.

Upgrades to the Lilburn Field Station's infrastructure occupied many volunteer hours this year, and replacing the roof looms large in the next year or so. The solar collectors are now doubled in size, quadrupling the output and allowing us to recharge the batteries that power the automated water sampling equipment now deployed at Big Spring and near Hart Tree trail crossing. An inverter allows us to have limited use of 110 VAC electrical appliances at the cabin. Will Heltsley is completing bracing of his fine woodshed, after last winter's double-the-normal snowfall collapsed the old supporting structure. Actually, the roof was just fine, so Will designed a frame that we could fabricate out of native vegetation. The design was quickly assembled and executed, then the roof was picked up and set down on the new support. The cabin's old chimney was crumbling away in several places, creating a health/deadfall hazard. Howard Hurtt supervised a crew of itinerant masons who contrived to topple the old chimney and replace it with 12 feet of insulated 8-inch diameter flue pipe. The chimney was then rebuilt in part, making a nicer-looking transfer from stone to metal. Flue capacity is slightly undersized compared to the size required to handle customary conflagrations during cold expeditions, so fires will have to be slightly smaller to avoid smoking up the cabin, or the sectional area of the front of the fireplace will need to be down-sized to reduce eddy effects and promote a more efficient air circulation. Or we'll need to raise another kilobuck to double up on the pipe. Stay tuned.

Most of the wherewithal for these upgrades came via a pack train that

Ron Bourret wading in Echo River, Canyonlands section of Lilburn Cave, CA.
Peter and Ann Bosted photo

Crystals, Lilburn Cave, CA.
Peter and Ann Bosted photo

resupplied the cabin on October 14. It was a never-to-be-forgotten day, when packer Tim Loverin, his wife, and a couple of friends showed up and with their four horses and seven mules moved a huge pile of materiel into Redwood Canyon from the Redwood Mountain Saddle trailhead as much as 6 miles to Big Spring and intervening points. They also then packed out lots of trash, like old chimney reinforcing rod, scrap metal, 8 of Bill Farr's SCUBA tanks, and dive weights and regulators and the like. It was a long day, but quite rewarding.

Summary: Project is healthy, vital, and for once, amazingly well-funded. We are very pleased.

Milestones: Shane Fryer (Joel Despain's understudy at SEKI) has accepted a new position as physical scientist and cave management specialist at Lava Beds. We congratulate Shane on his first career "solo" flight, and while we will miss him at SEKI, the folks who frequent Lava Beds are looking forward to working with Shane beginning late this fall.

SOUTHWEST REGION 2005

Guadalupe Escarpment & Fort Stanton Range, 11/2004 - 10/2005

Barbe Barker

CRF Southwest has had a very productive year thus far, working on a variety of areas and projects.

Carlsbad Caverns National Park

Four Expeditions were held at CCNP this last year during the usual 3 and 4 day holiday weekends. The breakdown of survey and restoration projects is determined and planned according to the expertise of the group on each expedition.

Survey has continued in Lower Cave with ongoing projects headed by the approved sketchers of the Park. We are almost through with the survey of Lower Cave and are in discussion with the Cave Resource Office on future projects. Scientific and Geology Inventory is done on every survey trip as well as one area that is dedicated to Scientific and Geology Inventory.

Restoration projects in Lake of the Clouds, The Guadalupe Room, New Mexico Room, The Dome Room, The Rookery and Long Fellow's Bathtub have kept many people busy and coming back to work on "their" projects. Over the Labor Day weekend, project members

finally reached the bottom of Longfellow's Bathtub which was approximately 12' deeper than when we began.

Fort Stanton Cave

The CRF Gate Building Team, headed up by Project Manager Jim Cox, finished installing the Roaring Hills Gate this year. The BLM District, Regional and National Members formed a committee to manage the Snowy River Section of Fort Stanton Cave. They will be the ones to review and accept proposals for future scientific, dig and survey activities of this portion of the cave.

Current projects within Fort Stanton Cave include restoration, photo monitoring, gate building, cave rescue training, guide training, leading trips, conservation and restoration training of groups.

Current projects at Torgac Cave include restoration, photo monitoring, impact mapping and leading the 6 trips allowed per year.

Summary

Things are great at CCNP. We work very well with Dale Pate and Stan Allison in the Cave Resource Office. Everything runs smoothly and they continue to have faith in our ability to carry out the tasks we have been entrusted.

We continue to have a very good working relationship with the BLM Roswell Field Office. They are very appreciative of our work and number of volunteer hours.

Total volunteer hours for the SW Region of CRF for this year: 5,700.

OZARKS OPERATIONS 2005

Cave Inventory, Mapping and Management

Scott House

Once again, CRF Ozarks enjoyed a good year of survey, inventory, and management activities.

Buffalo National River

CRF began coordinating a mapping effort in Fitton Cave back in 1985. A map was produced in 1990 showing a majority of the surveyed cave The present operating goal at Fitton Cave today is to create a new map series showing all the presently surveyed passages. Two expeditions were fielded this year with participants from several states comprising seven field parties. Large sections of the West Crystal trunk and Schemerhorn Cutoff have been resketched. Map work has begun on the West Crystal Room and Beauty Cave sheets. Expeditions operated out of the NPS volunteer facility at Steel Creek.

Mark Twain National Forest

The Mark Twain National Forest (MTNF) consists of 1.7 million acres of land, mostly in southern Missouri. Work by the Foundation on the Forest has been ongoing since 1986. There are approximately 520 known caves on MTNF land.

Nearly forty CRF trips were taken on the Mark Twain in 2005, the bulk of

which were in the Rolla/Houston district. This district, in south-central Missouri, features sections of the Ozark Plateau cut by deep river valleys. Most caves are located along the valleys but some have sinkhole entrances on the uplands.

Two trips were taken to Pittman Cave, a fairly large stream cave on the Gasconade River. The trips did mapping, biologic inventory and photographic work. Several more trips were taken to caves on Mark Twain National Forest land south of Waynesville and in a nearby extensive upland sinkhole area. Maps were completed of several caves. Several trips were also taken to relocate caves and locate new caves in a rugged area southwest of Fort Leonard Wood. Lastly, trips were taken to a private cave that the Forest acquired. One of these trips was a massive restoration effort involving approximately thirty cavers from across the state of Missouri.

Dawn Cardace and Jim Kaufmann work at restoring Onyx Cave, Mark Twain National Forest, September 2005.
? photo

Three trips were taken to the Willow Springs District along the North Fork River to conduct a biologic inventory of Still Spring Cave, the largest on Mark Twain land. Two more trips worked on finishing the survey of several caves in a cavernous bluff along the North Fork River.

Several parties were fielded in the Ava District of the Forest. One deep cave and two smaller caves were surveyed. One party looked for, but failed to find, a reported cave in the Cassville district.

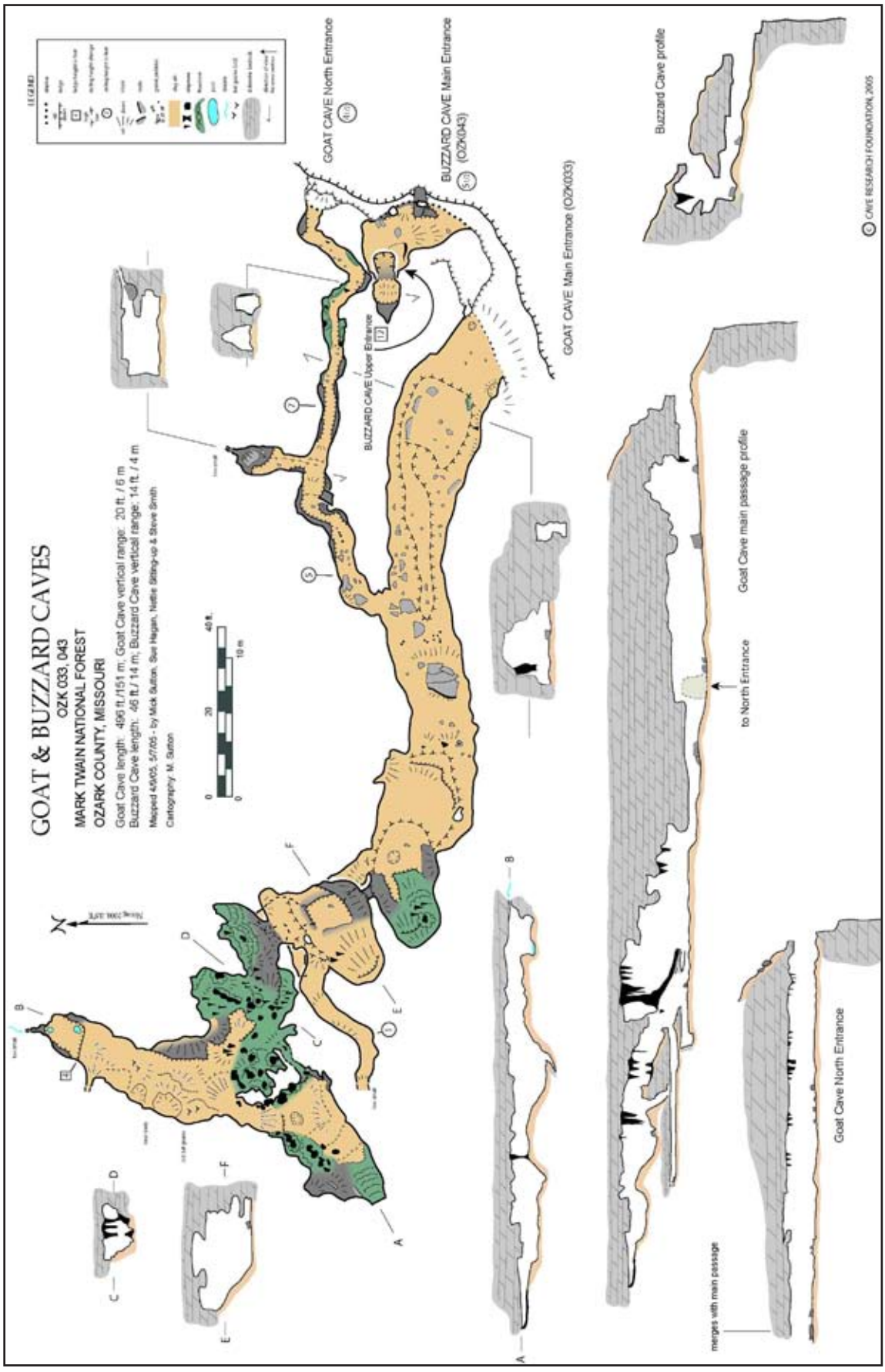
These efforts were supported by funding from Mark Twain National Forest; additional support for the cave snail hunt came from the Missouri Department of Conservation and Ozark Underground Laboratory.

Ozark National Scenic Riverways

The Ozark National Scenic Riverways consists of approximately 80,000 acres along the Current and Jacks Fork Rivers in southeast Missouri. A long term CRF and Missouri Speleological Survey (MSS) project here has increased the number of known caves from 80 in 1980 to over 320 today, and over 200 of these have also been surveyed. Survey and inventory continue on Riverways lands as time permits. A few smaller caves were surveyed in 2005 and new surveys of Branson and Bluff caves were continued.

Mick Sutton and Scott House continue to participate in the OZAR Cave Management Team, which guides management decisions for the park.

CRF was again contracted to provide certain cave management services to the NPS in the Riverways. This arrangement was found to be very beneficial to the park and was continued into the next fiscal year. Scott House was employed


GOAT & BUZZARD CAVES
OZK 033, 043
MARK TWAIN NATIONAL FOREST
OZARK COUNTY, MISSOURI
Goat Cave length: 496 ft./151 m; Goat Cave vertical range: 20 ft. / 6 m
Buzzard Cave length: 46 ft./ 14 m; Buzzard Cave vertical range: 14 ft. / 4 m
Mapped 4/6/05, 5/7/05 - by Mick Sutton, Sue Hagan, Nellie Sitting-up & Steve Smith
Cartography: M. Sutton
LEGEND
GOAT CAVE North Entrance
BUZZARD CAVE Main Entrance (OZK043)
BUZZARD CAVE Upper Entrance
GOAT CAVE Main Entrance (OZK033)
Buzzard Cave profile
Goat Cave main passage profile
to North Entrance
Goat Cave North Entrance
merges with main passage
© CAVE RESEARCH FOUNDATION, 2005

approximately half time over the year, with others either employed or having expenses paid for performing certain types of management work. Duties range from writing management plans, to performing biotic surveys, to installing cave signs, and so forth. The funding also allows us to help attract volunteer groups to the park.

CRF continued to support the Powder Mill Research Center. Numerous CRF and affiliate groups have used the facility for conducting cave related work in and around the park.

CRF survey crew in Forester Cave, Missouri Department of Conservation. Left to right: Kim Chiles, Bob Lerch, Tony Schmitt. Dan Lamping photo

Cave gates were completed on a couple of caves during 2005, directed by CRF members.

Pioneer Forest

Pioneer Forest is a privately-held forest of approximately 180,000 acres in the Lower Ozarks. CRF has been involved in survey and inventory of caves (of which there are over 100) located on these lands. In addition, we provide services to the Forest in the form of data and cave management. Specifically, we have integrated additional data into the database and provided that information to Pioneer Forest. CRF also provides support to volunteers from the Missouri Speleological Survey, especially the Meramec Valley Grotto, NSS, to do a great deal of work on the Forest.

Missouri Department of Conservation

CRF continues to map and help inventory caves owned by the Missouri Department of Conservation (MDC), an agency that manages state forest lands and wildlife. We also continue to provide services to the Department in the form of cooperative data management and consultation.

Powder Mill Creek Cave is a large, transitional cave (phreatic passages currently being modified by ground water movement) located in the Lower Ozarks area less than a mile from the Current River. While within the legislated boundaries of the Ozark Riverways it is actually owned and managed by the Department of Conservation. The cave is closed except for research purposes and harbors an increasing number of Indiana bats in the winter. CRF has been surveying the cave for the past fifteen years and it is now over 8 miles in length. (See separate report by Doug Baker.)

The MDC provided funds for CRF to build additional cave gates. A major gray bat maternity cave was protected in this fashion. MDC also provided funds for the aforementioned cave snail project.

In conjunction with MDC, several survey trips were taken to a private bat cave along the Meramec River to analyze air flow patterns, create a new map, and

prepare for a bat gate.

Missouri Department of Natural Resources (DNR)

Division of Geologic and Land Survey (DGLS) and Resource Assessment Division

CRF continues to work with the DNR/DGLS and the Missouri Speleological Survey on cooperative cave files. CRF continues to work with the MSS and DGLS on updating the computer database of state caves. Scott House heads up this project and is in charge of modifying and coordinating the state cave database. Additional help is provided by such CRF members as Bob Osburn, Jon Beard, Ben Miller, Andy Free, Mick Sutton, and Joel Laws.

State Parks Division

CRF continues its new survey of Fisher Cave. Three survey parties in 2005 extended the Hugh Dill Room survey and crossed the dreaded Pit and continued the survey there.

Missouri Speleological Survey

The MSS works to collect all cave info in the state. We cooperate fully:

- Maps and reports are turned in to the MSS and are archived by the Missouri Department of Natural Resources.
- We continue to financially support, maintain, and house the state cave database.
- CRF members continue to contribute maps and reports in great quantity.

Personnel and Management

We continue to work hard at attracting new talent. This year, as last, funding from Ozark National Scenic Riverways and Mark Twain National Forest enabled us to do a great deal of work.

Statistical summary of work:

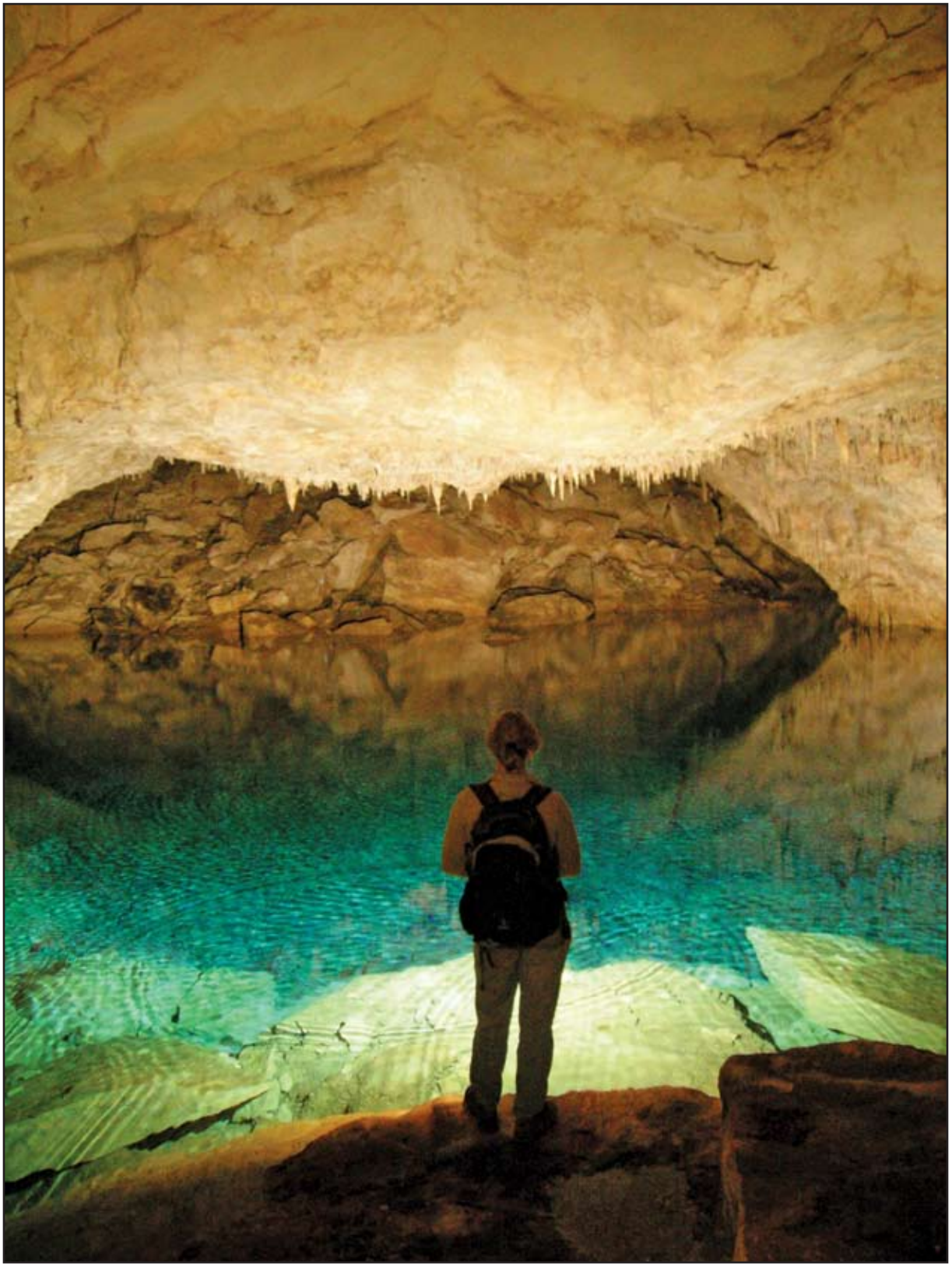
Trips/parties:	85
People/days:	281
Man/hours in field:	2164
Survey footage:	7984
Mileage driven:	29,500

At rates of $17.50/hour, $35 per diem for subsistence, and $0.375/mile, our field work alone thus far in the year has a value of over $58,000! This does not count time driving to expeditions, drafting and management work, data entry, cleaning gear, equipment costs, etc.

Ozarks Operation Area

Operations Manager - Scott House
Assistant Operations Manager - Pete Lindsley
Reporter and Ecologist - Mick Sutton
Geologist - Bob Osburn
Powder Mill Project - Doug Baker
Lower Ozarks Contact - George Bilbrey
Pulaski County Contact – Andy Free
Cave Gater – Jim Kaufmann

Jon Beard sketches in Knife Cave, Mark Twain National Forest, January 2005. ? photo



Dr. Ann F. Glasspool, Bermuda Biodiversity Project Leader,
is silhouetted in Church Cave.
Bern Szukalski photo.

Survey, Cartography and GIS

GARRISON CAVE #2

Christian County, MO

Jonathan B. Beard

For decades, this southwest Missouri cave was known to local cavers to be about 3,000 feet long. Its large entrance is found at the head of a steephead hollow on the Springfield Plateau region of the Ozarks. The main entrance passage leads to a 350-foot low, ponded bellycrawl that has acted as a gate in itself, preventing entrance to all but a few determined cavers to a dry walking passage that extended upland for 1,500 feet, with one lengthy side passage. The main passage ended in another low ponded bellycrawl, blocked by a 51-foot wide, wall-to-wall rimstone dam coming to within a few inches of the ceiling. Geology students of the late Dr. Ken Thomson mapped the cave in the early 1970's or so, and that was that--or so the world thought.

Then in 1996, members of Ozark Highlands Grotto managed to squeeze over that rimstone dam after a chert nodule was removed from the ceiling. At the end of what would total 400 feet of watercrawl, the continuation of walking passage was found, and with it an estimated two miles of main passage altogether. Time to rearrange mapping plans!

Bob Taylor would direct the remapping of the cave starting in September, 1996. His assignment was to map the main passage while I volunteered to map the watercrawls and side passages. By the end of 1997, however, the cave proved tough enough that Bob was having second thoughts about the project. With his blessing, I assumed the task of directing the mapping of the cave. By the end of that year, the mapped length of the cave surpassed 7,000 feet. The shocking part was that due to discovery of virgin side passages and loops, the mapping crews hadn't yet reached the discoveries of 1996. As so often happens when mapping, the cave was turning out to be more complex than any of us had imagined.

Cambarus Creek Crayfish, Garrison Cave #2. Eric Hertzler photo

By the end of 2001, mapping had reached Three Rivers, where the two primary cave streams converge to form the master cave stream named Cambarus Creek. The two main tributaries are North and South Creeks. Three Rivers is 6,200 feet into the cave when adding the shots of the main passage. But there was much more to be surveyed, for the survey parties had yet to reach the limits of the 1996 discovery trips.

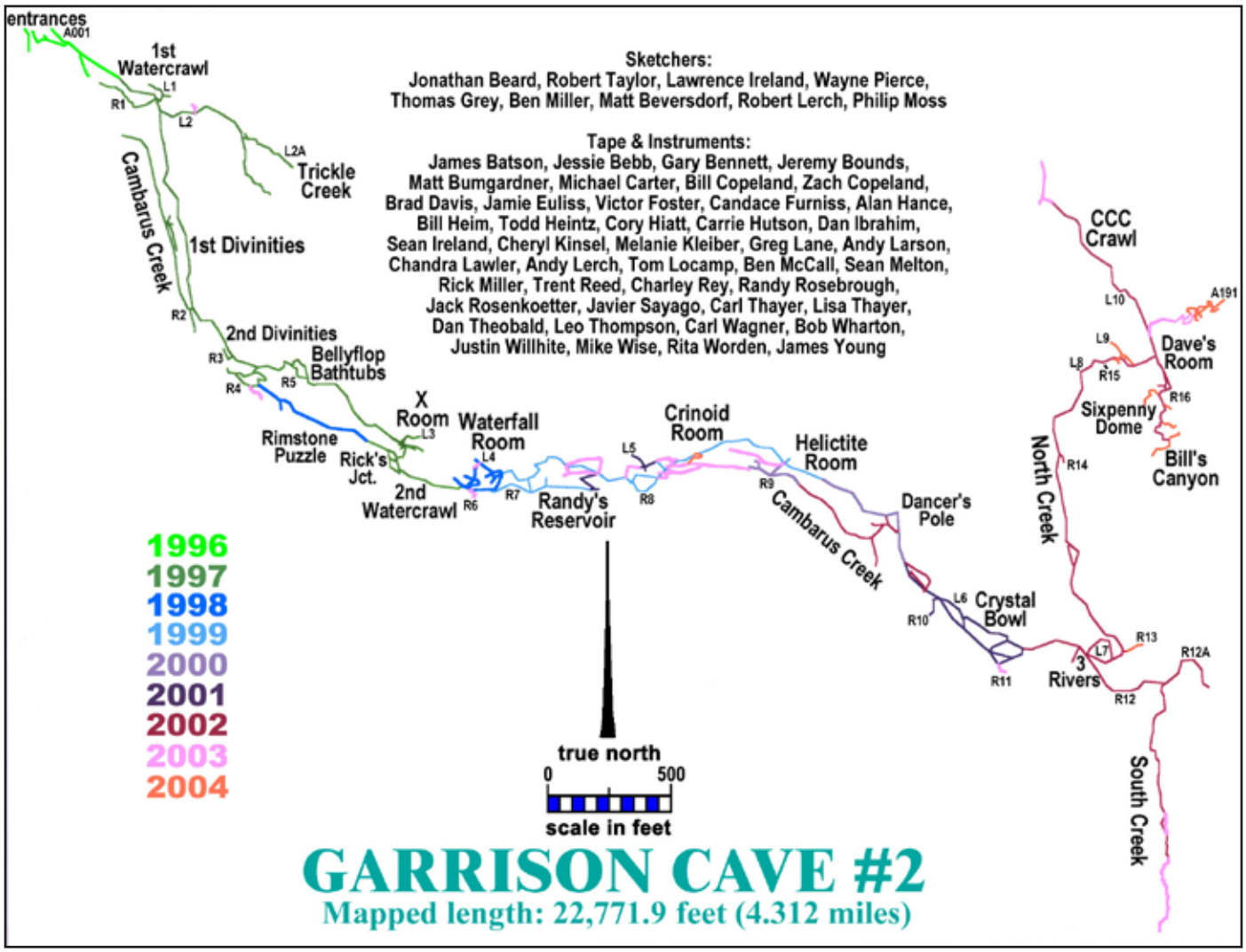
In 2002, the survey of the main passage finally reached the limits of the 1996 trips. Dave's Room, reached by following North Creek upstream for 2,000 feet, was the last large room discovered that first year, and provided a good place to look back and see what

else needed to be measured before final assaults might be made. The years 2003 and 2004 were primarily focused on pushing numerous leads along the main passage so that these "mop-up" trips could be completed and out of the way. More virgin passage would be mapped, including the unpleasant "Confounded Crystal Claydough Crawl" that led from Dave's Room. This descriptive name says it all, it's a sticky clay-floored crawlway with a crystal glaze that extended over 1,200 feet before mercifully getting too small.

Mazy waterways under one of the cave's largest rooms were surprisingly mapped to over 1,000 feet. Parallel stream passages to the main passage extended for thousands of feet until becoming too small or sumped.

South Creek, supplying Cambarus Creek with about 40% of its flow, was mapped over 2,000 feet by crews led mostly by Tom Grey, still with no end in sight. The amount of water flowing through South Creek has always been very promising, but the passage is a consistent contorted crawlway.

Beginning in 2003, Chandra Lawler agreed to direct the dye tracing of the sinkhole upland plain to determine the recharge area of Garrison Cave #2. The tracings were not especially surprising except the first few, which were designed



Calcite flower,
Garrison Cave #2.
Jonathan Beard photo

to determine how many springs along the steephead hollow would test positive. As it turned out, there were several "wet weather" overflow springs. The swiss cheese nature of Ozarks bedrock could not be more evident! The rest of the dye-tracing work showed that South Creek was being fed by Elk Valley, and North Creek was fed by an unnamed minor tributary of the Finley River, with about three square miles of recharge. Additional dye tracing in the future may further delineate the recharge, but the project participants were armed with a fairly good understanding of what was feeding Garrison #2.

By the start of 2004, all mop-up work had been completed along the main passage, with just two leads remaining: North Creek and South Creek.

Beginning in 2004, teams led by Lawrence Ireland took the initiative and began pressing upstream of Dave's Room, to boldly go where no caver had gone before! North Creek, which supplies 60% of the flow to Cambarus Creek at Three Rivers, turned out to be a labyrinth of braidwork in the first 750 feet that the mapping crews were able to manage past Dave's Room. While that work was being done, the crews I had led managed to finally get all of the other leads off of Dave's Room completed. One tall canyon passage discovered in 2002 by Bill Heim was calculated to be close to the surface above. Stretching the tape to its ceiling, it was later learned that there is but a scant 17 feet of bedrock between that and the surface. Another dome area off of Dave's Room, named the Sixpenny Dome, was discovered by Lawrence Ireland in 1996. Its most intriguing feature are the many white "sixpenny nails" growing in all directions from the bottom of stalactites, one per stalactite. Curious indeed.

The current mapped length of Garrison Cave #2 stands at 22,771.9 feet or 4.312 miles, exceeding everyone's expectations. The question is, what year will the cave surrender its last negotiable passage? It could end in 2005, or could it?

Some of Garrison Cave #2's more notable contents:

- Cambarus Creek's namesakes. There are stygobitic bristly cave crayfish (C. setosus) in every streamway and every large pool. As many as 40 have been counted on any one mapping trip, solely for the purpose of avoiding crawling or stepping on them. A serious biological survey of the entire cave may reveal hundreds. There are over two miles of streamways in which to search for them.
- Calcite flowers. In the Waterfall Room, beyond the Second Watercrawl, are 3-inch diameter calcite forms with large long crystals radiating from a central point. They are recrystallizations on old abandoned rimstone dams. No other explanation is offered here, but

they are unique to this author.

- Rimstone dams. Is there a cave on the Springfield Plateau with more rimstone dams? No passage is without them--big ones, small ones, dry ones, wet ones. Some old rimstones remain arched 10 feet above the floor in the main passage, as if they are old Gothic doorways to the rest of the cave. The cave's largest, "Leo's Squeeze" is also the cave's most famous. It is the 51-foot wide dam that marked the beginning of the 1996 discoveries. There is a 1,000-foot side passage named the Rimstone Puzzle. It is a passage with over 100 wall-to-wall rimstone dams that come within inches of the ceiling. The plan view of this passage resembles a long, serpentine jigsaw puzzle. Many rimstones are still in use, offering melodious epiphanies to weary surveyors.
- The two largest rooms known in the cave are named after the smallest of things. The Crinoid Room is over 90 feet wide, but is named for some dramatic crinoid stems on a small breakdown block in the center of the room. The Helictite Room, the cave's largest at 104 feet wide, is named for its forest of fish-hook helictites that adorn thousands of long translucent soda straws. Not to be ignored, there are many columns and other speleothems to be found in that room.
- The two most photogenic areas are found along the main passage between the First and Second Watercrawls. These are the especially beautiful First and Second Divinities, 50-foot wide areas of white flowstone and countless rimstone pools lined in cave coral. Photographers are challenged in these areas due to the close proximity of the opposing wall.
- The Waterfall Room. Named for four perennial waterfalls known as The Falls of the Four Sisters that emanate from an unenterable vadose ceiling channel. The room is large and complex with multiple levels and a number of short dome passages fan out in different directions.
- Pete Fountain. This is a four-foot column with a perennial supply of water flowing down its surface in sheets. For years it was called simply the fountain, but I thought it deserved a name. Say hello to "Pete".
- The Crystal Bowl. This is an 8-foot long, pure white—now dry—crystal lined pool with a 2 mm thick translucent calcite "roof" that nearly seals the pool (rimstone growing in all directions toward itself).
- Sixpenny Nails. Imagine hundreds of brown stalactites, each with a white sixpenny nail growing from its tip. No two "nails" point in the same direction. Each nail is as straight as, well, a nail. Go figure.

Pete Fountain,
Garrison Cave #2.
Leo Thompson photo

POWDER MILL CREEK CAVE 2004

Shannon County, MO

Doug Baker

The first survey trip of 2004 took advantage of unusually good weather in May to complete mapping of the far upstream reaches of the cave. The purpose of this 17-hour trip was to check the four remaining leads near the end of the main stream passage. The most important of these was a continuation of a muddy tributary passage located 14,100 feet from the entrance. In calendar year 2003, the first 150 feet of this passage was mapped, and the team stopped at where the floor had risen to within a few feet of the ceiling. In calendar year 2004, we extended this survey line for another 140 feet to a 5-inch high pinch-out. We also rechecked a small passage near the upstream siphon of the main cave stream (15,950 feet from entrance). This passage was even more constricted than it was in calendar year 2003 due to additional washed-in gravel, and it could only be entered a short distance. Since this appeared to be a continuation of the main passage, we mapped this final 17 feet to where the ceiling height was reduced to 7 inches (and appeared to get smaller further ahead).

Two other leads in the upstream section of the cave were checked without resulting in additional survey. A 13-foot high dome located 15,800 feet from the entrance was climbed to check for upper level passages; none were found. The fourth, and final, lead in the upstream area was at the end of a torturous narrow canyon located 14,600 feet from the entrance. This was mapped in 2003 for 80 feet, to a ceiling level crawl that appeared awkward but passable (named "Z8" after a nearby survey station). We rechecked this lead in 2004 and found that it soon deteriorated to a narrow 1.5 to 2 foot high crawl, only 9 inches wide at mid point; a tapering narrow crack in the floor made travel even more difficult. This went around a 30-degree bend then the floor dropped down 5 feet into a funnel shaped hole—the passage beyond continued 6 feet high by 1.5 to 2 feet wide. We could not find a safe way to negotiate the climb since getting through the squeeze necessitated having arms in a position that could not brake a fall. Backing into this passage was also considered, but ruled out since it would require one person to support most of the weight of another in cramped conditions--it also would make negotiating the 9-inch wide squeeze more difficult. We settled for sketching the crawl and the area beyond without additional survey.

After fieldwork in the upstream section was completed to our satisfaction, we thought all that remained to be done was to improve the sketch detail of some of the survey books from our first (1985) season working on this project. What was supposed to be the 'final' trip was delayed until August 2004 so the four persons that have helped the most with the Powder Mill Creek Cave mapping project could be present (G. Bilbrey, S. Irvine, J. Kaufmann, in addition to myself). Well, things did not go according to plan.

On the August 2004 trip we found a previously unknown tributary passage 2600 feet from the entrance; which required a return trip in September (this time with full wetsuits) in order to map it. This passage is located at the back of

an overflow meander niche that extends 40 feet into the west wall. From here, a low opening gives access to a muddy, wet crawl 2 feet high by 4 feet wide, and 150 feet long. This was mapped to where the ceiling lowers to about 5 inches above the gravel floor. A room is encountered near the beginning of this crawl with dimensions of 20 feet long by 15 feet wide and 6 feet high. There are a number of possible claw marks in this room—from something larger than a raccoon, but smaller than a bear.

The discovery of this 'new' tributary relatively close to the entrance prompted a thorough recheck of all stream undercuts in the outer 5000 feet of the cave. The result was that an even longer passage was found 3950 feet from the entrance on the September 2003 trip. This starts out as a wide, water-floored alcove at the back of a meander niche of the cave stream; after 40 feet, it narrows to a 1.5-foot high by 6-foot wide crawl. This crawlway continues for another 310 feet with average dimensions of 2 feet high by 14-24 feet wide. It has a chert floor with frequent pools of stagnant water; there are a fair number of soda straw stalactites (up to 6 inches long) and mud stalagmites. It was surveyed to where the ceiling lowers to within 3 inches of water level. This passage is actually going downstream; a plot of the survey data indicates that it is an overflow route that ends about 30 feet from some of the larger pools in the Hellhole passage. Most of this passage was mapped on the September 2004 trip, but we had to sketch in the last survey shot since mud and water had taken a toll on our compasses.

Another passage in an undercut 1700 feet from the entrance led to a water floored passage that was 26 feet long. Despite its short length, it was interesting since it provided access to a "window" of the main stream just upstream of where it first siphons.

During the August 2004 survey trip we also mapped a 37-foot long side passage located 1500 feet from the entrance (sketched in 1985, but long enough to warrant a survey) and checked two upper level leads 2500 feet from the entrance. The latter openings were noted in 2003, but we lacked proper equipment to investigate them safely. These were successfully reached on our August 2004 trip using a belayed climb, and were found to be opposite ends of a short loop—which was sketched.

CARROLL CAVE SURVEY PROJECT 2004

Camden County, MO

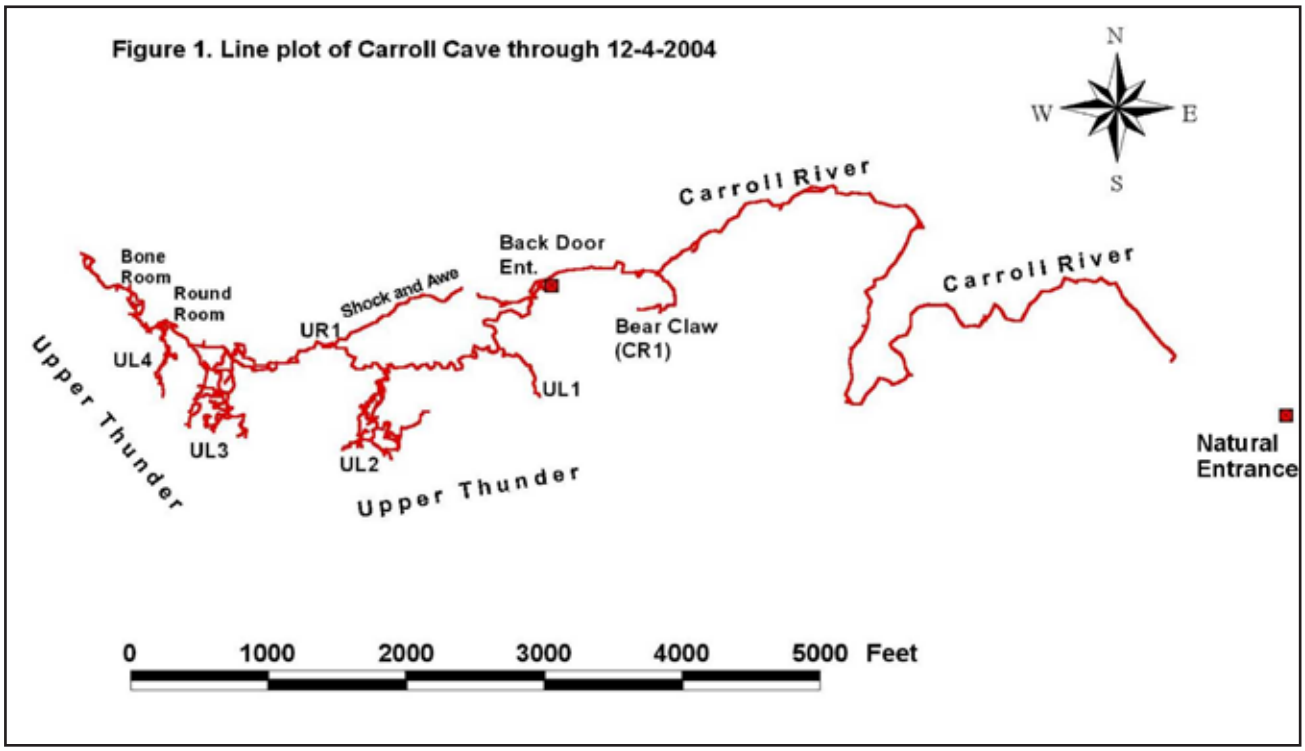
Bob Lerch
Survey Project Chairman, NSS 45004; CCC 140

The Carroll Cave survey had its most productive year yet, with just under 22,000 feet surveyed in 2004 (Table 1). The total surveyed passage is now 40,803.9 feet (7.73 miles), and the estimated passage length surveyed is 38,326 feet (7.26 miles). We mapped 3125.3 feet more in the last 12 months than the previous 14 months of the project. In 2004, we averaged 1830.4 feet (0.35 miles)/month compared to the previous 14-month average of 1345.7 feet/month. That's a nice 36% increase in productivity. We have mapped 3.25 miles of previously

unmapped side passages along with 4.48 miles of re-mapped trunk passage. Figure 1 shows the current line plot with the side passages and major sections and rooms labeled. Figure 2 is perhaps a more impressive way to show our progress, providing a visual comparison between the footage surveyed to date with that surveyed through 2-28-2004.

Since the start of the survey, 50 people have participated, but we picked up only 5 new participants this year (Table 2). Twelve people were Active Survey Participants (ASPs) in 2004, i.e., those people that showed up 4 or more times within the last 12 months. They deserve some special recognition for devoting a major amount of their free time to the Carroll Survey Project, so they get their names emphasized in Table 2. Seriously, though, the ASPs are the core of the Carroll survey project, and all of them have in one way or another pushed me to do more and do it better. So, far I'm successfully resisting. As a rough estimate, the surveyors volunteered about 1600 hours of time in the last year. To all who showed up to survey in 2004, "Thanks for your time, and please keep coming back in 2005." I will continue to offer generous bribes of food, beer, and spirits, but the bottom line is that you gotta want it because Carroll will work you!

Some of the highlights in the last year for me have been the big increase in the number of sketchers, the big increase in productivity, the huge footage days in Carroll River (see below), and the camp trips in August and December. When we started, only a handful of people were sketching, and this limited the number of teams, and, of course, footage acquired. In the last year, we typically have teams in which one person does plan and another does cross-sections. This has been a huge help in speeding up the sketching in trunk passage and contributed to the increased productivity. Other reasons for the improved productivity have been the discontinued use of the Transit, the relative ease of sketching in Carroll River



trunk passage, and an increase in our average trip length. Following multiple discussions with more experienced project surveyors, I became convinced that the Transit, which was excruciatingly slow to use for survey, was less accurate than hand-held instruments for large surveys because of the greater likelihood of additive errors. So, it was decided in late 2003 to no longer use the Transit for in-cave survey. It will, however, be useful for tying-in radio locations above ground. We steadily increased our trip lengths out of necessity in 2004, with typical trips now in the range of 15-18 hours. Long trips are now a requirement for most anything in Upper Thunder or Carroll River. We will have some shorter trips for a couple of months once we begin surveying Lower Thunder, which will start in 2005.

Early in 2004, our efforts were focused on pushing the far reaches of the UL2 (Convention Hall) side passage and continuing the main Upper Thunder trunk (U Survey). By mid-summer, the U Survey reached the Bone Room, and we started the UL4 Survey. Most of our efforts in July-September were focused on UL4, teasing us with the possibility of breaking under Traw Hollow. After netting a hard earned 1610 feet of upper and lower canyon passage, the possibility of getting past Traw looks low but not zero. We have another 1000 feet or so of stream level canyon to push before we give up hope. In addition, the UL4 stream, a sinuous but significant tributary (~1 cfs at baseflow) to Upper Thunder River, was observed to have cavefish. Thus, both the UL2 and UL4 streams have been added to the growing amount of cavefish habitat known to exist within Carroll. The U Survey went through the biggest and most convoluted passage we have surveyed so far. At one point, the passage is over 200 feet wide and car-sized breakdown is scattered throughout.

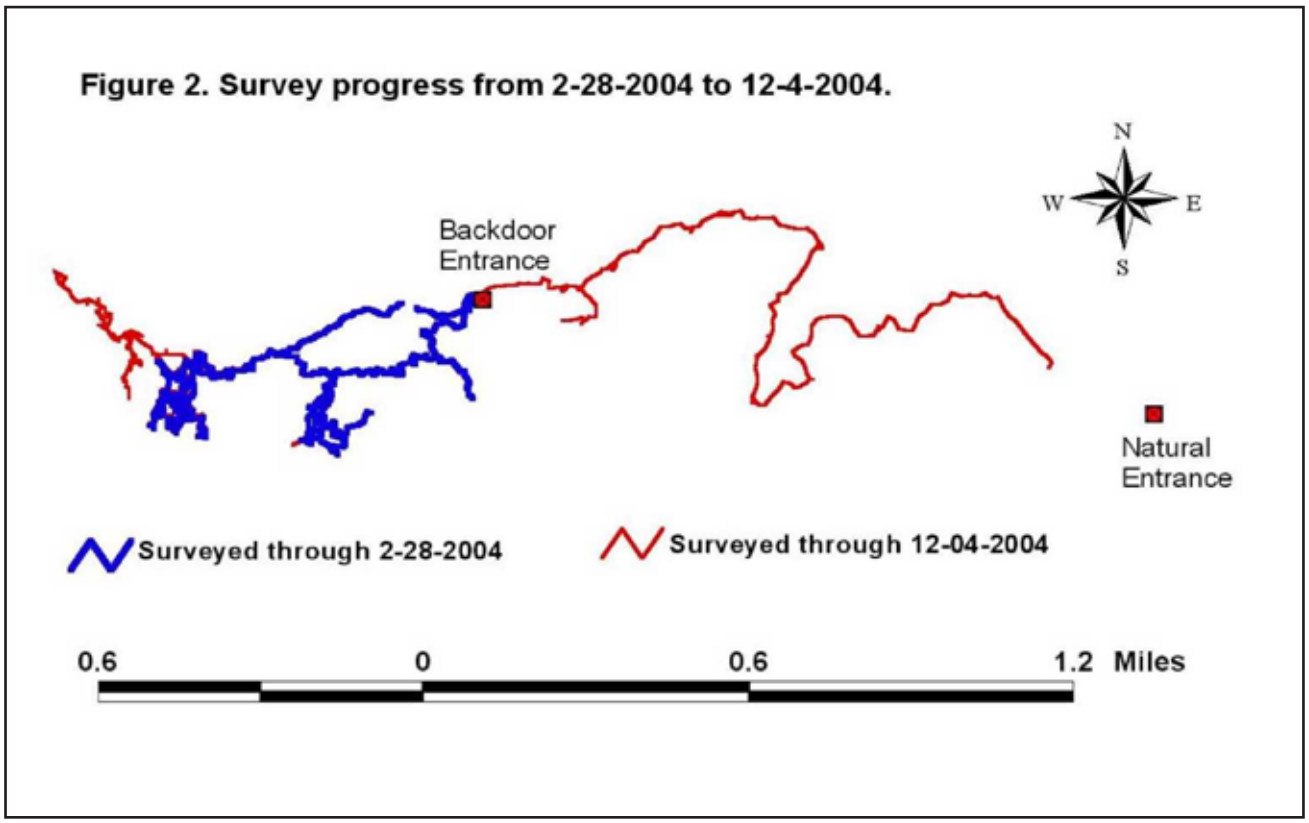


Figure 2. Survey progress from 2-28-2004 to 12-4-2004.

Table 1. Summary of Carroll Cave survey statistics through December 2004.

Passage	Total Surveyed†	Surveyed in 2004†	Number of Stations	Feet/ Station¶
Upper Thunder				
Main (U Survey)	11,959.8	4,711.0	254	47.1
UL1	790.9	0.0	29	27.3
UR1	1,451.6	0.0	46	31.6
UL2	6,020.4	2,791.5	285	21.1
UL3	6,260.2	141.1	274	22.8
UL4	1,610.3	1,610.3	80	20.1
Sub-Total	28,093.2	9,253.9	968	29.0
Carroll River				
Main (C Survey)	11,872.3	11,872.3	183	64.9
Bear Claw (CR1)	838.4	838.4	24	34.9
Sub-Total	12,710.7	12,710.7	207	61.4
Total	40,803.9	21,964.6	1,163‡	35.1

†All distance units in feet. ‡ Actual survey total; station totals in table add to 1,175 because of common tie-in stations. ¶ Indicator of survey difficulty.

Table 2. Carroll Cave survey participants since September 2002.

Dan Austin	Bill Howard	Val Schmidt (1) ‡
Jessie Bebb (5)†	Jeremy King	Tony Schmitt (3)
Brian Borton	Charlie Knight (2) ‡	*Joe Sikorski (6)*
Roger Brown (2)	Robert Kramer (1) ‡	Eddie Simmons
Randy Bruegger	*Dan Lamping (8)*	*Amber Spohn (6)*
Greg Buckley	Ron Lather	Jeanna Tennyson
Kim Chiles (3)	Lorely Lather	Rodney Tennyson
Jeff Crews (Spike) (4)	*Bob Lerch (12)*	Carl Wagner
James Corsentino	*Andy Lerch (8)*	Marsha Walker
Ashley Fleming (1)	Heather Levy (1)	Paul Woods
Andy Free (1)	Tom Lounsbury	Nick Worden
Mike Freeman (7)	Chris McCracken	*Rita Worden (10)*
Bill Gee (1)	*Ben Miller (10)*	
Brian Goertz	Pat Moriarty (sp?) (1) ‡	50 total participants
Matt Goska (6)	Jessica Nave	
J. Hinesley	Jeff Page	
Pedgie Heinz	Tom Panian	
Lawrence Ireland (1) ‡	Matt Platter (2)	
Dan Isbell (4)	Wayne Pierce	

†(x) = no. of survey trips in 2004. *Active Survey Participants in italics.* ‡New participants in 2004.

In most of the passage beyond the Bone Room, the stream is essentially a separate passage, requiring its own survey. We also hit a new right-hand side passage (UR2) near the current end of the U Survey, but we have yet to begin surveying it. In all, we surveyed 9254 feet in the Upper Thunder section of the cave in 2004, with just over half of the footage in the main trunk. The U Survey is now about 1.8 miles (estimated passage length) from the Backdoor entrance. UL2 and UL3 are currently vying for the longest side passage (see Table 1) at well over a mile each. Both of them are down to mop-up trips, but they still have several hundred feet or more of footage remaining to be surveyed. UL2, 3, and 4 all rate low on the feet/station index, which is a reasonable indicator of surveying difficulty (Table 1). UL4 is the new misery leader at a mere 20.1 feet/station. Goals for Upper Thunder in 2005 include finishing UL4, finishing the mop-up in UL2 and UL3, beginning UR2, and pushing the trunk passage past the end of the Helwig map and beyond the breakdown barrier.

Overall this year, we obtained more footage in Carroll River than any section of the cave (Table 1), adding 2.25 miles of trunk passage (C Survey) in 2004. We are now within about 500 feet of the Mountain Room. We made the most of our limited access, with 3 trips in the spring and 3 in the fall. Sketching at a scale of 1 inch = 40 feet, combined with simple passage features and consistently long shots, made for some especially big footage days in October (2639.9 feet), November (2086.8 feet), and December (3899.7 feet). We had our biggest one-day (3200 feet) and total weekend footages in December, with just three teams leap-frogging in Carroll River trunk passage. At 64.9 feet/station the C Survey has been by far the easiest surveying to date. Goals for the Carroll River section in 2005 include pushing the C Survey to the natural entrance and begin surveying as many side passages as possible. By the way, I would like to dispel the myth that there are 100+ side passages in the Carroll River section. We found less than twenty between the Backdoor up to the current survey. I know of several more near the Mountain Room, but I am sure we will not have anywhere near 100 side passages.

If you are interested in participating in the Carroll Cave survey, please contact me at lerchr@missouri.edu or blerch420@yahoo.com. Trips are the first weekend of the month, unless otherwise posted on the CCC website calendar (http://carrollcave.org/). CCC trips are also announced on the Survey Mercenaries listserv, contact Matt Goska to subscribe (goska@umr.edu).

POWDER MILL CREEK CAVE 2005

Shannon County, MO

Doug Baker

After 20 years, cartographic field work in Powder Mill Creek Cave was completed last year. During alendar year 2005, a single mapping trip finished checking all remaining leads and resolved note “fix ups” issues. The only remaining unmapped passage continuations will require considerable digging or are considered risky due to dangerous climbs or loose boulders.

The main goal of the 2005 trip was to complete an effort started in calendar

year 2004 to improve the original 1985 sketch and data for the outer 4200 feet of the Main Passage. Specifically, we were able to improve some significant sketch scaling and floor elevation problems for prominent ledges 1600-1750 feet from the entrance and improve the representation of a room-like enlargement of the Main Passage just downstream from the Hellhole junction. Additional wall definition survey shots were also done in the entrance alcove.

The discovery of two new passages in the entrance area prompted a thorough recheck of stream level meander crawls in the outer 5000 feet of the cave (we were more comfortable with the "wet" lead checking of subsequent trips – due to lower water levels if nothing else). This activity was completed in 2005. While no new passages were found, survey lines were extended in two low, wet leads found last year. At 1650 feet from the entrance, a low passage was surveyed for about 30 feet – though short, this passage is interesting since it provides access to an air pocket just upstream of the first siphon of the cave's main stream. In addition, the survey of an overflow passage mapped in 2004 was extended another 10 feet to a terminal siphon (this was sketched last year without a survey line due to fogged survey equipment -- a more 'formal' survey was desired after data reduction indicated the close proximity to Hellhole). In conjunction with this effort, sketches were also made for two wide stream meander undercuts in the vicinity of the Hellhole junction - one of which contained possible claw marks from a raccoon or similarly sized animal.

The most interesting animal life observation was that the sculpin sightings were more frequent and they were found far deeper into the cave than seen in recent years, including several individuals about 2300 feet from the entrance. Three large adult cave salamanders were grouped together in the southwest corner of the entrance alcove, with a fourth individual spotted beyond the First Water Crawl. Dung beetles were identified at 3500 feet from the entrance. There were no new signs of beaver usage since last year, and the only bats noted were solitary individuals, probably pipistrelles.

The current surveyed length of Powder Mill Creek Cave is now 46,719 feet. This is considered a conservative number since it is based on horizontal projection of survey shots and excludes survey shots made strictly to define passage walls or that "double back" over an existing survey to better position a survey tie for side passages.

2004 GIS UPDATE FOR MAMMOTH CAVE NATIONAL PARK

November 26, 2004

Aaron Addison
CRF GIS Program Director

Summary

Much of the GIS work by CRF at Mammoth Cave National Park has slowed since my head trauma accident on October, 20 2004. The major push at the moment has been the completion of the Control Point project. Details of this project are outlined below. Other

GIS efforts have been on creation of a geodatabase schema for GIS data storage, incorporation of Metadata information to GIS datasets, and storage of data gathered in the small caves inventory. Additional items that may be of interest to the Park include the development of *ArcGlobe* 3D data layers for visualization and the incorporation of lineplot data (*Walls* only) into the GIS data.

Individual Project Updates

Control Point Project

Aaron Addison (CRF) and Bob Osburn (CRF) have been working with Lillian Scoggins (NPS) and Pat Kambesis (CRF) to deliver a set of geo-registered map sheets of the current MACA map sheets. This is a significant undertaking in terms of man-hours and computing time. Bob has now completed scanning all known paper quads and also has digital copies of any maps being generated by computer.

Milestones

- Completion of scanning paper maps – Oct. 2004
- Acquisition of digital map files from various cartographers – Summer 2004
- Establishment of real world grid for all map sheets – Summer 2003
- Generation of workflow to geo-register map sheets – Summer 2004
- Geo-registration of first paper map – Spring 2004
- Delivery of raw scans to NPS – Summer 2004

Coming up

- Completion of geo-registration effort
- Delivery of additional raw scans
- Final delivery of project

Geodatabase Schema

This project is the foundation for the storage of all CRF GIS data in regard to MACA. Aaron Addison has worked extensively on this project and will continue to revise as necessary. All changes or suggestions to this database design should be coordinated with Aaron.

Milestones

- First Geodatabase schema design – Spring 2004
- Presenter at ESRI International User Conference on geodatabase design for caves and karst systems – Summer 2004
- Revisions made to CRF geodatabase for MACA – Fall 2004

Coming Up

- Limited implementation of geodatabase for CRF work at MACA

Metadata

Mike Yocum led an effort to establish standardized metadata for all GIS information at MACA. This idea was not implemented prior to Mike's untimely death. Aaron Addison has been reviewing Mike's work and conclusions for incorporation in to the CRF GIS system.

Small Caves Inventory GIS

This effort is in support of other researchers currently involved in the documentation of smaller caves within the Park. Some assistance has been offered to assist in the design and implementation of GIS towards these research goals. Currently, this project has not progressed beyond discussions and agreement of all parties that something should be done to leverage GIS towards this effort.

2005 GIS UPDATE FOR MAMMOTH CAVE NATIONAL PARK

November 25, 2005

Aaron Addison
CRF GIS Program Director

Summary

The year 2005 saw much progress on the GIS of Mammoth Cave and for the Ozarks Operation Area. Bob Osburn continued to acquire original maps on mylar for scanning. It is hoped that these large works of art will never need to be scanned again. As Mick Sutton has demonstrated with the Blue Springs Branch quad, a hybrid of hand drafting (ink on mylar) and computer drafting (Adobe Illustrator) can work quite nicely. It would be a huge help if those cartographers that have now had hand drawn maps scanned would continue future work digitally. Currently about half of the +60 quads have some information in the GIS.

Other notable successes of the past year include the completion of the Control Point Project that provided geo-registered maps to the Park, the beginning of GIS for the Small Caves Inventory, and many GIS maps for the Ozark region. We held a "GIS for Cavers" workshop at the NSS Convention in Huntsville, and provided GIS support and consultation for several other GIS projects. Finally, 2005 marked the first year that GIS was widely used in the Ozarks. CRF was able to demonstrate some of this work in presentations and posters at the annual CRF Members meeting held in Cape Girardeau during November.

Individual Project Updates

Control Point Project

The Control Point project was delivered to the Park during the Memorial Day expedition. This concluded a multi-year effort to provide geo-registered scans of the tourist trail maps to the Park. Many thanks go out to those that made this project possible, including Mark DePoy, Rick Olson, Lillian Scoggins, Bob Osburn, Pat Kambesis, Dave West, Jim Borden, Bernie Szukalski and the late Mike Yocum. Also thanks to the cartographers without whose work there would have been nothing to geo-register! That includes Scott House, Bob Osburn, Mick Sutton, Pat Kambesis, Bob Gulden, Ed Klausner, Kevin Downs, Doug Baker, Paul Hauck and anyone that I may have missed. Without your help and the support of ESRI (GIS software grant), this project simply would not have been possible.

Mammoth Cave Data Viewer

A data viewer for the data assembled in the Control Point project was developed in the spring of 2005. The goal of this project was to make the GIS data more accessible to CRF expeditions and the research community. The initial version of the viewer includes the ability for the user to zoom to areas of the cave by name, dual coordinate tracking in cave coordinates and real-world coordinates, dialog boxes for database queries and the ability to choose one of several templates for printing. It is anticipated that the GIS data and the data viewer will be installed on a computer at Hamilton Valley in the near future.

Mammoth Cave Atlas

As a spin-off of the Control Point project and the Data Viewer project, work has begun on an atlas of Mammoth Cave. Based on some early calculations, the atlas will be in 11" x 17" format and will be around 250 pages. Having all of the MACA data in GIS makes this a much more approachable task without the need for individual page layouts. In fact, the software supports the development of different scales and digital publishing to PDF with the click of a few buttons.

As a companion to this project and to commemorate the 50th anniversary of CRF, Bob Osburn and Aaron Addison are hoping to present a "Map of Mammoth Cave" at the 2007 NSS Convention to be held in Indiana. This map will be at 1 inch = 50 feet and will contain all of the cartographic efforts to date. The map will be approximately 60 x 60 feet and will be laid out on a large surface (basketball court?) for convention goers to walk through the cave.

Geodatabase Schema

Aaron Addison has taken on the task of developing a GIS geodatabase schema for speleology as his master's thesis in GIScience. The data model will be designed to handle base map information used by explorers and scientists a like. It is hoped that a usable data model will be forthcoming by summer 2006.

Parts of the geodatabase may be tested with MACA data and data from the Small Caves Inventory. Implementation of the geodatabase will provide access to new functionalities within GIS such as feature definitions, relationship classes, network analysis, and more compact data design.

Small Caves Inventory GIS

The coordination of the Small Caves Inventory was transferred from Scott House to Aaron Addison in October 2005. Many thanks go to Scott for corralling this ever expanding project for so many years. The database has grown mightily in those years.

The Park had two summer interns that spent the vast majority of their time working with the "small caves" of MACA. They collected many entrance locations and sorted through the various paper files in order to update the database. The next steps will be to verify this information against CRF files and maps. All of the information will compiled into a database and GIS for future use in exploration and research efforts.

Ozarks

2005 was the year that the CRF Ozarks region jumped into GIS. Several maps were incorporated into GIS and presented on various overlays for the NPS and the USFS. Some of these projects include Powder Mill Cave, Still Spring Cave, Pittman Cave and Rimstone River Cave. Future projects are planned.

Fitton Cave, situated in the Buffalo National River backcountry, also got its first GIS in 2005. Survey data entered and compiled in Walls was exported to shapefiles and added to topographic, aerial and geologic maps for the area. This data supported the creation of a nice "Geology of Fitton Cave" map created by Chuck Bitting of the NPS. The GIS also assisted Scott House and Bob Osburn in undertaking the cartography for the cave.

Overall, it was a busy year for GIS efforts. Currently there is much more to be done than CRF has resources. If you are interested in volunteering to work on GIS projects, we can assist you with hardware and/or software. Please contact Aaron Addison (addison@caveresource.com) for more information.

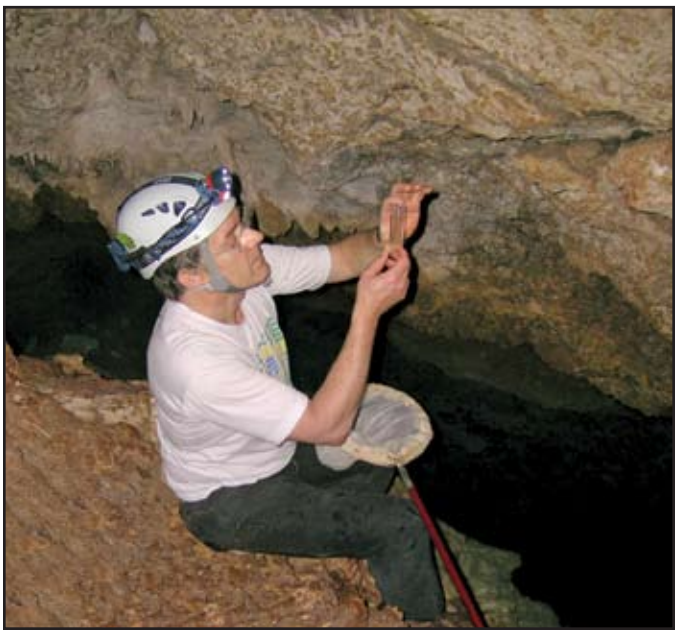
A STRATEGIC ACTION PLAN FOR BERMUDA'S CAVES

Text and photos by Bern Szukalski

A meeting to discuss the development of a strategic action plan for Bermuda's caves was held February 21 through 24, 2005, at the Bermuda Aquarium, Museum, and Zoo (BAMZ). The meeting was attended by roughly 20 people, including myself and a handful of others that were supported by BAMZ funding to attend the meeting. The invited attendees included Geoff Boxshall, Natural History Museum, London (authority on Copepods found in Bermuda caves), Paul Hearty, University of Wollongong, Australia (an authority on Bermuda's geology), Tom Iliffe, Texas A&M University at Galveston (the "father of Bermudan Speleology" and a marine biologist) Storrs Olson, Smithsonian Institute, Washington, D.C. (a bird expert who has conducted paleontological work in Bermuda), and Terrence Tysall, Cambrian Foundation, Orlando, Florida (a graduate student and cave diving instructor). Other attendees included BAMZ personnel and representatives from the Department of Planning, Department of Conservation Services, the Ministry of the Environment, and the Bermuda Biodiversity Project.

I was invited to attend since I had been involved in mapping several caves in February, 2002, with Bob Richards, Sandy Stephens, Robin Barber, and two of Tom's graduate students. On that trip we completed the mapping of the dry portions of Admiral's Cave, Walsingham Cave, and Subway Cave. That year I also began the initial groundwork to establish a country-wide GIS system which includes all of the known caves and their associated inventory data. Almost all of the information known about Bermuda caves at the time can be credited to Tom Iliffe, whose long term involvement and vision for protecting Bermuda's unique resources has resulted in or catalyzed the vast majority of the research and inventory of caves in the country. Tom's

Left: Dr. Geoff Boxshall sampling for copepods in Roadside Cave. Right: Roughly 500 used oil barrels, discarded after WWII, create a hazard for cave fauna in Bitumen Cave. The rust and residue left in the barrels threatens a pristine pool just below this room.



database and inventory became the foundation of the cave and karst GIS system.

The GIS project has grown to encompass many layers of information, and has become known as the Bermuda Cave and Karst Information System, or BeCKIS Project. A summary of the 2002 trip with photos, GIS maps, and other information was published in the August 2003, issue of the NSS News. One of Tom's graduate students, Darcy Gibbons, who was one of the students participating on the 2002 trip, completed her master's work following up on some of Tom's early work. Her thesis was completed in 2003, and used GIS to analyze change in Bermuda's caves, comparing Tom's 1983 inventory and observations to her 2003 inventory and assessment.

Though many initiatives were discussed during and subsequent to the 2002 and 2003 activities, much of the original goals remained unfulfilled. The 2005 sessions were designed to revitalize some of the initiatives which had been lying fallow, and to elevate the importance of cave resources throughout various branches of government, as well as to increase public awareness. The meetings covered a variety of topics each morning, followed by field trips in the afternoon. The main objective was to get a handle on the work ahead, identify scope and needs, and to institutionalize a process whereby the growing BeCKIS information system can be leveraged to help protect Bermuda's cave resources.

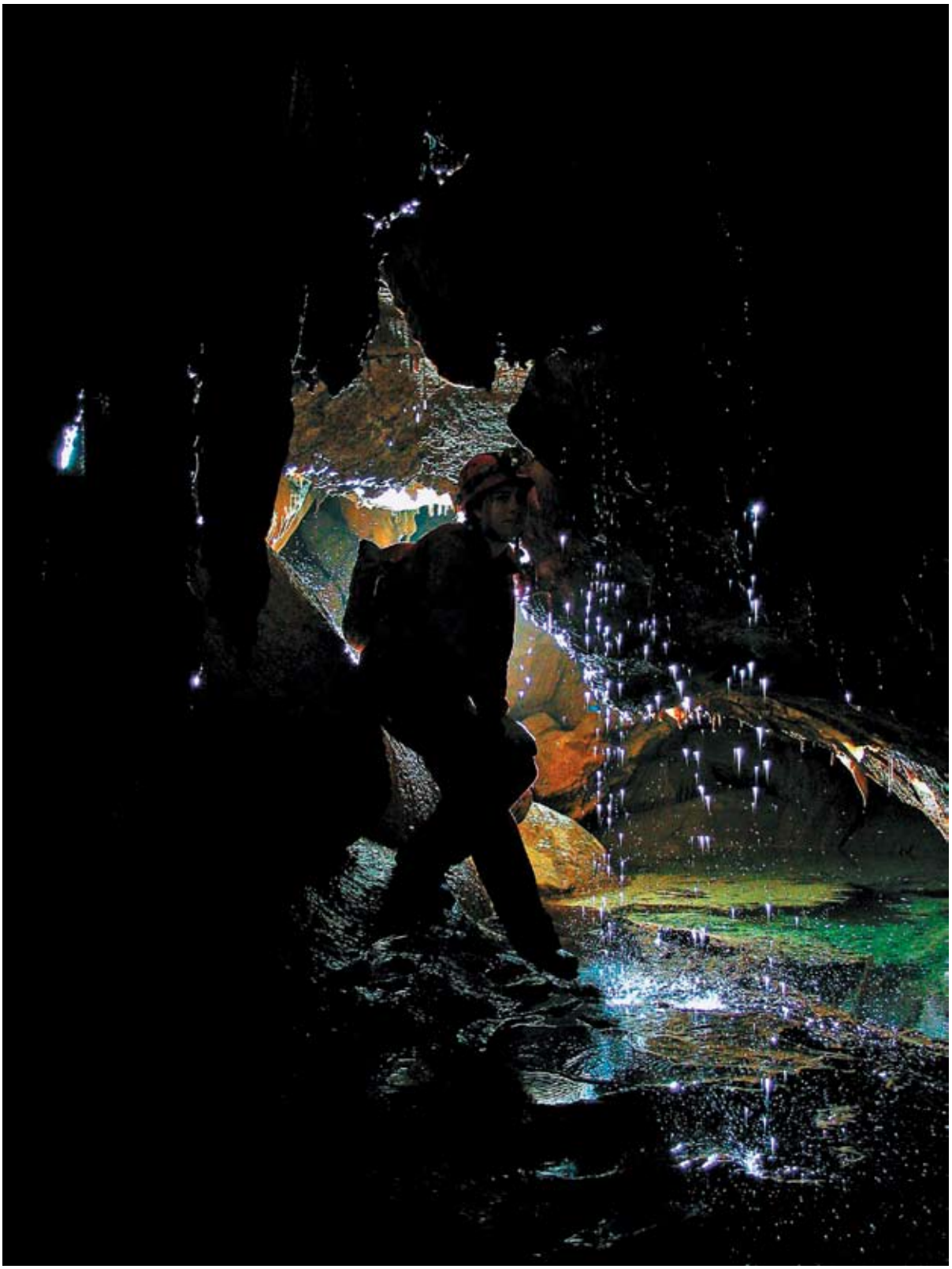
The main public event was a series of presentations and a panel discussion led by Tom Iliffe, with each of us presenting on our specialty, in front of a packed auditorium at the Bermuda Underwater Exploration Institute. Over 200 people attended, and stayed throughout the entire 2-hour program.

Some interesting Bermuda cave statistics:

- There are 66 stygobitic species, 56 of which are endemic to Bermuda
- 25 of these species are critically endangered
- 10 of the species are found in only one cave
- 6 are known only from a single specimen

While nearly 200 caves have been identified, only a handful or so of the caves have been surveyed. Many are interconnected via complex networks of underwater passages. Green Bay Cave is currently the longest in the country with over 2 km mapped, and is completely underwater. The Walsingham Cave System includes the country's two commercial caves – Crystal Cave and Fantasy Cave – along with several others which have been connected via underwater passages. The Walsingham Cave System currently stands at 1.3 km long, with lots of big underwater leads remaining to be pushed. Admiral's Cave is one of the larger caves with a significant above-water component, and we surveyed roughly 2,500 feet of passage there in 2002.

There remains great potential for all sorts of cave mapping, inventory, and scientific work in Bermuda, and for new finds. Researchers and cavers alike are encouraged to consider projects there. Though somewhat logistically challenging, with transportation problems (visitors can only rent scooters), no camping facilities, and somewhat expensive lodging, a framework is evolving to better support research activities. A follow-up meeting, field training workshop, and exploration and survey trip is planned for late 2006.



"In the Stream"
CRF Joint Venture caver Karen Caldwell in the stream section of Gap Cave, Cumberland Gap National Historical Park, May 2005 expedition.
Kenneth Storey photo

Science

THE PINK PLANARIANS OF DEVIL'S ICEBOX, MISSOURI

Michael Sutton

Devil's Icebox is a large stream cave (>10 km long) within Rock Bridge Memorial State Park, on the outskirts of the City of Columbia, Missouri. It drains a basin of about 30 square km, via a losing stream and a sinkhole plain. The input channels are quite open, and as a result the cave stream is much more eutrophic than a typical Ozark cave stream. This in turn results in the cave being biologically diverse, ranking third in the state for diversity. Among the stream fauna is the only known population of a large stygobitic planarian, *Macrocotyla glandulosa* (Kenk) (Figure 1). The planarian is categorized as critically imperiled by the State of Missouri (Missouri Department of Conservation, 2003), but a case for placing it on state and federal endangered species lists cannot be made without more data on the population than currently exists.

The flatworm is a Kenkiid in the order (or suborder) Tricladida. Its closest relative, *M. lewisi* is known only from Perry County, Missouri, 200 miles from Devil's Icebox. *M glandulosa* was first collected by P. W. Frank in 1955 (Hyman, 1956), and was described by Kenk (1975). It is eyeless, pallid with variable amounts of reddish-orange pigment, and has been reported as large as 3 cm long. The planarians produce distinctive egg cases that are dark red spheres 2-3 mm diameter adhering by a short stalk to the underside of rocks. Based on Kenk's laboratory studies, the planarian seems to be a strict predator, primarily of amphipods and isopods—captive specimens readily accepted live crustaceans but refused beef liver. There is no evidence of predation upon the planarians, but there is a likelihood that they are preyed upon by the northern crayfish *Orconectes virilis*, and there is at least one other potential predator in the Icebox stream, a dytiscid diving beetle (*Agabus* sp.). The planarian shares its habitat with a diverse stream community, including a number of epigean fish and amphibians.

Figure 1: Macrocotyla glandulosa (head to the left, length approximately 2 cm)
Michael Sutton photo

The continued existence of *M. glandulosa* has been a matter of concern since at least the early 1970s (Hargrove et al., 1973). The primary threat is the relatively poor water quality and its potential for further deterioration. In recent years, the stream has consistently shown nitrogen levels in the order of 2 ppm total nitrogen, 60% of this in the form of nitrate, suggesting input from agricultural fertilizers, livestock excretion, and septic system output (Robert Lerch, personal communication).

While this is not exceptional for a stream in an agricultural setting, it does suggest that the stream's nutrient load is in excess of that which would occur in a natural setting. Bacteria levels also tend to be high during periods of high runoff, and pesticide levels tend to be high in spring (Roxie Campbell, personal communication).

Devil's Icebox is especially vulnerable to water pollution and siltation because both parts of the drainage basin drain into the cave via more or less open channels. The cave's watershed adjoins Columbia, and the expanding population of that city is putting developmental pressure on the sinkhole plain. Cave streams in this kind of setting have had an unfortunate propensity to turn into open sewers, with detrimental consequences for the stream ecosystem, unless development occurs with careful attention to the karst landscape.

Census protocols

The project had two related aims: 1) collect initial data on the population density, habitat preferences, aquatic community makeup and seasonality of the pink planarian; 2) develop protocols such that minimally trained volunteers can produce systematically comparable counts in semi-permanent representative census areas. The study was confined to the more accessible first 2.2 km of the main stream, together with the major tributaries in that section.

The study relied primarily on fixed census plots, although random sampling was also attempted. A total of seven census plots together with several control plots were devel¬oped. Each plot extends along 5 m of stream bed. Parameters recorded included average channel width, average channel depth, approximate substrate composition, and person-minutes of effort per count. In addition, water stage and temperature were recorded. The protocol was to divide the channel longitudinally using a measuring tape and use two team members to count. Results were combined and recorded by a third member. Working from the downstream end, each moveable rock was overturned and areas with no rock coverage were closely examined. In turbulent settings, clear plastic viewers were used to observe the stream bed. Fauna other than planarians were counted (to an approximation in the case of large concentrations). For the planarian observations, the setting (under a rock versus in the open) was recorded and measurements were made of the fully extended length of the animal. The pigmentation was subjectively assigned as dark, pale, very pale or white. Once measurements were completed, the planarian on its rock was replaced gently. In addition to adult animals, planarian egg-cases were recorded, along with their setting.

Not all plots proved equally useful, and not all were counted during every trip. Only one plot (the Shark) was counted during each of the six field trips. The control plot at the Shark was counted during the first and last trips only. Timed searches of typical favored habitat (rocky riffles) were carried out in several locations, and a quasi-random census protocol was also tried: working upstream, 100 meters were paced off, and a meter square grid was counted in the center of the channel at each resulting location. Timed counts of planarians were also conducted in the surface stream in the karst window downstream from the cave, where planarians washed out from the cave frequently are found.

We also attempted to attract

planarians by setting bait consisting of a mixture of raw chicken liver and cooked shrimp. On the first day, 20 cc of bait was placed in each of five wire-mesh suet feeders and placed in the cave stream in various settings in pools and riffles of the main stream and the Rollercoaster tributary. Rocks were piled around the baits to try to inhibit access by crayfish. All bait stations were checked and removed the next day.

Planarians and other fauna were searched for within the stream sub¬strate. In rocky riffles, small-scale excavations were carried out using a hand trowel. Approximately 20 cm diameter patches of sand/gravel/pebble substrate were excavated. A kitchen sifter was placed downstream from the excavation to catch any macroinvertebrates which may be washed out. Individual pebbles were examined for fauna as they were removed. In pools with fine sediment, sediment was collected with a hand trowel to a depth of 25 cm, and a measured volume, selected 200 ml at a time from random spots, was filtered through a 1.5 mm mesh kitchen sifter.

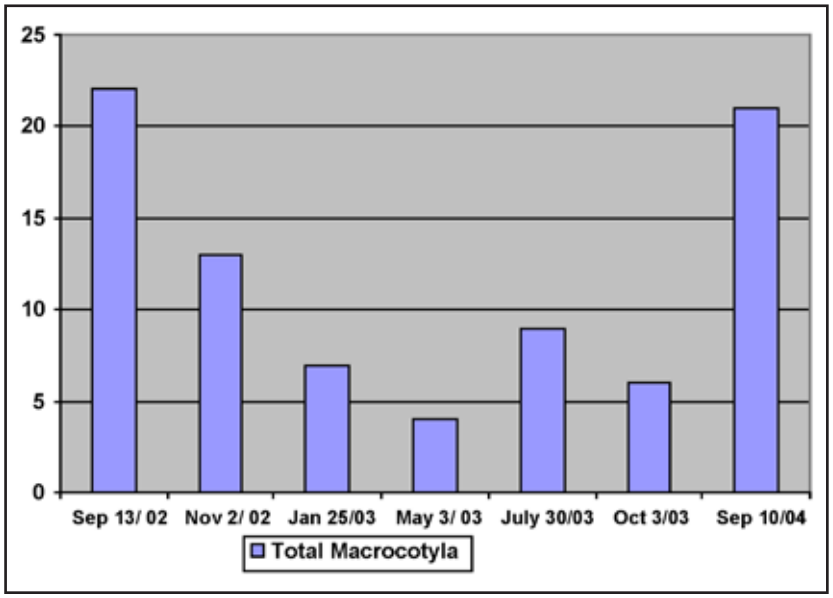
Stream fauna surveys were also conducted in the three major tributary streams within the study area: The Rollercoaster, 1810R, and the Left Fork. The general natures of the three streams were assessed, and representative patches of rock/gravel streambed were exam¬ined for fauna.

Results and Discussion

Figure 2 shows the overall trend in total *Macrocotyla* numbers. The first five bars are from the study; the sixth bar shows the count from the first of the routine scheduled surveys.

The decline in population numbers from the September 2002 trip was first suspected to reflect seasonality, but this hypothesis became much less likely when the numbers failed to rebound the following October. Another likelihood was that the census protocol was disruptive enough to depress populations within the plots for more than the two month interval between counts – note that the last, higher, count followed a one-year hiatus. However, several lines of evidence tend to support the notion of a real decline and recovery in population numbers. First, semi-quantitative data from Rock Bridge State Park staff indicate planarian numbers comparable to the September 2002 trip. Three parties searching more or less the same area as the present study found the following numbers: 9/23/98 – 27 animals; 7/27/99 – 23 animals; 9/8/99 – 22 animal (Campbell, 2002). In comparison, the total planarian count for the September 2002 trip was 22. Second, planarian numbers in the control plot at the Shark, which remained undisturbed between the first and last trips, declined from 6 to 0. This would strongly suggest that the

Figure 2: trends in total Macrocotyla observations.



decline was not a result of detrimental effects of the census protocol. Random timed counts in typical planarian habitat outside the census plots also supported this conclusion.

Assuming the decline in population was real, it is unlikely that it was due to a decline in water quality, as water quality indicators were essentially flat during the period of the study (Robert Lerch, pers. comm.). From weather records at the University of Missouri, Columbia, it is also unlikely that catastrophically high runoff flushed out a large portion of the population, as may possibly happen following exceptional storms. It is entirely possible that the observed change in numbers falls within the range of normal population fluctuation. One of the values of continuing to monitor the census plots is that the data should help to shed light on what constitutes "normal" population fluctuations.

Of the seven fixed census plots, the most useful in terms of planarian numbers were those at the Big Room, the Shark and 1940L, and our recommendation was that combined planarian numbers from these three plots form the basis of the long-term census. The first two of these plots are low gradient, rocky riffles; the third is a pool with isolated rocks. It is important to bear in mind that the census plots were not random. They were first chosen to reflect representative sections of various habitats, but the plots with larger numbers were those finally selected for long-term monitoring - the aim was to maximize count numbers in order to make a census baseline more meaningful for tracking future trends, not to attempt to derive a total population estimate. As is generally the case in the cave environment, the habitat is very patchy. The patchiness, together with the low density of planarians even at favorable sites, renders the question of a total population estimate very problematical. The quasi-random paced quadrants failed to include any planarians—the planarian is scarce enough and its preferred habitat patchy enough to render this approach impractical.

Timed counts versus area counts

There is a trade-off between obtaining meaningful results and the effort needed to obtain a count. Five meter lengths of stream seemed appropriate, at least in the relatively high population density areas. Greater lengths would have resulted in difficulty in obtaining more or less uniform substrate types, and would probably have rendered count times impractically long. The counting time was closely correlated to the number of moveable rocks to be turned over.

Close parallels of the census data as corrected for stream length and as adjusted for count time suggest that census protocols could as easily depend upon timed counts as upon fixed length of streambed, provided that the timed counts took place in the appropriate habitat. The advantage of using fixed census plots is that it guar¬antees that the habitat counted matches from one count to the next, at least in the short or mid term. The longer term risk is that, sooner or later, a high runoff event will rearrange the bed composition of the cave, including within the census plots. It would be desirable to photo-document the census plot streambeds so that future changes in composition can be tracked.

Size and color

The overall mean extended length for all planarian observations was 17.9 mm (n=60, standard deviation, s = 5.2 mm). The range of extended lengths was 9-35 mm. The 35 mm maximum

is larger than the 30 mm previously reported (Kenk, 1975). The sizes show a more or less normal distribution, with a slight skew towards smaller animals. It is characteristic of long-lived troglobitic species for age/size-class structure to be skewed towards older, larger individuals, compared to related non-cave species, but the longevity and reproductive patterns of the pink planarian are unknown factors.

Of the subjective color categories, 20% of planarians were categorized as dark pink-orange, 45% as pale, 16% as very pale and 19% as white (n=49). There was no clear correlation between color and size. It is curious that the amphipod *Crangonyx forbesi* also tends to show a strong orange pigmentation, a characteristic it has not displayed in a large number of Ozark cave obser¬vations (Sutton 1993, 1998). Is there something peculiar to the Devils Icebox environment which results in pink-orange pigmentation of some *Crangonyx*, and is the planarian pigmentation a result of predation on *Crangonyx*? Interestingly, in Kenk's (1975) laboratory experiments, one planarian was maintained on a diet of isopods, and it "lost its pinkish color over several months and appeared almost purely white…" in contrast to other planarians which were fed a diet including gammarid amphipods.

Habitat

The census results help to clarify the favored habitat and the community setting of the pink planarian. The main stream is of relatively high gradient (for Midwestern cave streams) and consists of alternating pools, with predominantly fine sediment, and riffles, with predominantly larger clastics. In the higher gradient rapids the clastics tend to be well cemented, wildlife in general is relatively sparse, and no planarians were ever observed. Planarians were also never observed on the sandy/silty floors of pools. The most favorable setting for planarians were low-gradient gravelly/rocky riffles, where the stream bed, although well compacted, was not as highly cemented as in the steeper rapids. Planarians were most frequently observed beneath rocks—some indi¬viduals were observed in the open, but always in a setting closely surrounded by rocks. Planarians also occurred with some regularity beneath isolated rocks in shallow pooled areas.

The above observations can be quantified as follows, taking the sum of data for dark-zone planarian observations throughout the study, both within and outside the census plots:

- Underneath rocks in riffles: 78% [n=47]
- Underneath isolated rocks in pools: 8% [n=5]
- Exposed among rocks in riffles: 13% [n=8]
- Exposed in pools and on fine sediment: 0%
- Riffle habitat: 89%
- Pool habitat: 11%

Community structure

Figure 3 shows the combined census data for all dark-zone rocky plots. Since the area of habitat searched and the total search effort varied from trip to trip, the data is adjusted for search effort. The data was also analyzed by adjusting for length of stream-bed searched, with broadly similar results. Note the different scales for abundant vs. scarce animals. There is no data for *Physa* eggs for September 2002.

The community is dominated by the troglophilic isopod *Caecidotea brevicauda*, which occurs in remarkably high densities, as high as 100/square meter,

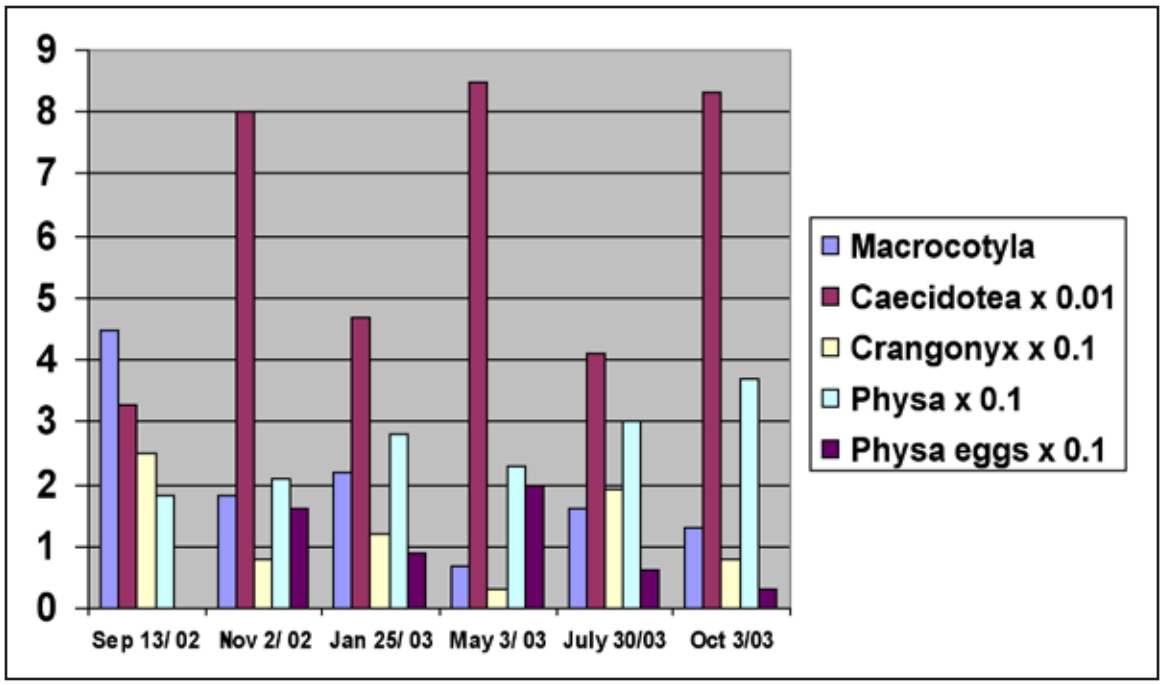
and made up nearly 94% of all animals counted. This is the least troglomorphic of cave isopods in Missouri, being eyed, somewhat pigmented, and relatively squat. The second most numerous animal is the troglophilic amphipod *Crangonyx forbesi* (4% of total animals). Usually in Missouri this amphipod is restricted to near-entrance situations; it is unusual for it to be so abundant in a deep cave site. This too is probably an effect of high nutrient loading in the stream. A small aquatic snail, an unknown species of *Physa*, is also abundant (2% of total animals), and its egg masses were also conspicuous. Snail and snail egg abundance was noticeably higher in more turbulent sections of the stream, provided there were sufficient loose rocks. Rarer fauna include animals which may nevertheless have ecological importance for the flatworm, especially the Northern crayfish *Orconectes virilis*, which occurs regularly but was rarely counted within a census plot. The crayfish is a trogloxene with few obvious cave adaptations. It is widespread throughout eastern North America, usually in surface settings.

The trends within individual plots, whether corrected for search area or for search effort, are broadly similar to the overall rocky plot trends. Seasonality is apparent for some of the fauna.

Tributary streams

No planarians were observed in any of the three side passages; moreover, there seem to be no previous records of planarians in any of the cave's tributaries. The streams examined were all considerably lower in volume than the main stream. They also had significantly lower population densities, although the population make-up was very similar to that of the main stream. In the Rollercoaster, an interesting troglomorphic *Caecidotea*, clearly differing from the predominant *C.*

Figure 3: Census data for all dark-zone rocky plots (corrected for number per person-hour search effort).



brevicauda, was collected from under a rock, and another was observed in the Left Fork—this is discussed in more detail below.

There is no obvious reason that planarians would not use the tributary stream habitat—although the densities of potential prey animals are less than in the main stream, amphipods and isopods are still abundant. The apparent absence of planarians from the tributaries is of concern, since if the main stream population suffers a catastrophe, there may not be sub-populations available to repopulate the habitat.

Baiting

In no case was *Macrocotyla* found at bait. In retrospect this is not surprising, in view of Kenk's finding that *M. glandulosa* would take only live food. It should also be noted that baiting is not a substitute for counting census plots when it comes to defining community make-up, as fauna is attracted to bait to different degrees and at different rates. For example, the species make-up at the bait stations after 24 hours showed far higher numbers of *Crangonyx* than *Caecidotea*, the converse of what was observed by counting the census plots.

Sediment excavation

No planarians were found buried in either the fine sediment of pooled areas or within the gravel/rock substrate of riffles. The riffle substrate was found to be very compacted and difficult to move, and no macroinvertebrates were observed.

New stygobite

The isopod collected from The Rollercoaster was far more troglomorphic than the predominant *C. brevicauda*: the specimen was white, slender, and had relatively long antennae and uropods. The specimen was a male and appeared to be mature, allow¬ing the possibility of a positive identification. The specimen was examined by Julian Lewis (J. Lewis Associates) and was judged to be an undescribed species of *Caecidotea*. Thus, Devils Icebox has not one but two endemic stygobites. The troglomorphic *Caecidotea* seems to be exceedingly scarce. That none were observed in the main stream over a total of 25 person-hours of observation suggests that the species is largely restricted to the tributary streams (although the main stream may provide a route for genetic interchange between side passage sub-populations). It is likely that the eutrophication of the main stream, and the overwhelming dominance of the latter by *C. brevicauda*, precludes the troglomorph by competitive exclusion. A case can be made that this species is more acutely endangered than the pink planarian.

Conservation and future outlook

The scenario of a stream environment with continued unnaturally high levels of nutrient does not bode well for the continued well-being of *Macrocotyla* or the stygobitic isopod. If nutrient levels in the stream increase further, it can be predicted that the community structure will tend to shift further in the direction of less cave-adapted species, putting further stress on the endemic planarian and isopod. There are many potential mechanisms by which this could occur—one plausible one would be via an increase in crayfish numbers resulting from increased isopod and amphipod numbers, thereby potentially increasing predation pressure on the planarian. Increases in *C. brevicauda* numbers alone would put additional competitive

pressure on the endemic isopod. Preventing further deterioration of water quality will not necessarily be sufficient to ensure the long-term viability of either species. It is likely that both rare species are under stress from nutrient-tolerant competitors and predators.

Recommendations

Recommendations include establishing routine counts at six-month intervals of the three 5 m census plots identified as having the highest planarian numbers. In our experience, naïve helpers were able to quickly learn to distinguish the common elements of the stream fauna. Since eutrophication of the stream is a likely factor in planarian viability, it would be helpful to continue to monitor overall stream fauna numbers, especially those of *Caecidotea*. Another advantage to doing a full species count is that it forces the counter to move more slowly. It is important that it be stressed to volunteer assistants that the objective is to obtain a reliable count, not to move through the census plot as quickly as possible. Although the planarians are (relatively) large, conspicuous animals, we demonstrated on several occasions that it is possible to overlook one.

Although we did not keep close track of *Orconectes* numbers during the study, this would be useful and relatively straightforward data to collect. Since the crayfish may well be a significant planarian predator, tracking its relative numbers might give some additional insight as to whether stress on the planarians is increasing, decreasing, or stable. A total count of all crayfish encountered along the routine route should be feasible.

The karst window should be monitored as convenient, for planarians only, using timed counts within the large expanse of rocky habitat. Although our preliminary data show that planarians here are scarce, this is balanced by consid¬erably less investment of time and effort compared with an in-cave trip. At least one person-hour should be invested per count, and the total search time should be standardized.

Additional efforts to search for planarians in tributary streams, including streams not examined during the present study, would be desirable. It would also be beneficial to search for planarians along the main stream beyond the limit of the present study in order to get a broader picture of planarian dis¬tribution within the cave as a whole.

Follow-up studies on the troglomorphic isopod would be desirable. Although the specimen collected was an apparently mature male, additional speci¬mens would be required in order to describe the new species. Given the scarcity of the isopod, it may not be a trivial matter to obtain additional mature male specimens. One post-study trip to the two passages where the isopod was seen did not discover any more (Bill Elliott, pers. comm.).

The single factor which would be most likely to ensure the continued existence of both the planarian and the new isopod would be improvement of stream quality, or at a minimum, preventing further deterioration. Of course, this is a socio-political issue beyond the immediate control of Missouri Department of Natural Resources (DNR) staff, but the State agencies nevertheless have a significant role to play, especially in the areas of education and public outreach. Consideration should be given to adding *Macrocotyla glandulosa* to Missouri and federal endangered species lists.

Acknowledgements

I would like to thank the staff at Rock Bridge State Park, especially Roxie Campbell, who did the lion's share of trip organization, arranging for volunteer assistance, and helping with the field work. Thanks also to Scott Schulte at DNR and Bill Elliott at the Missouri Department of Conservation (MDC) for helping to set up the project, and to Kat McCarthy for field assistance. This project would not have been possible without the enthusiastic group of field-work assistants, comprising a combination of DNR staff, DNR volunteers, CRF members, and MDC interns. I especially thank Sue Hagan, who took part in every trip, and also: Jessie Bebb, Kathy Christiansen, Kat McCarthy, Jeff Page, Steve Samoray, Mike Slay and Darla White. Thanks also to Bill Elliott, David Ashley and Bob Lerch for their input and enlightening discussions.

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RESISTIVITY SURVEYS AT FORT STANTON CAVE

Lincoln County, New Mexico, March 2004

John McLean

Introduction

A series of experimental geophysical measurements beginning in 2000 have been made near Fort Stanton Cave in support of John Corcoran's digging project. The project, including the geophysics, has been supported by members of the NSS, SWR, BLM, and CRF who have generously provided field support for the often slow and tedious data collection. Initial surveys of the

area were made using a passive system of measuring the natural potential (voltage) differences along lines across the cave using non-polarizing electrodes. These measurements have shown that a positive-to-negative transition from east to west is sometimes associated with known cave passages (McLean, 2002). A natural-potential survey of the area south and west of the end of the Bat Cave passage of Fort Stanton Cave conducted in 2002 and 2003 gave somewhat ambiguous results, so active resistivity measurements using a dipole-dipole array were begun in April, 2002.

The active system incorporates a line of metal electrodes that are driven into the ground. A battery-powered source injects a constant current through two electrodes, and the voltage difference (potential) is measured sequentially between all the other pairs of electrodes. Current is then injected into the next pair of electrodes and the process is repeated for all the electrodes.

Data were analyzed initially using a free semi-demo version of the program Res2dinv (Loke, 1997). This program gives an estimate of the resistivity distribution within the earth presented as a profile similar to a geologic cross section. Later, Dr. Barbara Luke at the University of Nevada at Las Vegas (UNLV), made a final analysis incorporating topography with the full version of the program. Dr. Luke also brought a commercial resistivity system to the August, 2003 expedition. The data collected with the latest 'home-built' system compare favorably with the data collected by the commercial system.

The twenty-nine resistivity lines that have been run successfully are discussed in a report to the Bureau of Land Management. A copy of this report is available by email or on CD-ROM from johnmclean@interfold.com.

Interpretation of Resistivity Profiles

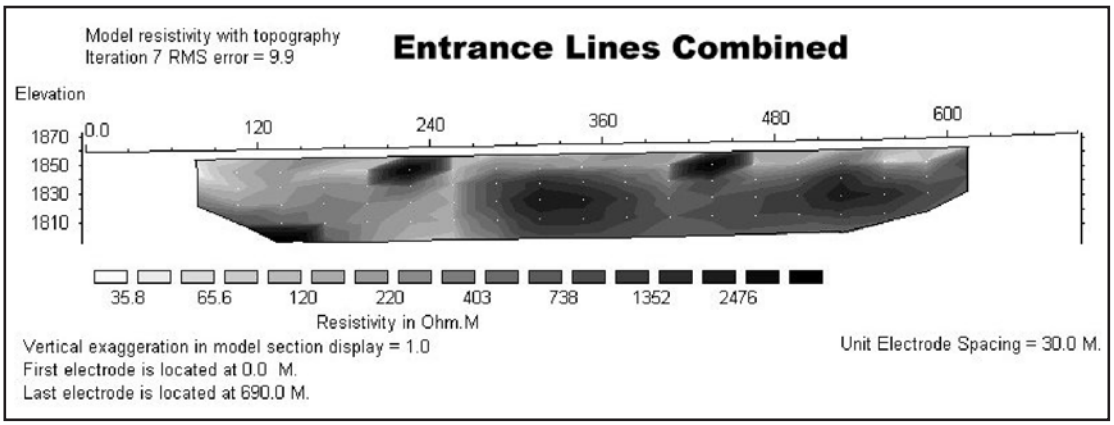
Several limitations of the resistivity method must be remembered when interpreting the resistivity profiles. First, the electric current occupies the entire volume of earth between and near the electrodes. This means that the interpreted profile is affected by resistive zones to the side of the line as much as by zones beneath the line. In the extreme case, a sinkhole or canyon 10 meters to one side of the line would appear to be a cave 10 meters below the line. Second, the resistivity technique, in common with most geophysical methods, cannot uniquely identify a feature. An anomaly can be caused by air-filled spaces in breakdown piles, small solution passages located close together, or (we hope) large individual cave passages. Third, the ability of the technique to resolve a feature varies with electrode spacing. Closely spaced electrodes can detect shallow caves, but will not extend the interpreted profile deeply enough to detect deeper caves. Conversely, widely spaced electrodes can detect deep caves, but only if they are large; while small, shallow cavities may be overlooked. The profiles are reproduced in gray scale, and presumptive caves are shown in black.

Resistivity Profiles

Several profiles were run over known sections of the cave to evaluate the success and limitations of the method.

A profile near the entrance of the cave (Fig. 1) shows the entrance sink at about 240 meters and the Circle Route between about 300 and 360 meters. In addition to these known cave passages, the section indicates a possible passage

Figure 1



(named the 'camp anomaly') at about 510 to 540 meters at a depth of about 35 m, similar to the depth of the rest of the cave in this area. A shallow feature is also present along the line at 420-450 m, and there is an indication of a possible deep passage at the west end of the line (120 m). There is no known connection from Ft. Stanton Cave to these latter features.

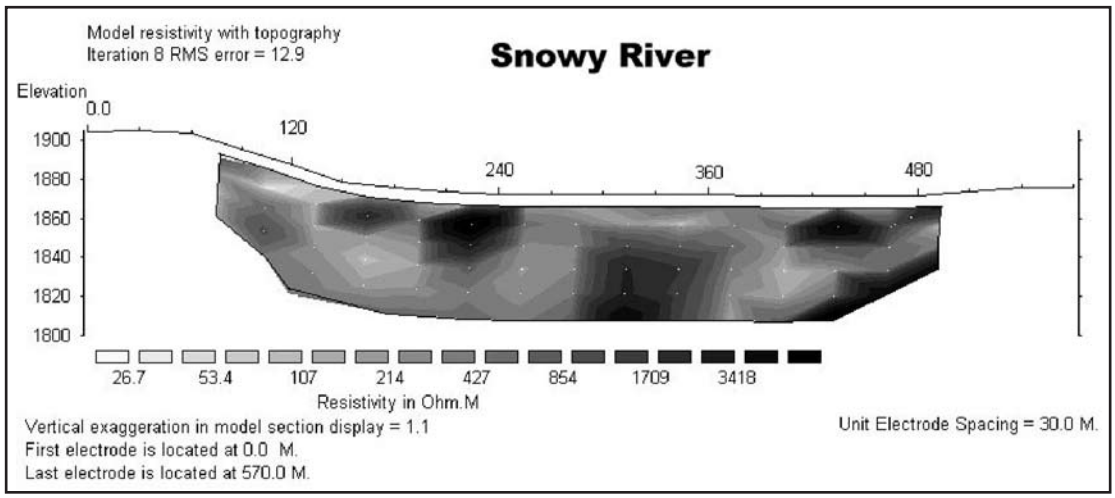
An even better way of validating the resistivity method is to locate a resistivity anomaly and later prove it to be a cave passage by connecting it with known cave passages. This occurred when a line was run along Big Tank Canyon after the Snowy River passage was discovered, but before the passage was explored.

The profile of this line (Fig. 2) shows an anomaly at 330 m that was determined to be coincident with the Snowy River passage when the survey within the cave was extended to the south. Anomalies at 110 m and 220 m are close to the south end of Skyscraper Domes and the breakdown pile at the north end of Don Sawyer Hall. A deep anomaly at the east end of the line was explained when the Metro passage was discovered and determined to pass under the east end of the line.

Likewise, the profile (Fig. 3) of an east-west line across a valley south of the previous line has a large central anomaly that later was found to coincide with the beginning of the Mud Turtle passage.

Several lines were run across areas where there were no known cave passages. A surprising number of them located large, shallow anomalies that appear to be breakdown domes above deeper passages. One of these (Stagecoach Road

Figure 2



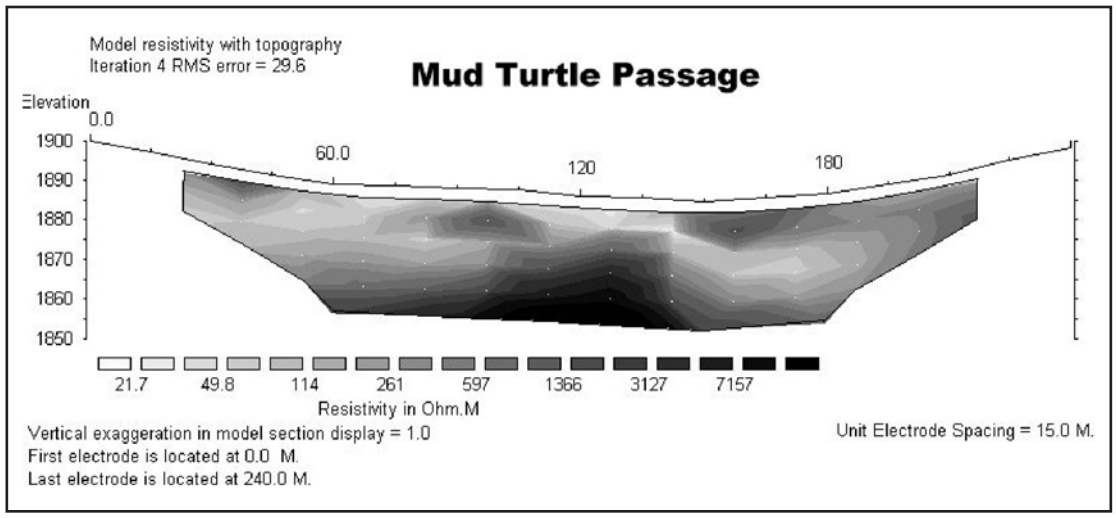


Figure 3

anomaly, Fig. 4) underlies a road just south of the cave entrance road.

Several lines south of an area between the Bat Cave and Hell Hole Two passages identified scattered resistive zones. The first line, Hell Hole Two Line 1 (Fig. 5), run with the UNLV Sting system shows a large resistive anomaly beneath the center of the profile at a depth of about 20 m with an upward extension that may come within 10 m or less of the surface. The extent and continuity of this anomaly indicate that it is probably a large cave passage. There is no surface expression of this feature, as it is beneath a smooth hillside covered with dirt and gravel.

Summary and Conclusions

The dipole-dipole resistivity method works well in the area of Ft. Stanton Cave. Known passages could usually be located, and resistive anomalies on some profiles were later discovered to connect with known cave passages. The horizontal locations of the passages appear to be accurate within the limitations imposed by the electrode spacing, however the method is not as well suited to estimating depth. Although some anomalies agree with the passage depths, in some cases

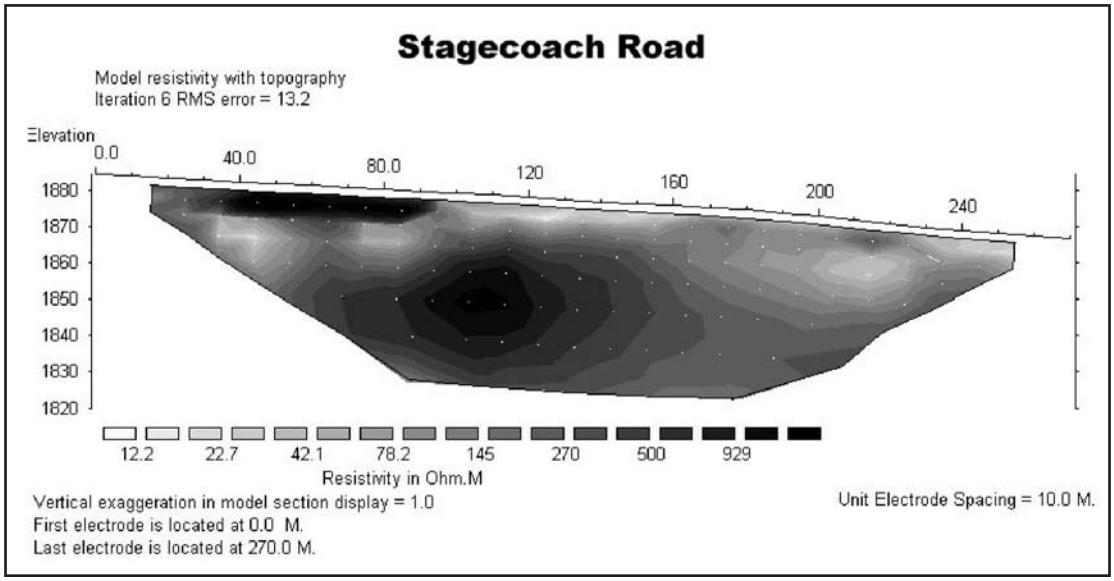
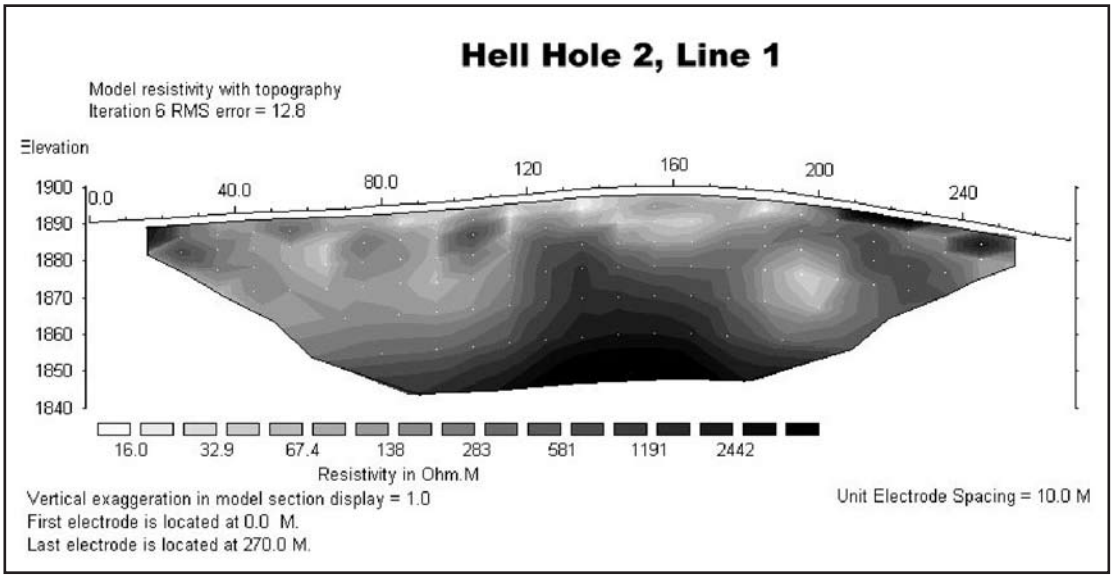


Figure 4

Figure 5



the passages are as much as twice as deep as the anomalies shown on the profiles.

The results of the resistivity surveys indicate that only about half of the passages in the immediate vicinity of Ft. Stanton Cave have been entered. This observation agrees with the fact that so much of the known cave has been discovered by digging through collapse zones or sediment-filled passages. The complex history of sediments in the cave, revealing several episodes of sediment filling and re-excavation (Baer, 1972), also indicates that there are likely to be passages isolated from the known cave by unexcavated sediments.

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ANALYSIS OF CERAMICS FROM CUEVA DE LAS PINTURAS

Petén, Guatemala

This work was supported by a 2002 CRF Fellowship Award to

Ann M. Scott

In 2002, the Cave Research Foundation provided funding to analyze ceramics recovered from the archaeological cave site of Cueva de las Pinturas, located about 15 km south-southwest of Flores, Petén, Guatemala (Figure 1). The cave consists of a large, impressive entrance chamber along with two side passages (Figure 2). The site received scientific attention because it is only the fifth Maya cave found to contain hieroglyphic inscriptions (Mayer 1995). The main panel of inscriptions is polychrome, painted in red and black on a yellow background directly on the cave wall (Figure 3). This is the only known example of polychrome cave glyphs in the Maya area. Limited investigations of Cueva de las Pinturas were conducted in 1997 by a team of specialists focusing on cave mapping, photographing the inscriptions and features, as well as some excavation and artifact recovery (Brady et al. 1997). They reported extensive architectural modification to the passages extending to the north-west, in the form of many constructed stone walls, the largest of which (14 m long) restricted access into the passageway.

A portion of the ceramic assemblage collected in 1997 was made available for analysis during the summer of 2002. Using the type-variety classificatory system, the analysis recorded data on a number of attribute categories including: vessel form, rim form, rim diameter, basal diameter, maximum thickness (rim, base, or body), and interior and exterior finish and color (using Munsell Color Chart book). Paste was also examined with a 10x eye loupe recording paste texture and color (using Munsell book), presence of carbon center, and temper color, shape, type, and grain size. The analyzed ceramics were photographed using a digital camera.

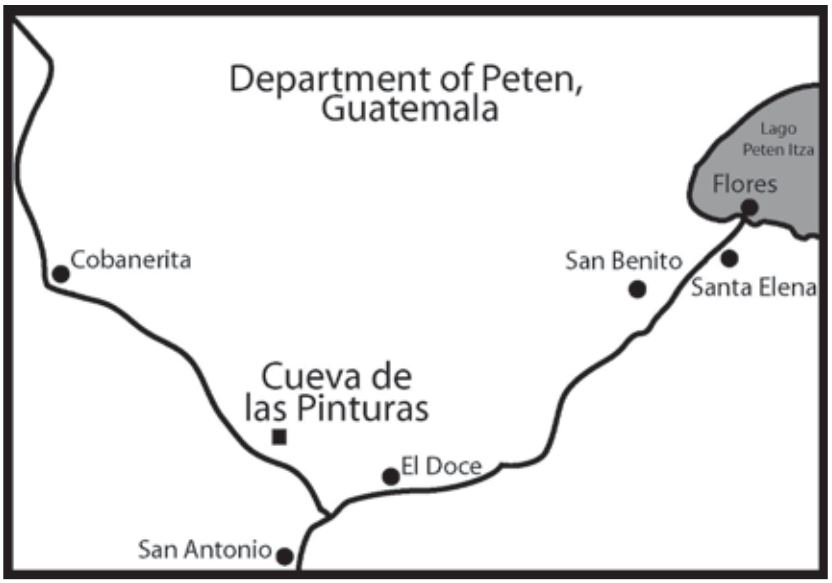

Figure 1. The location of Cueva de las Pinturas in Petén, Guatemala.

The majority of the ceramics fell into the Paso Caballos Waxy Wares and consisted mainly of red to orange slipped monochromes (Sierra Red) and white to light brown waxy slipped Flor Cream. Vessel forms included bowls, plates, jars, and a cup. All of this material falls into the Chicanel Ceramic Sphere dating to the Late Preclassic [300 B.C. – 300 A.D.]. A limited number of Tecomate forms with Joventud Red slips were encountered. These belong to the Middle Preclassic [900 – 300 B.C.] Mamom Ceramic Sphere. A radiocarbon date from strata producing the tecomates suggests an age between 350 – 300 B.C. (Brady et al. 1997).

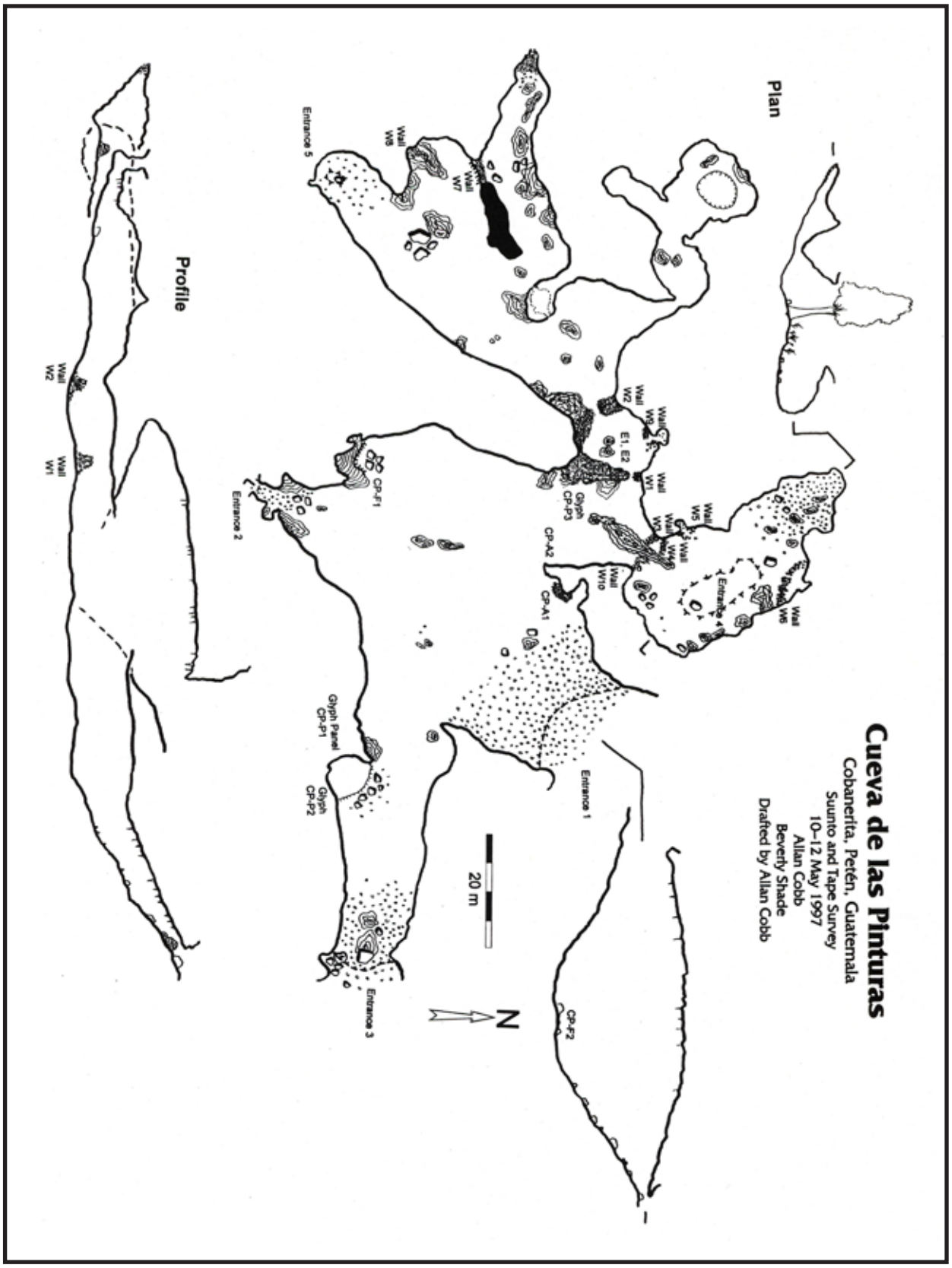

Figure 2. Cave survey map of Cueva de las Pinturas.

The most recent material was represented by eight vessels exhibiting tetrapod mammiform supports. Most varied in color from red to red-brown to orange brown and were classified as Aguacate Orange or Gavilan Black-on-orange depending on the surface treatment. Several carried a Flor Cream waxy slip typical of Late Preclassic material. The mammiform supports as well as the black-on-red and black-on-orange decoration are diagnostic of the protoclassic ceramic stage [75 B.C. – A.D. 400] (Brady et al. 1998) (Figure 4).

Significance

This study of the ceramic assemblage from the Cueva de las Pinturas suggests that utilization of the cave dates from at least the end of the Middle Preclassic. This is significant in that little Middle Preclassic material has been reported from Maya caves. Utilization appears to have been most intense during the Late Preclassic judging by the amount of ceramic present. The most interesting component is a well represented protoclassic assemblage. The identified types and lack of any gloss wares in the cave indicates that the assemblages belong exclusively to the Early Phase of the protoclassic. This suggests that utilization of the cave ceased before A.D. 150.

Figure 4. An example of Early Phase protoclassic ceramic (Sacluc Black on Orange). Ann Scott photo

Figure 3. Polychrome style Maya hieroglyphic inscriptions in Cueva de las Pinturas measuring approximately 4.5 m long by 1.5 m high. Ann Scott photo

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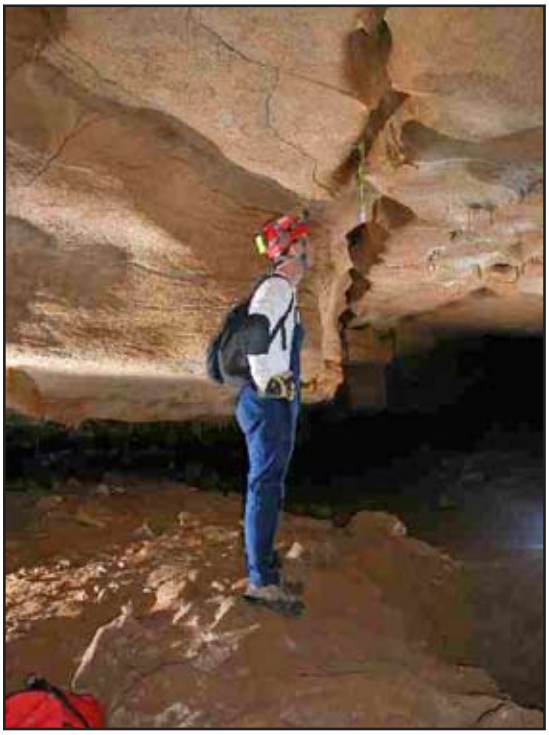
ASSESSMENT OF LOW COST DATA LOGGERS FOR TEMPERATURE MONITORING IN CAVES

Pete Lindsley

Abstract: New higher resolution data loggers called iButtons sparked an interest in demonstrating that they could be used in caves for air temperature studies. By using a Palm Pilot with a program called iTemp the author was able to both download timely data in the cave and also re-mission each unit as appropriate. The initial work, which was done in 2002 in a South Texas cave, showed promise and an application was made in the fall of 2002 to run a feasibility project in Fitton Cave, Arkansas. An 18 month project was approved and the first units were introduced in the Ozark cave in early 2003. The units were serviced both during regular CRF survey expeditions and other special trips during 2003-2004. In January 2005, most of the units were transferred back to South Texas where they are being used to simultaneously track temperatures in three related caves.

Figure 1: Will Harris inspects an iButton positioned for air temperature measurement in Fitton Cave.



The Cave Research Foundation supported an iButton study at Buffalo National River in 2003 and 2004. The objective of the study was to investigate the effectiveness of small iButton temperature data loggers when used to conduct studies in a cave and answered the questions:

- Where to place the iButtons?
- How to label and mount the units?
- Will the units survive the environment?
- Are the units suitable for bat studies or air movement studies?
- Can the units be downloaded and re-missioned in the cave?
- The iButton units are much smaller and also less expensive than the more widely used "Hobo" units, and if it could be shown that they are practical for use underground in the cave environment it could impact future temperature studies.

Some of the practical uses in caves might include the following:

- Monitor the temperature of cave areas frequented by bats to learn why different species favor different areas. This sort of study is usually done using Hobo units, which also record the humidity, a potential limitation of the iButton units. By using several iButtons in addition to a primary Hobo unit in hibernacula, additional temperatures could be monitored to detect changes due to air velocity. If located near the cave entrance, small temperature changes could be synchronized with the changes in outside conditions caused by weather patterns.
- General temperature analysis of a cave system over a period of time. This might be of interest in a very remote cave that is visited only once a year. For instance, if the entrance is a spring that is only open part of the year during the dry season, temperature logging could better define open periods. If

installed at different potential water levels in the passage, data could be obtained to correlate water levels in the cave with surface conditions such as snow melt or floods (assuming flood waters differed slightly in temperature from the air).

- Cartographers of extensive cave systems could use iButtons to better understand the movement of airflow inside the cave, including hidden passages. For caves with breathing entrances, where the flow direction changes from time to time, synchronizing the temperature at multiple locations in the cave can provide clues to the relationship of different passages.

Hardware: An iButton looks like a watch battery on steroids. Each iButton has a unique serial number that is read when the iButton is downloaded or programmed. This same number is laser-etched on the external case. For this study the units were attached to a plastic tag with the researcher's contact information plus a statement that the unit was part of a cave study. The tag also had a serial number for easy reading in the cave. The tags were tied to the wall with nylon cord or were screwed to the cave wall with drywall screws to prevent theft by cave vermin.

For wet caves it may be advisable to place the units inside plastic baggies. Heavy-duty plastic clips are also available and were used on the units installed to trees outside the cave.

A main impetus for this study was that new higher resolution iButtons became available in 2002. Previously Bob Buecher had used the lower resolution units to monitor the long-term air temperature of a cave in northern Arizona. Rick Toomey had also used the low-resolution units to monitor the rock temperature in Kartchner Caverns, also in Arizona. The improved resolution of +/-0.225o F plus maximum storage of 2048 data points, and the ability to download the units in the cave now made the iButton units more than just a toy and probably of interest to a greater number of cavers all over the world.

Figure 2: The iButton case looks like a large watch battery. They were mounted on tags for the experiments in the caves.

Newer iButton units became available in 2004 with +/-0.11o F resolution and 8K data point storage space. In addition, humidity units also became available in 2004 that include the higher temperature resolution and 8K data point storage space.

The easiest way to get started with an iButton project is to purchase one or two

Figure 3, left: The Palm M515 with rechargeable batteries was the main PDA used; the color screen was easier to see in the cave. A custom pigtail serial connection to the iButton Blue Dot adapter made the whole package smaller. The iTemp software allowed non-volatile backups to the SD Card memory card. Either a titanium PDA case or a small Pelican box was used to carry the Palm and camera in the cave.

Figure 4, right: One of the lessons learned was to have a backup PDA on long trips in case a defective cable or iButton unit caused a problem with in-cave missioning. This Palm IIIxe with a monochrome screen required a different serial adapter for the older PDA unit. It connects to the same iButton Blue Dot adapter and used two Alkaline AAA batteries.

starter kits from Maxim Semiconductor. The main web page of interest is located at: http://www.maxim-ic.com/products/ibutton/ibuttons/thermochron.cfm and the starter kit information is at: http://www.maxim-ic.com/products/ibutton/products/kits.cfm. The DS1921K starter kit with instructions, which can be ordered online, includes:

- DS1921L-F51 Thermochron iButton
- DS9093F iButton Key ring Fob Attachment
- DS9490R 1-Wire to USB Adapter
- DS1402D-DR8 Blue Dot Receptor with RJ-11 Connector

Software: When you first order the starter kit for the iButtons you will either get a CD with PC software that can talk directly to the iButton unit via a serial port through the blue dot connector, or you can download the appropriate PC software from the iButton site. For cave use you will probably prefer to use high-resolution units, which require compatible software.

An Internet search will yield several possibilities for PDA software that will allow remote access to the iButton units. The iTemp software for the Palm PDA was one of the first packages compatible with the new high-resolution iButtons and is a product of Digitsense. iTemp was used exclusively for this study and several modifications were made by Digitsense to improve its usefulness in the cave environment.

iTemp allows you to:

- Choose the time to begin temperature taking
- Set a sampling rate
- Set high and low alarm thresholds

Once the data has been sampled, iTemp allows you to:

- View a chronological log of the temperature data
- View a graph of the temperature data
- View a histogram of the data
- View the High and Low alarms, and the duration that the temperature was in an alarm state.
- Save the data to a database (Enterprise Edition only)
- Save the data to external memory: SD card, compact flash card, or MMC (Enterprise Edition only)
- Export the temperature data to a comma-separated value file (Enterprise Edition only)

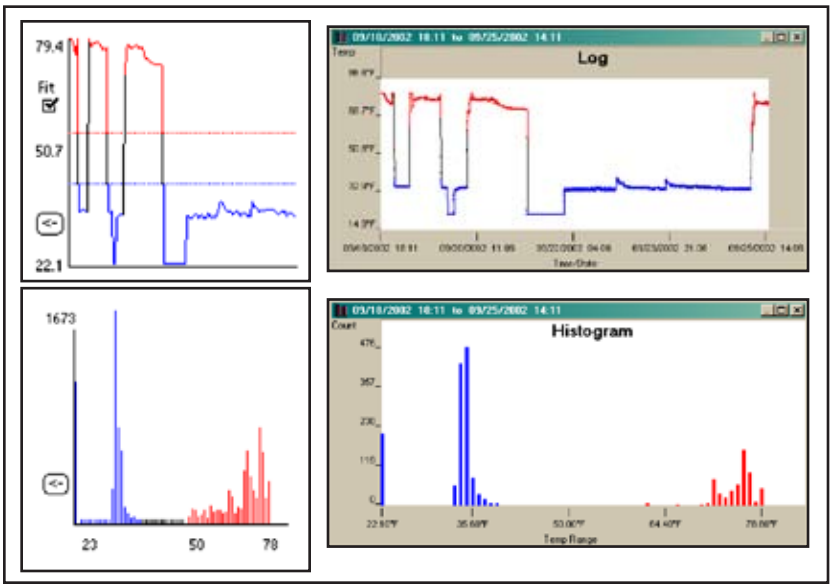
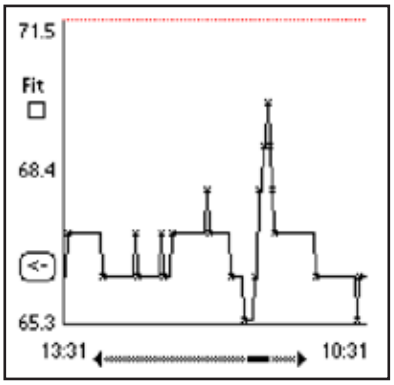


Figure 5: Screen graphs of the temperature data and a histogram for the Palm (iTemp) on the left and for the Maxim PC software on the right.

Typical Data Downloaded: The pictures below show the downloading of data at a crawlway constriction in a cave. All the exact temperature data can be reviewed and a graph formatted for the Palm screen can viewed. For important data it is prudent to both save the data to the PDA RAM and also in a text file to a non-volatile SD card. Screen shots of the graphs can also be saved for review in the cave or to aid in the data sorting following the trip into the cave. When the Palm is hot-synched with a PC, the individual data files are saved in a folder on the PC. These saved data files can then be processed by a

companion program that extracts the data into a comma-separated file format that can be directly imported into Excel. If you are not hot synching your Palm to a PC, the easiest way to extract the data is to use the text files saved to an SD card which can be read by any computer.

If you have a number of units taking data at the same time it won't take long to generate a large data set that now offers a challenge to display the results in a simple chart. For instance, 16 units each taking 2000 data points will result in over 32,000 points! The Excel graph below shows a typical data set with iButton units located outside an entrance showing daily swings in temperature, while the in-cave data is much more stable.



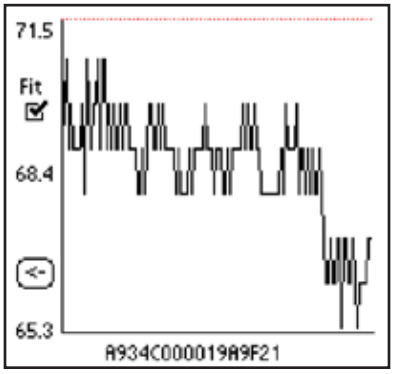


Figure 6, above: Downloading data at a crawlway constriction in a cave with a Palm M515 and Blue Dot connector. Screen shots are from the Palm iTemp software package.

Plan your iButton Mission: The most important part of installing iButtons in caves is the initial planning. You must decide what you are trying to monitor and how often you will be able to service the units. Since the units can be programmed for sample intervals between 1 and 255 minutes, you must decide on the proper interval. For instance if you want to correlate the air temperature with daily events such as the daily 24 hour sun cycle and run a study for a long time, by using a sample interval of 240 minutes (4 hours) you will get six data points per day for a

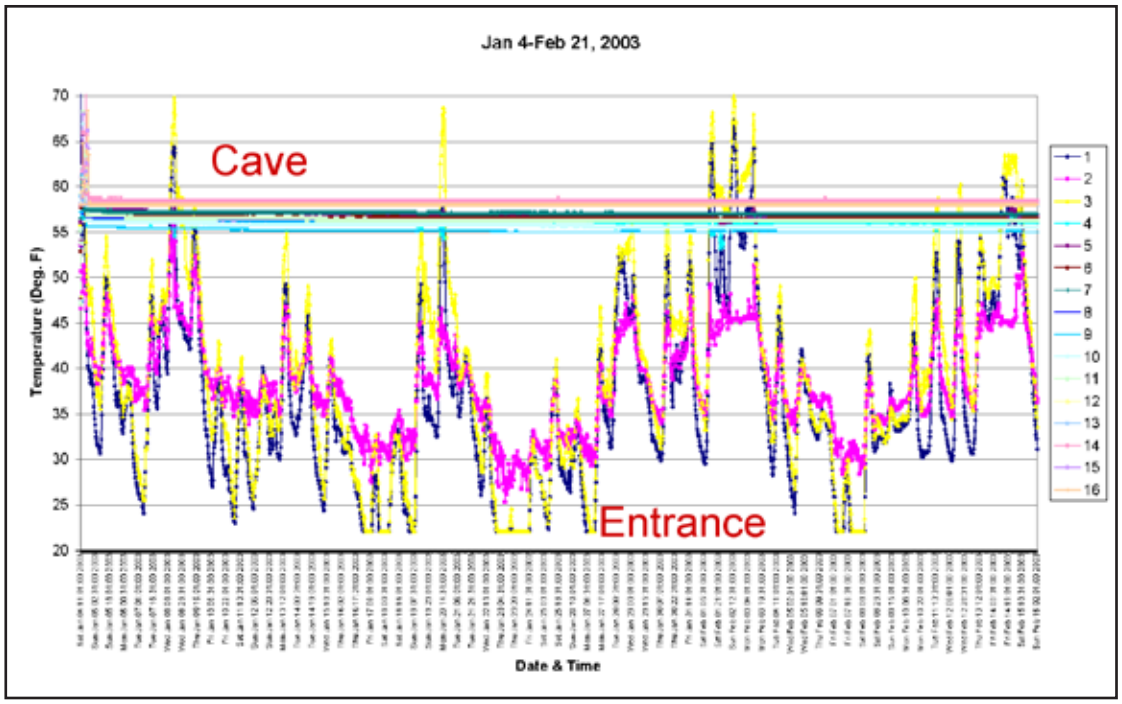


Figure 7, left: Seven weeks of raw data at Fitton Cave, imported to Excel

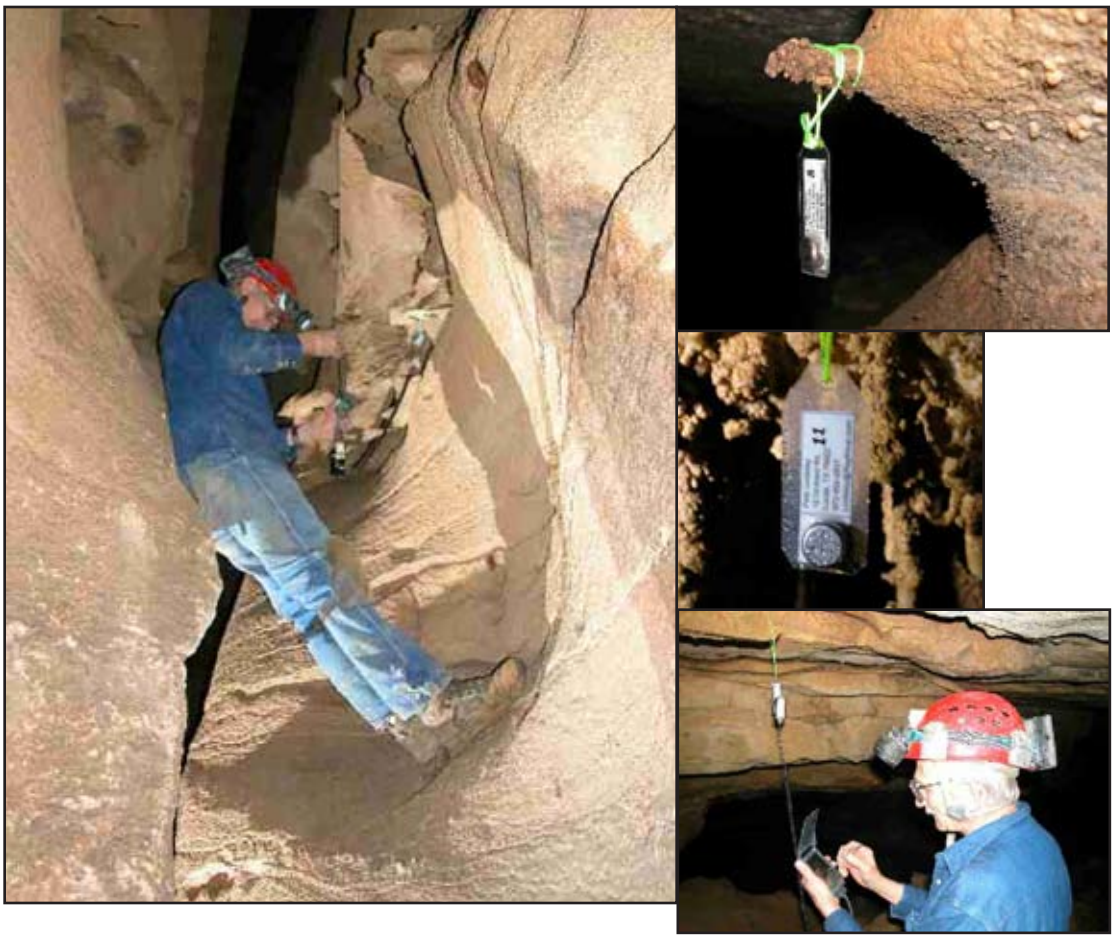


Figure 9: iButtons are glued to custom laminated tags with "Shoe Goo" or "Marine Goop", high quality silicon adhesive. Nylon cord used to loop tags to projections. Pete Lindsley using a Palm M515 to download data in the cave.

time period of almost a year. Such a data set was started in January 2005, in three related caves in South Texas with the goal of monitoring potential bat roost locations during 2005. Since you will be gathering a large amount of temperature data it may also be important to synchronize all your readings so that you will obtain simultaneous data at each point. This is easy to do by delaying the start of the first data point to the same time on the day following installation of all the units in the cave. For most applications you will want to set the devices to stop recording once the memory is full.

On the other hand if you are monitoring something like a storm surge of water passing through your favorite stream passage, a setting of four-hour increments could totally miss the event. If you are prepared to immediately visit the cave after the storm water passes through, it would be more prudent to set the devices to run continuously, perhaps with 10-20 minute intervals, and to overwrite the memory with just the most recent data. Here are some of the possibilities for iButton measurements:

Entrance areas

Establish relationship between weather and cave temperature

Monitor impact of human visitation, including volume of visitors in commercial caves

- Monitor influence of sudden weather changes including suspected entrances
- If the cave entrance is a spring that is only open part of the year during the dry season, temperature logging could better define open periods
- Profile temperature zones in vertical caves
- Several units can be used at different levels to determine change in water depth. Be sure to properly secure your units in flood zones!

Bat studies

- Hibernacula
- Long term studies to monitor temperature variation over the seasons
- Monitor times when the bats arrive or depart roost areas
- Relate temperature to number of bats

- Monitor the temperature of cave areas frequented by bats to learn why different species favor different areas

Airflow analysis
- Check blowing leads for possible connections to known cave
- Cartographers of extensive cave systems could use iButtons to better understand the movement of airflow inside the cave, including hidden passages
- Small temperature changes could be synchronized with the changes in outside conditions caused by weather patterns
- For caves with breathing entrances, where the flow direction changes from time to time, synchronizing the temperature at multiple locations in the cave can provide clues to the relationship of different passages

Plan mission time to coincide with trips
- 4 hour data interval runs for a year
- 10 minute interval runs for 2 weeks

Part of mission planning includes identifying where and when you place the iButtons. If possible tie each location to a survey station or at least provide a description so that if another person retrieves the units at a later time they will be successful in locating all the units. For some highly visited caves you might want to conceal the location of the units and you need good records.

Installation in Caves: Although usually you would mount the units to monitor airflow, you could also monitor the rock temperature or water temperature. Expect that many of your cave units will experience 100% humidity and may be covered with drops of water when you service them. You should plan to dry off the units before connecting to the blue dot connector. Pick a good location for Palm downloads without moving the unit's position. Be prepared to climb above the normal line of sight to place the units in obscure locations to minimize vandalism. Consider using screws to mount units near potential cave rat activity.

If you are interested in correlating the variation of cave temperature with the outside weather, pick a nearby tree far enough away from the entrance airflow to provide an adequate baseline. Drywall screws are convenient methods for attaching the external units. Remember that if you are planning to monitor the outside temperature with high-resolution units, you may require a pair of iButtons to properly cover the temperature swings over the seasons. Likewise, don't plan to install a high temperature high-resolution unit in a cold cave that may be out of range of the iButton.

Buffalo National River Project: iButtons were placed just outside and inside two entrances at the start of the study. Additional units were placed inside the cave at several major junctions and along trunk passages. As expected, temperature variation a few feet from the entrance was strongly related to outside temperatures. A mile deep in the cave the temperature was quite stable, varying by only 1 or 2 degrees.

The primary impetus to initiate this study was the availability of new units that had improved temperature resolution suitable for tracking the expected small temperature changes in caves. The premise at the start of this study was that the units would only cost $10-15 each in quantities of 25-30. Unfortunately that amount had increased somewhat, but a close inspection of the product information available on-line indicated that newer units were now

Figure 10: iButton units mounted to trees external to the cave monitor the local weather.

available that provide additional features including 8000 data points (instead of 2000) and humidity measurements in conjunction with high resolution temperature.

In this study the best iButton unit for Fitton Cave, with its average temperature of 54-58 degrees F, is the DS1921Z-F5. For use in warmer caves the DS1921L-F5 should be considered. For correlation with outside temperatures that are expected to vary widely, it may be more practical to use a single unit (such as the DS1921G) that will cover a broad temperature range even if it has a slightly poorer resolution of 0.5 degree C. The units just mentioned have an approximate cost of $25 in small quantities and all have memories that can hold 2048 data points. New units that hold four times as much cost around $50. Another new unit (DS1923) with the larger memory plus a humidity function costs around $100.

Lessons Learned:

- Although the iButton units can be pre-programmed external to the cave environment and exchanged with alternate units on a periodic basis, the number of locations in the field can be doubled by the use of real-time data download and re-mission capability of a PDA in the cave. If multiple caves are being studied, a re-mission of the units external to the cave becomes more practical.
- The cave environment can cause failure of computers and cables and the researcher should plan to suitably protect the equipment and consider the use of spare cables and PDA units, as well as backup iButton units. One of the units positioned under a rock on top of gypsum sand failed in a manner that also hung up the PDA. Caution, a full PDA reset in the cave might delete important data. You would be well advised to learn how to reset your PDA computer at different levels so that you can more easily recover from a crash in the cave and not lose previously downloaded data.
- In-cave failures of two out of 12 iButtons were most likely due to moisture. Attempts to access these units in the cave also caused the PDA to lock up. Protection of the iButtons in a waterproof plastic bag should be considered for wet caves.
- A third unit was declared missing and only the nylon cord was found after being chewed into two places, most likely by a cave rat. Another unit that was left in a South Texas cave was also lost, probably due to flood waters that washed the unit down into a breakdown pile. The advertised life of the iButtons is approximately 8-10 years, so that if either of the lost units is found it still may be possible to recover the data set.

Conclusions: The use of iButtons in the cave environment is certainly of great value due to their small, rugged packaging and precision of measurement.

In addition, by using the iTemp Palm PDA application, it is possible to evaluate the in-situ results and modify the mission based on previously measured data or new goals. The best iButton unit for Arkansas caves, with an average temperature of 54-58 degrees F, is the DS1921Z-F5. For use in warmer Texas caves the DS1921L-F5 should be considered.

The baseline study was successful and a new study was initiated in January 2005, in the Texas Cave Management Asssociation's Punkin Cave and Deep Cave and features

- Units placed near bat roosts
- Synchronized measurements, 6 samples a day.

Appreciation is expressed to both the National Park Service and to members of the Cave Research Foundation for their assistance and support of this study. In particular I would like to thank team members Chuck Bitting, Will Harris, Mike Pearson, and several others that provided field support and suggestions for the project. I also want to thank Scott Dreslinski at Digitsense for his valuable assistance on the iTemp software.

References: The iButton web page of interest to researchers considering their use in caves (or for other studies) is located at:
http://www.maxim-ic.com/products/ibutton/ibuttons/thermochron.cfm
http://www.maxim-ic.com/products/ibutton/

Cost: The cost of units used in the study was $25 / each for 2048 data point capacity. Although this cost has increased somewhat, quantity discounts are available and new units that hold four times as much cost around $50. Another new unit (DS1923) with the larger memory plus a humidity function costs around $100.

"Shoe Goo" or "Marine Goop", adhesive for bonding iButtons to plastic tags:
http://www.goopit.com/

Waterproof Pelican or similar boxes for transporting the PDAs in the cave were obtained from:
http://www.cases4less.com/
http://www.all-pelican-cases-4-less.com/detail_pelican_1120.html

iTemp software used with the Palm PDAs in the caves is featured at: *http://www.digitsense.com/palmos/itemp/index.asp*
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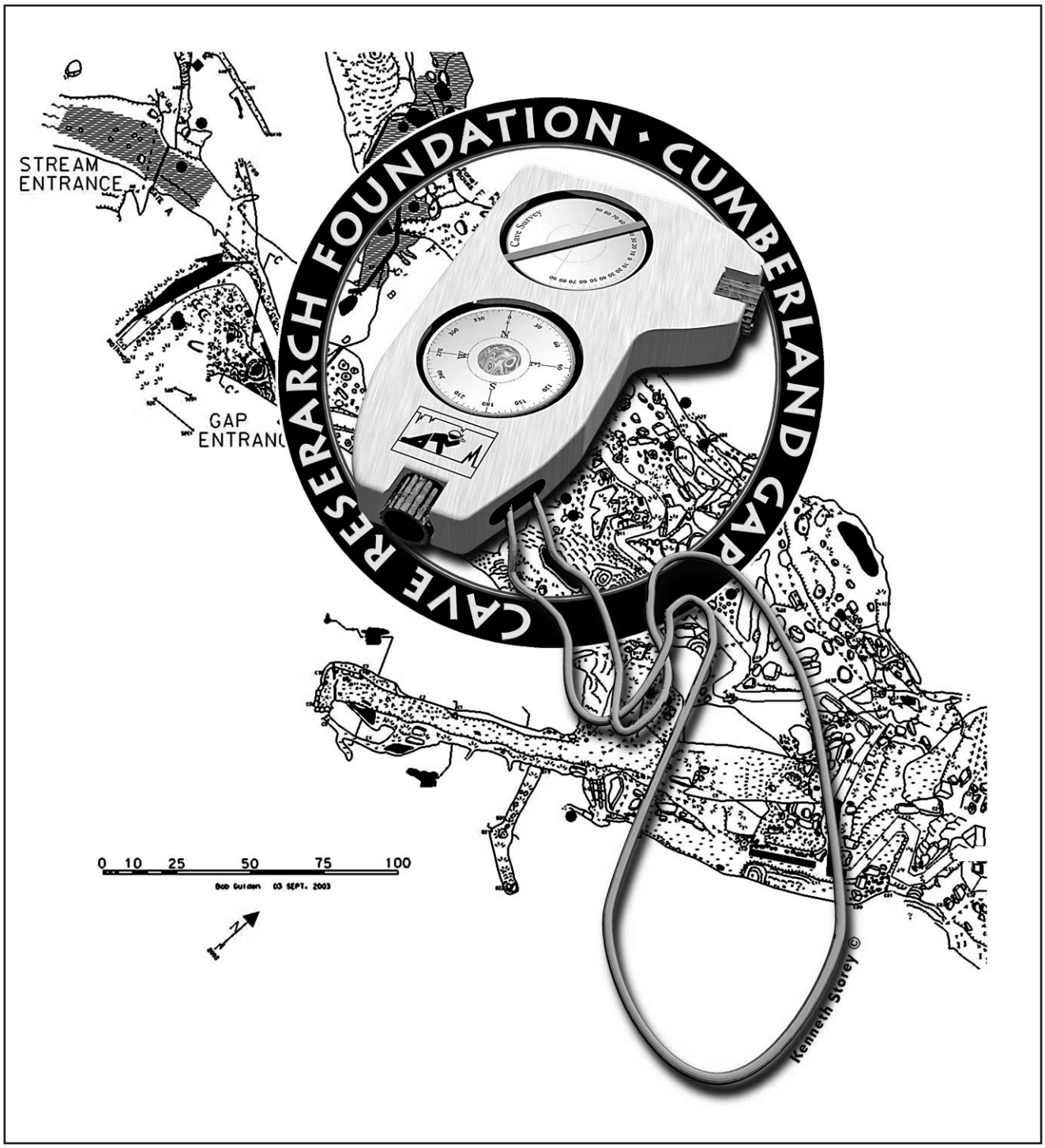

CRF Cumberland Gap Shirt
by Kenneth Storey

This shirt logo design includes a portion of the map of Gap Cave,
by CRF Cartographer Bob Gulden.

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