AMERICAN CAVING ACCIDENTS

IMPROVING SAFETY THROUGH 50 YEARS OF ACCIDENT REPORTS AND ANALYSIS

EXPLORE • STUDY • PROTECT
NATIONAL SPELEOLOGICAL SOCIETY
NSS
American Caving Accidents
50TH ANNIVERSARY EDITION
1967 - 2017

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Improving Safety Through 50 Years of Accident Reports and Analysis

Editor
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DISCLAIMER OF LIABILITY
Serious injury or death could result from use of the techniques, practices, or equipment described in this book. It is your responsibility to obtain for yourself qualified instruction in safe caving and cave rescue, understanding that even the best training only reduces, and does not eliminate, the risks of death or injury.

You assume the risk of injury or death by using the techniques, practices, or equipment described in this book.

About the cover:
Members of the Knoxville Volunteer Rescue Squad (left to right, Mike Greene, Mark Walker, Trevor Pickel) hone their cave rescue skills at the bottom of Ausmus Well in Tennessee. Photo by Chris Higgins. To see more of Higgins' work, visit www.chrishigginsphoto.com.

Photo next page:
Cave rescue practice in Maligne Cave, Alberta, Canada. Photo by Greg Horne.

Cover designs by Charlie Vetters.

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A Tribute to *American Caving Accidents*

During four-and-a-half decades of caving, I have found it enjoyable, educational, and meaningful to study each edition of *American Caving Accidents* (*ACA*). Upon reflection, it seems that *ACA* never ceases to provide laughter, learning, tributes, and remembrances.

Laughter because of those little incidents that have a happy ending, and that are embarrassingly familiar to most cavers that have gone underground for more than a time or two. An accidental slide down a muddy slope into a chilly pool of water. Then hopping back up, straightening your eyeglasses, and enduring the playful teasing of your teammates. A cup-over-teakettle tumble, planting you on your head, but surprisingly finding things none the worse for the wear. Starting a perfect rappel, and then having your partner point out that she is still holding your helmet in her hand. Frogging back out to near the top of a surface pit, and then realizing that you have left the cars keys conscientiously hidden under a rock near the bottom of the deepest drop. Lots of caving. Lots of experiences. Lots of smiles.

Learning by reading about the misfortune of others, and then applying those lessons to your future cave explorations. Being reminded that some incidents are catalyzed by a singular catastrophic calamity, while others seem to snowball from a series of little hiccups into something that is eventually out of control. As such, *ACA* serves as a tutor and as a mentor. Proving by written example the old adage, "Except by the grace of the good Lord, there go I." Raw experience certainly is a ruthless teacher. But, fortunately, *ACA* is a more benevolent one.

Tributes to cavers who survived scary events, and to the rescue personnel that saved them. Consider, for instance, an underground entrapment caused by unexpected flash flooding. It takes a lot of strength of character to hustle above the high-water mark, try to stay warm, marshal your resources, keep your spirits up, and hang in there for however long it takes for the water to go back down. It's a tough situation, testing the courage of the caver. Meanwhile, the rescuers (often including your cave-club friends) work relentlessly, fret, worry, rely on their training, fight through exhaustion, and hope for the best. *ACA* is replete with inspiring stories of cavers, and of rescue teams, who have endured much to bring everyone back home safe and sound.

Remembrances of people, of cavers, of friends, and of times that changed everything forever. Honoring those that are gone. Encouraging those that are left behind. Powerful stories, these. Moving words shared with the world through the mechanism of *ACA*. On a splendid day, two exceptional young men and their team journeyed to one of the greatest pits in the South. An open-air wonder, a speleo-classic, a frequently visited spectacular, a drop for the ages. Two young men, full of hope and of promise. Excellent students from one of the top technological universities in America. Positioned at the bottom of a 23-story-deep pit, and ensconced in the recommended safe place—under a sheltering overhang, and thus well protected from small stones accidentally kicked in by explorers from above. They did everything right; everything perfectly. Suddenly, without warning and totally unprovoked, tons of the pit wall immediately above the boys exploded from the geologic attachment point. And, in a twinkling of an eye, they were gone. The reasons for some things in life are unknown and unknowable. Perhaps God needed a pair of heroes like these two young men back in heaven—right now—for another important assignment. And he knew that the rest of us would be tough enough to handle the heartbreak.

Laughter, and learning, and tributes, and remembrances. All in a single written volume. Quite a publication indeed.

Dave Hughes, NSS 14550

EDITOR'S NOTE

Fifty years ago, NSS member Rane Curl was reading his latest issue of *Accidents in North American Mountaineering* when he had an excellent idea. Why not create a publication that records, reports, and analyzes caving accidents, similar to what the American Alpine Club had been doing since 1948? And so, in 1967, the National Speleological Society began collecting and reporting caving accidents in what was soon to become one of the NSS's most popular publications, *American Caving Accidents* (*ACA*).

ACA is more than just the journal of record for caving accidents in North America. It is a valuable educational tool for novice and experienced cavers alike. By reading accident and incident reports, cavers are reminded of, and often introduced to, the many things that can go wrong underground. Analytical comments are provided with most of the reports, and a wise caver will take the time to think about each report carefully. Is the incident something that could happen to you or to your teammate? Do you regularly carry the necessary equipment to deal with the emergencies reported in these pages? Do you know how to help a fellow caver who is stuck on rope, halfway up a 200-foot pitch or who has a fractured ankle?

This special 50th anniversary issue of *ACA* includes several feature articles, written by experts in their fields along with two years of accident reports. Whether you have been caving since before the first edition of *ACA* or you just joined the NSS, I am confident you will find something new, educational, and interesting in this issue.

At times, it may seem as if this book is one long promotion for the National Cave Rescue Commission (NCRC)—several of the contributors are NCRC instructors, many of the photographs are from NCRC training events, and you'll find the NCRC mentioned dozens of times in these pages. This is not intentional, but it cannot be helped; the NCRC is the world's leading cave rescue training organization. Every year, hundreds of cavers, rescue agency personnel, and land managers take part in NCRC trainings.

An obvious benefit of this growing interest in cave rescue is the increasing number of successful, small party rescues reported to *ACA*. My favorite recent example is the incident at Neffs Cave, Utah, in February, 2016. A caver dislocated his shoulder after completing several rappels in one of the country's deepest caves. Unable to climb out on his own, he was assisted by his teammates, who built counterweight systems and traveling hauls to get him up four pitches. This was accomplished with gear from one caver's pack. That caver knew how to build and operate different types of rescue systems because he had recently taken the NCRC's Small Party Assisted Rescue class. In fact, he had taken the class twice. Because of thoughtful rescue preparedness on the part of one caver, the patient was out of the cave and on his way to a hospital in less time than it would take for the county search and rescue team to even reach the cave entrance.

A few months later, I saw on social media that seven cavers, exploring deep within the Binkley Cave System in Indiana, were overdue, and portions of the cave were flooding. This was especially troubling news because some of those cavers are my friends. Yet I was extremely optimistic. The overdue cavers were all experienced. They had participated in rescue trainings and mock rescue scenarios. The local cavers who responded were some of the country's most experienced rescuers. All of that training paid off. The cavers underground took the appropriate actions to stay safe and warm while they waited for the floodwaters to recede, and cavers and land managers on the surface organized a response that adequately planned for a full-scale rescue without overtaxing resources unnecessarily.

Looking back on 50 years of *ACA*, a familiar message resonates through every issue—understanding what can go wrong underground can help cavers avoid getting in similar situations. But caving accidents will happen, no matter how careful or prepared we are. I hope in this book that an additional message comes through—when cavers are trained in technical rescue and wilderness medicine, the outcome of a caving accident can be vastly improved.

Bonny Armstrong, NSS 43003
Heber City, Utah

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B.A.

***American Caving Accidents* editors**
and the years they reported

Rane Curl 1967–1970

Jennifer Anderson 1971

Richard L. Breisch 1972–1975

Steve Knutson 1976–1993

William O. Putnam 1994–2005

Ray Keeler 2006–2010

Bonny Armstrong 2011–present

All issues of ACA *are available to NSS members at*
www.caves.org

Preparing to Win

Fifty Plus Years of Cave Rescue in America

Don Paquette NSS 8545

National Collegiate Athletic Association (NCAA) basketball coach Bob Knight frequently said, "The key is not the will to win…everybody has that. It is the will to prepare to win that is important." Since its inception the National Cave Rescue Commission (NCRC) has been doing just that. It is one of the more respected Internal Organizations of the National Speleological Society (NSS), but that has not always been the case. This article will attempt to chronicle the development issues and victories won by the NCRC as it evolved into what it is today. The opinions stated are completely the author's, and right or wrong, are mine and mine alone.

The buzz in the campground and in various discussions around the 1965 NSS Convention in Bloomington, Indiana, was the recent tragedy in Schroders Pants Cave in Manheim, New York, with the death of James Mitchell. The attempted rescue and failed body recovery was effected by the National Capital Grotto Cave Rescue Team, out of Washington, D.C., led by Bill Karras. The general opinion was that the group of cave rescue "heroes" swooping in on Air Force 2 and the subsequent publicity were an embarrassment to the NSS as a whole. In contrast, two weeks prior to the convention, Jim Dowling, from Connersville, Indiana, was rescued from Neffs Canyon Cave in Utah in a relatively complex multiday operation performed by local agency and caver personnel. The ordeal made a small blip in the national media and was barely mentioned in the convention discussions.

Karras's general discord with several NSS directors led to his formation of the Speleological Society of America (SSA) in 1966. In May 1967 three Hannibal, Missouri, youths, Craig Dowell, 14, his brothers Bill Hoag, 10, and Joey Hoag, 13, disappeared. A new road cut near town had opened a cave entrance and the boys were assumed to be in the cave. Karras, the president of the SSA and chief of the rescue team, arrived on scene and spent several days talking to the media. The boys were never found. The media did not distinguish between the SSA and the NSS. Once again the excessive publicity of the fiasco added fuel to the fire against the idea of a national cave rescue team and cave rescue publicity. The situation reached a point where the mention of cave rescue organizations or training resulted a in negative reaction from the caving community.

Things related to cave rescue on the national level calmed down for the next 10 years with rescues handled at the local level. Walker County Rescue in Lafayette, Georgia, and Hamilton County Cave and Cliff Rescue in Chattanooga, Tennessee, handled the southeastern U.S. Chuck Hempel, Bob Barlow, and others were doing weekend training in the eastern U.S. Some Virginia cavers formed the Cave Rescue Communication Network (CRCN). Triangle Rescue was operating in southern Virginia, Eastern Tennessee, and North Carolina. Local cavers responded when necessary in Indiana. A national rescue coordinator, with vague duties and responsibilities, was appointed in the NSS President's department. Among those holding the position were Ken Laidlaw from Berkley, California, and Don Black from Chattanooga, Tennessee. The major problem of the era was conflict between agency personnel, who were legally responsible for public safety, and cavers, who were knowledgeable and comfortable working in the underground environment. Rumors persist amongst cave rescue personnel today of cavers being held back at gunpoint while police and firefighters severely complicated a relatively simple rescue.

In 1976, Dan Smith, a Fire Department Training Captain and caver from Petaluma, California, came up with the idea of forming a commission in the NSS to focus on joint training of agency personnel and cavers in cave rescue operations and management techniques. This would help to "grease the skids" between cavers and agencies for future rescue operations. He further divided the country into separate regions, each headed by a local commissioner, to coordinate resources. The initial regional commissioners were Rick Rigg, Northwestern; Howard Hurtt, Western; Perry Denton, Southwestern; Steve Hudson, Southeastern; Gene Harrison, Eastern; Karl Kingsley, Northeastern; and Doug Carter, Canada. The Central Region was vacant. Terry Jones, from Texas, was appointed the NCRC's Deputy Director in 1978. Smith was the National Commissioner. The title of Commissioner was soon changed to Coordinator. The first national training seminar, a five-day event, was held in San Antonio, Texas, the week prior to the 1978 NSS Convention in New Braunfels, Texas. The principle instructors were Smith; Hudson; Butch Farabee, Chief Rescue Ranger at Grand Canyon National Park; Tom Vines; and Dr. John Franklin, Leader of England's Cave Rescue Organization (CRO). The training consisted of lecture and fieldwork culminating in a mock rescue in a commercial cave on the last day. The stretcher used was a modified Neill-Robertson litter, a conglomeration of wood slats attached to a metal frame originally used for evacuating sailors through tight ship hatches.

I first got involved with cave rescue shortly after I started caving, in 1961. Living in Bloomington, Indiana, very close to the Garrison Chapel Ridge and Buckner Cave area, put me into a cave search group by default. I participated in many searches, rescued those who could not climb out of Shaft Pit, and assisted with the triple body recovery from the Salamander Cave flood of 1976. When I would bring up the subjects of rescue practice, preparation, or training around the campfire or at caver parties, the "older and wiser" cavers would always reject these ideas. Ghosts of the Bill Karras past still lingered with the masses.

Smith presented a paper on the National Cave Rescue Commission at the 1978 NSS Convention in New Braunfels, Texas, and I attended. My first impression of Smith was that if he was not a used car salesman, he had definitely missed his calling. Smooth talking and persuasive, his message was exciting and made a lot of sense. He spoke of training and preparation, resource management and caver-agency cooperation, and all the rest of the cave rescue-related topics I had been espousing back home. After the presentation, I asked Smith who the Central Region Coordinator was. He asked me where I was from, and I said, "Bloomington, Indiana." He smiled, looked me straight in the eye, and said, "You are."

In December 1978 Chris Kerr broke his leg in Cueva del Brinco in Mexico. The NCRC coordinated an Air National Guard C-130 flight to take several cavers and a 4-wheel drive vehicle from Austin, Texas, to Victoria, Tamaulipas. Kerr was successfully rescued. This was the first personnel and equipment resource transfer aided by the NCRC and was somewhat tricky, because it involved flying a military plane into Mexico as a rapid response.

In March 1979 Barry Beck and six students were rescued from Anderson Spring Cave near Lafayette, Georgia, after being trapped by floodwaters for 33 hours. The NCRC aided in coordinating the flight of Dr. Bill Clem, rescue personnel, and a warm gas inhalator for hypothermia intervention from Virginia by the Air Force. It was the second personnel and equipment resource transfer aided by the NCRC.

Smooth-talking salesmanship is one thing, but competent financial management is another. When I arrived at the 1979 national training seminar in Albany, New York, and met Hudson and Lee Noon, the new Eastern Region Coordinator, I discovered the NSS Board of Governors had decided to disband the NCRC at the Pittsfield, Massachusetts, NSS Convention the following week. Evidently Smith had made some unauthorized travel expenditures for NCRC activities. There were also fears that Smith was trying to form a national cave rescue team. Ghosts of the Bill Karras past still lingered with the masses. This resulted in the "Albany Coup." Hudson, Noon, and I worked with Russ Rhodes to write the new NCRC Charter. It emphasized that the NCRC did not perform cave rescues; its main purpose was training, resource coordination, and management; and finally all financial transactions would be accomplished through the NSS treasurer. Chuck Hempel, a caver from the Eastern Region, was conducting some rescue training, but had a few major philosophical differences with other caving groups and the NCRC. We decided it would be better to work with, rather than compete with, Hempel's group, so we suggested that he replace Noon as Eastern Region Coordinator. Noon would replace Smith as National Coordinator, and Smith would become Western Region Coordinator. We approached Smith with the new charter and suggested restructuring, and we informed him that if the changes did not occur, our group was sure we would lose the NCRC. He reluctantly agreed. The following week at the convention, Hudson and I spent the entire week lobbying directors to adopt the new charter and give the NCRC one more chance. They did.

The Albany, New York, NCRC National Weeklong Training Seminar was successful. It was the first Level 2 class. Everyone went to the same lectures. Level 1 students were assigned to a Level 2 team leader on the first day and stayed with the team the entire week. The instruction format was all day classroom alternating with all day fieldwork. The October 1977 rescue at Twigg's Cave in Maryland was a major topic of conservation. The problems discussed from the Twigg's rescue were bad air, tight vertical passages, and personnel shortages. The mock rescue from the training seminar that year was in McFails Cave. It started at 8:00 p.m. on Thursday night rather than Friday morning as in past years. A four to one piggyback haul system was rigged at the Hall's Hole entrance, and mock patient John Mylroie was successfully extracted at the break of dawn. During the evacuation, Level 1 student and future instructor Tom Patterson was instrumental in developing the turtle carry for litter transport in narrow canyon passage.

However, there were problems with the mock rescue at the 1980 NCRC National Weeklong Training Seminar in Chattanooga, Tennessee. The mock patient was a fairly big guy, well over six feet tall. He was placed at the bottom of the Nuisance Drop, an 18-foot drop, between the Warm Up Pit and the Balcony of Fantastic Pit in Ellison's Cave. Once again the mock was started on Thursday evening

Instructors Steve Hudson and Dr. Bill Clem demonstrate the operation of a 4:1 piggyback haul system at the 1979 National Weeklong Training Seminar in Albany, NY. Photo by Don Paquette.

when everyone was tired, rather than Friday morning. After several failed attempts to get the litter over the Nuisance Drop lip, the mock patient quit and left the cave. The mock was aborted. The class and the instructors were very disappointed with the result.

The 1981 NCRC National Weeklong Training Seminar in Bloomington, Indiana, was an international training in conjunction with the International Congress of Speleology held the following week in Bowling Green, Kentucky. Several Level 1 students were to play key roles in the future of the NCRC including Dr. Noel Sloan from Indianapolis, Indiana; Bill Renaker from Fox Lake, Illinois; and Harold Chrimes from Troutdale, Virginia. Frank Reid from Bloomington, Indiana, was invited as a guest lecturer on amateur radio two-meter repeaters and the use of cave radio location equipment for two-way communication between the underground and the surface. Reid enjoyed the seminar so much that he continued to teach and contribute until he passed away in 1998. The first *Manual of U.S. Cave Rescue Techniques*, edited by Toni Williams was published and given to the students. We decided that the NCRC needed a Training Coordinator and asked Dave Morrow, an instructor from Virginia, to take the position. Once again the mock rescue, held in Doghill Cave in Bedford, Indiana, was started on Thursday evening. During the mock, the next-door neighbor of the cave owner came home around midnight with a somewhat inebriated wife who called the local police and demanded that the training course personnel be evicted from the premises immediately. Negotiations with the responding officer allowed us to stay, as long as everyone remained quiet. One of the unique things about the international seminar was that several of the students were actually very experienced rescuers in their own countries. At the mock, Mike Meredith from France led the first team into the cave. We called them “Bash Teams.” It took a few years to replace “Bash” with the more conservation-leaning “Initial Response.” When he returned, during his debrief, he pulled a notebook from his pocket where he had drawn a very accurate sketch map of the entire cave from the entrance to the patient, and noted every obstacle and what would be needed for evacuation, much to the amazement of the observing instructors. When Meredith paid a return visit to the United States the following year, we used him for an instructor at the California weeklong event.

The NCRC National Weeklong Training Seminars continued with modifications to the training. The seminar schedule was changed to include a morning classroom and an afternoon fieldwork component. The SKED® litter and Oregon Spine Splint replaced the very awkward Neill-Robertson litter. In 1982, we finally started the mock on Friday morning. During the mock rescue at Wind Cave, the haul system main anchor moved, resulting in the mock being aborted for safety. In 1982, Noon resigned as National Coordinator, due to job commitments, and was replaced by Vines. Getting instructors was at times challenging. The only remuneration provided to instructors was the meal plan, provided the class was large enough to support it. All instructors paid their own travel and lodging expenses, as they continue to do today. Agency students were frequently subsidized by their departments, but we had to keep the cost as low as possible to attract cavers, who were frequently poor college students. Ideally, we wanted to have a caver/agency personnel ratio of 50:50 in each class. Another problem was getting good publicity into the caving community while maintaining a very low profile, as the ghosts of the Bill Karras past still lingered with the masses. Despite these problems, we managed to break even and frequently create a small surplus to replenish equipment without getting any money from the NSS.

Precinct #11 Cave in Rockcastle County, Kentucky, flooded in April 1983 trapping eight members of the Greater Cincinnati Grotto. With NCRC support, the Air Force Rescue Coordination Center (AFRCC) flew cave divers Steve Maegerlien and Jeff Forbes from Bloomington, Indiana, and Hudson and Forrest Wilson from Marietta, Georgia, to London, Kentucky. The successful multiday rescue taught us that huge pumps can help with a flooded cave and not to place internal combustion engines near a flooded entrance. If the siphon breaks and the cave is sucking air, the carbon monoxide exhaust will be sucked into the cave. It was a successful demonstration of interregional cooperation and use of AFRCC and sump divers.

In 1984, Vines resigned, and I replaced him as National Coordinator. Dr. Noel Sloan replaced me as Central Region Coordinator. By charter, we were required to have a meeting at the NSS Convention. We also had a business meeting during the winter. In working to develop a standard curriculum, volunteers would commit to a topic but normally fail to follow through. We were all volunteers with jobs and families and other lives. Progress was slow on the second edition of the manual. With all of us coming from different parts of the country and having different rescue problems and needs, getting a consensus on curriculum and policies was almost impossible. This was the time before e-mail, so communication was by mail, expensive long distance telephone, or face to face. Setting up a seminar by typewriter and telephone was almost a full time job. Our meetings turned into major arguments, and progress came to a halt. Another problem discussed was agency students wanting more than a certificate of attendance. We passed a policy that the NCRC logo would not be made into a patch or used on clothing in order to keep our profile low. What kept working on my mind was, “Who certified us to certify them? What standards do we use? How do we document training? How do we keep the necessary records? What records do we keep? How can 13 members of the Board of Regional Coordinators (BORC) arrive at a consensus?”

Four paramedics from Texas—Rod Dennison, Brett Marsh, Leroy Vargas, and George Marquez—enrolled in a Level 1 at the 1986 NCRC Weeklong Training Seminar in Carlsbad, New Mexico. Dennison was a paramedic instructor with a lot of experience with curriculum development, and he became an instructor and did a lot of work with the curriculum. After the seminar, I drove home with the complete national training equipment cache in the back of my pick-up truck. We were still teaching only two levels, but many graduates were clamoring for a Level 3. It had been and was being discussed, but any kind of agreement was in the mist. Bill Renaker replaced Dave Morrow as Training Coordinator.

At the 1987 NCRC Weeklong Training Seminar in Abingdon, Virginia, instructor Tom Patterson arrived with check-off sheets for students to demonstrate skills in patient packaging, haul and lowering systems rigging, knot tying, communications equipment operation, and medical assessments. This was well received by the students. They enjoyed the hands-on activities and felt like it enhanced learning. On the drive home, while thinking about the success of the check-off sheets, I had an epiphany: NCRC should create hard documentation of each student's skills proficiency. We could keep and file check-off sheets. We could claim that we were the most knowledgeable about cave rescue, and if any one disagreed, they would be challenged to prove us wrong! Also we needed to get the curriculum-development personnel into a smaller group. At the NSS Convention in Sault Ste. Marie, Michigan, I presented my thoughts to the BORC. First, we will create an Education Board to get the curriculum developed. The members will be the National Coordinator, the Training Coordinator, the Medical Officer, and two at-large members who are not regional coordinators. This small group will get people to develop lesson plans and submit them to the Education Board for review. Once a lesson plan is complete, it will be submitted to the BORC for approval. The Education Board will also develop the criteria for instructor certification and recertification. Second, each coordinator would submit no more that three candidates to be grandfathered as certified instructors for a period of three years. Each candidate must have taught previously at a National Weeklong Seminar. After three years they must meet the requirements developed by the Education Board to recertify.

At the winter meeting the names for grandfathered instructors were submitted as requested, except that Hempel submitted 27 names of instructors he used for Eastern Region training—none of whom had ever taught at a national weeklong seminar. One of the individuals submitted was offended for not being selected. He was a highly skilled ropes technician and a radio communication expert who taught for several years in the region, but he had not taught at a national weeklong seminar. He went to the NSS Board of Governors and accused the NCRC of conducting secret meetings and demanded that he be grandfathered as a certified instructor. In subsequent discussions with several directors and a meeting with Tom Rea, NSS Administrative Vice-President, I assured them that we never had any secret meetings. He simply did not meet our selection criteria because he had never taught at a national weeklong seminar. Their review of our policies determined that we needed to correct the fact that none of the coordinators had any term limits. Each coordinator, except the National Coordinator, would have a three-year term, with potential replacements to be nominated by their region. The BORC would recommend the coordinator for confirmation by the NSS Board of Governors (BOG). There would be no limit on the number of terms. The BORC decided to certify only instructors, but to issue certificates of completion to the students.

Many viewed the NCRC as a group of squabbling egomaniacs who wanted to save the world. In one sense they were correct. We were definitely squabbling. The Eastern Region wanted NCRC association, but also wanted autonomy. Some of the differences were far reaching. The charter mandated that we maintain a low profile. The Eastern Region liked patches, stickers, and publicity. They wanted vertical requirements to be optional for both students and instructors. The arguments over grandfathering instructors continued for over three years, until 1990. The region was doing some good training, but wanting it both ways slighted several BORC members.

The 1988 NCRC Weeklong Training Seminar at Wind Cave National Park saw the first Level 3. We had a small overall class, so during the mock, a few of the instructors participated with the students to bolster the cadre of rescuers. The second edition of the *Manual of U.S. Cave Rescue Techniques*, edited by Steve Hudson was published.

The 1989 Monteagle, Tennessee, weeklong established the beginning of instructor training. Rod Dennison put together and taught a two-day pre-seminar course consisting of construction and use of course objectives and goals, use of audio-visual equipment, construction of lesson plans, types of tests, and test construction, with each person doing an evaluated mini-presentation. This evolved over the next few years into the Instructor Qualification (IQ) class, the weeklong course that prepares instructors for certification by the BORC.

In 1991, Emily Davis Mobley broke her leg during an expedition in Lechuguilla Cave. The resulting rescue took four days. During the operation Ron Kerbo called me looking for a phone patch, a device that connects the field phones in the cave to a radio on the surface, thus allowing someone in the cave to communicate directly with the remote command center. I contacted Frank Reid, and he faxed a schematic diagram of the circuit and a parts list to Kerbo. The parts were bought at a local Radio Shack, and the patch was constructed and used for the remainder of the operation. This is yet another example of NCRC providing resource management.

One of the problems with our training was dispatching the class for the mock rescue. The class would completely organize the night before with all job responsibilities pre-assigned and then arrive at the cave as one big group. In reality, cave rescues evolve with people arriving as they get notified with variable travel time. At the 1991 Schoharie, New York, weeklong seminar, Bill Renaker arrived at the Friday morning dispatch meeting with a box of plastic poker chips. Each student had to draw a red, white, or blue poker chip out of a hat. This randomly divided the class into three groups that were dispatched 30 minutes apart, providing a much more realistic beginning.

At the NSS Convention the following week in Cobleskill, New York, I asked Hudson if he would take over as National Coordinator. The NCRC was progressing pretty well, we needed a new Medical Officer, and I was getting burned out. Dr. Sloan became the Medical Officer, and I would return as Central Region Coordinator. Hudson agreed to take the position for a couple of years.

Anmar Mirza came to the 1992 NCRC Weeklong Training Seminar Marengo, Indiana, as a Level 1 student. Anmar was an Emergency Medical Technician (EMT), amateur radio operator, and caver, and he had been assisting with Central Region Orientation to Cave Rescue (OCR) courses for the past few years. He had more actual cave rescue experience than most of the instructors on site. As an early 20-something, he had a fairly short fuse, and I think that at least three or four times during the week I had to stop him from packing up and leaving the class. His frustration was the result of a situation that was starting to brew. We were instructor-heavy with some that should not have been cleared to be instructors. The process at the time was simply to take Levels 1, 2, and 3, then go to instructor training, and immediately you were an instructor. Over the years, word got out to many agencies that the NCRC training was an inexpensive but high-quality high angle rescue course. We were getting instructors that did not live anywhere near a caving area and only came near a cave at a seminar. Between seminars, their knowledge of the curriculum and the specifics of cave rescue would diminish. This would result in conflicts between instructors and students. Also, this seminar made enough money to allow the NCRC to purchase a trailer for transportation of the rapidly growing training equipment cache. Chrimes would keep and maintain the cache at his home in Virginia.

In 1992, the Eastern Region began teaching a weeklong seminar at the Old Timer's Reunion (OTR) site in West Virginia. The BORC approved the training for Levels 1 and 2.

In 1994, Hudson resigned as National Coordinator and was replaced by Butch Feldhaus. David Ashburn replaced Renaker as Training Coordinator. Feldhaus and the BORC developed an adversarial relationship over the next few years. The NSS BOG extended the term limits to include the National Coordinator. At the end of his term, Feldhaus resigned and was replaced by John Punches.

In 2005, the Education Board addressed the instructor quality issues. In addition to attending periodic instructor curriculum updates and teaching, each instructor must now pass a written exam on NCRC policies and curriculum every three years. The selection criteria for students to enter the instructor training class were refined and tightened. This rapidly thinned the instructor pool, as only those who really wanted to teach would expend the effort to bone up on the curriculum to pass the exam.

In 2009, John Punches resigned as National Coordinator and was replaced by Mirza. Hudson replaced Ashburn as Training Coordinator.

In 2010, a class called Tactical Operation and Field Exercises (TOFE) was first offered at the Mentone, Alabama, Weeklong. It is a fun class for students who have completed Level 2 or above and consists of a week of hands on fieldwork.

In December 2013, the NCRC suffered a great loss with the untimely passing of Hudson. Since its beginning in 1978, Hudson was the backbone of the commission. His technical knowledge, experience, and leadership coupled with plain hard work will be sorely missed. The Training Coordinator position was filled by Punches.

The NCRC has continued to improve and thrive. In recent years, we have considered offering a Wilderness First Responder class. Requests for a small party self-rescue course have been around since the beginning and many people have worked on it for years. It is now being offered as a three-day course called Small Party Assisted Rescue (SPAR). The third edition of the *Manual of U.S. Cave Rescue Techniques*, edited by Mirza, was published in 2015. Possibly the greatest success has been reducing the caver-agency disparity. Over the years, many agency individuals have become recreational cavers, and likewise cavers are getting advanced medical training and are involved with emergency management. The dividing line between "cavers and agency" is fading. The NSS BOG has recently authorized the NCRC to provide cave rescue certification for students. Ghosts of the Bill Karras past are fading away, but they are not completely gone. Many people still think the NCRC is a rescue team!

The NCRC has gotten to where it is today because of the hard, unpaid, volunteer work of countless people. Dan Smith got it all started. We are still using his regional division system. Dr. John Franklin, from England, taught at our first three national weeklongs. Steve Hudson, one of the founders, at one time or another held every NCRC management position, edited the second edition of the manual, provided unparalleled vertical expertise, and gave more hours than probably anyone. Rod Dennison got us off the ground with proper lesson planning and curriculum development. He, along with Jim Davis, was also instrumental in the development of Level 3. Harold Chrimes has spent years managing the national training cache and continues to do so. Diane Cousineau significantly refined the IQ class. The late Frank Reid developed the communications training that we still use. Chuck Hempel developed the model we still use for the weekend Orientation to Cave Rescue course. Jeff Parnell started the work on the third edition of the manual. John Punches has provided tremendous leadership and demanded instructor professionalism both as National Coordinator and now as Training Coordinator. Anmar Mirza used innovative creativity to refine Level 2 and continues to provide great leadership as National Coordinator. The late Joe Ivy worked along with Becky Jones and Tom Burroughs in starting the coursework for SPAR. My two contributions were creating the Education Board and keeping Anmar from quitting as a Level 1 student.

The NCRC was started by a group of people with a little cave rescue experience, a little teaching experience, and the desire to fill a void and solve some existing problems in the caving community. We based a lot of our early classes on mountain rescue techniques, existing medical protocols, military communications, and fire service Incident Command System (ICS) management. Some of the stuff worked, some did not. As we taught, we learned. We developed cave-specific techniques. We had failures and successes. Each region had different kinds of caves and different kinds of problems, including deep pits in the southeast, tight passage in the northeast, water in the central U.S., and long distances between people and caves in the west. We managed operations differently. We had personal preferences and biases. Every mock rescue is a learning experience for both the students and the instructors. We watched. We learned. We observed how the students absorbed the material, and we listened to their complaints and requests. We argued among ourselves. Teaching a curriculum that fits every part of the country is impossible, and teaching a solution for every possible problem to be encountered on a cave rescue is impossible. The Education Board developed standards for the curriculum. These are training standards, not rescue standards. For every method we teach, there are many other methods that work. Some better, some worse, but on a given day in training a student was taught and demonstrated a method that would work in most cases, and that could be documented. Standards were developed for instructors, especially in teaching the curriculum. Every instructor disagrees with one or more things in the curriculum, but all agree to teach it first and then present their own opinion.

We continue to learn from mock rescues. We continue to learn from real rescues. We continue to observe students. We solicit feedback. Technology advances. Philosophies change. We still have strong differences of opinion. All of these things add up to modifications to the curriculum. The Education Board is constantly revising what is taught and when. Whether it is a weekend Orientation to Cave Rescue, a Regional Seminar, or the full National Weeklong Training Seminar, we have enlightened thousands of cavers and agency personnel about the nature of cave rescue and taught some tools that might work, depending on the situation. Almost every rescue is now handled on the local level and with the lowest profile possible. Are we fully prepared? No. Will we ever be fully prepared? No. But we are more prepared now than in the past. We will be better prepared to win in the future than we are now.

Roman philosopher Seneca said, "Luck is what happens when preparation meets opportunity." Hopefully in future rescues we will get lucky.

Cavers participating in an NCRC training seminar. Photo by Mike Futrell.

Dragon Cave: America's First Cave Rescue?

Dean H. Snyder NSS 17870

For the greater part of the nineteenth century, the most famous cave in Berks County, Pennsylvania, was found in a farmer's field a mile northeast of Virginville in Richmond Township. People from far and near, including Philadelphia and New York, visited the cave and wrote about it as a great natural curiosity. Dragon Cave represents one of the earliest cave references in the United States; it appears on W. Scull's 1770 map of Pennsylvania. It may also be the site of the first cave rescue in North America.

Sometime around 1750, settlers from the village of Oley went on a fishing trip to the Maiden Creek. The group stumbled upon the cave's entrance, but without light sources, they could not go far into the cave. When the group returned later to explore more thoroughly, their candles went out. They wandered aimlessly in the dark without finding the entrance passage. Several days later, a search party entered the cave, and rescued the missing group. To make sure that they could find their way out the cave, the search party tied one end of a long rope around one of them, and tied the other end to a tree on the surface. The unfortunate explorers were found with "their candles long since burned out, their nails scratched off, and their bodies not a little weakened."

Dean Snyder in the entrance of Dragon Cave, circa 2000. Photo courtesy of Dean Snyder.

Dragon Cave is one of the few caves in the commonwealth with a natural entrance; most caves in Pennsylvania were found by quarry activities or during road construction. The main feature of the cave is a large stalagmite, 4 feet thick at its base and 8 feet high. For many years during the nineteenth century, it was a popular destination for visitors, many of whom spent the night at the nearby Dreibelbis Hotel. A foot-square block of a white stalagmite from the cave was proudly displayed at the hotel. However, the Dreibelbis children were forbidden to explore the cave—their elders had always talked of the 1750 rescue.

In the winter of 1892, Professor Lafayette Lesher visited Dragon Cave with his township school students. The cave was mapped by Mike Shaffner in 1932, with the map appearing in future NSS President Ralph W. Stone's *Pennsylvania Caves*. Another NSS President, Charles Mohr, of the Reading Public Museum, visited Dragon Cave with his nature class in 1934. Dragon Cave was on the Dreibelbis family property until the early 1940s, when it was sold to George Lesher. Early on, he was very cordial to cave explorers. But in the late 1970s, after some boorish visitors drove through his yard to park at the cave entrance, Lesher closed the cave to all visitation. However, he refused to allow township officials to physically close the cave, which they deemed in their infinite wisdom to be dangerous. After Lesher's death, the property was sold and became part of the Dragons Den Residential Subdivision. With landowner permission, the cave remains open today.

Perspectives on Cave Rescue Preplanning

John Punches NSS 39211 & Bonny Armstrong NSS 43003

The fact that you're reading this issue of *American Caving Accidents* suggests you're either a caver or someone tasked with managing rescues in caves. In both cases, thinking about and preparing for rescues will help you to address these challenging situations more effectively and may help you avoid the need for complicated rescues in the first place. This article considers cave rescue preplanning from a series of perspectives: the individual caver, the person leading a caving trip, project and expedition cavers, and the agency or organization responsible for an organized cave rescue. We'll think about how cavers can mitigate risk and ensure that they can care for themselves to the maximum extent feasible, and how agency or cave resource management personnel can be best prepared for a rescue.

Caver Preparation

Typical cavers probably aren't thinking about rescues when they plan a caving trip, but they should be. Caves are challenging environments, and we shouldn't brush off the possibility of a mishap. In fact, we'd argue that it's irresponsible to go caving without thinking through the objective hazards and doing what you can to minimize risk.

The best way to avoid the need for a rescue is to ensure that every member of your caving group is properly prepared for the trip. What it takes to be prepared depends on the cave trip itself. A stroll through easy borehole may require little more preparation than calling the gang and throwing the gear in the truck. In contrast, a multiday expedition in a deep vertical cave could require months of pre-trip personal and group effort to ensure all the bases are covered. Preparation for any trip should start with a clear understanding of the challenges that the cave will (or could) present. Trip members should then undertake appropriate physical conditioning and ensure that their caving skillset is up to the task and that all personal and group equipment is ready. The following checklist will help you to cave safely—note that it starts well in advance of the actual cave trip.

Checklist for Caver Preparation
Well in advance and ongoing:
• Engage in regular physical activity. Cardiovascular conditioning, strength, and agility are invaluable attributes while caving, and they do much to mitigate risk of injury.
• Obtain and use cave-worthy clothing, footwear, and protective equipment. Learn what is appropriate for differing types of cave trips. Make sure your gear works well for you.
• Invest in high quality caving lights. Experiment with them so you'll know how long you can expect batteries to last, and plan accordingly. Learn how to implement field repairs. Always carry extra lights.
• If you plan to engage in vertical caving, obtain a real caving ascending system, seek qualified help tuning it to your body size and configuration, and practice until you can ascend, perform a changeover, and descend smoothly. Learn how to pass knots, protect yourself on traverses and approach lines, transfer from one rope to another, and downclimb. These are essential skills that should be mastered before you go in the cave. (See the Vertical Caving Notes, at the conclusion of this article, for more on this subject.)

Prior to the trip:
• Get details from your trip leader about what to expect (nature of cave, objectives, route, difficulty, duration).
• Check and pack gear, lights and supplies. Make sure all is in good working order and that you have everything needed.
• Assemble a Palmer Furnace kit (large trash bag, candle, flame source) and learn how to use it.
• Tell friends and family where you are going, what route you'll take to and in the cave, and when you anticipate returning. Give them the contact information for your surface watch (which should be established by the trip leader).
• Ensure that you are rested, hydrated, and as healthy as possible. Starting a cave trip already fatigued or dehydrated heightens your risk.
• Pack sensibly. Carrying too much (weight or bulk) can prevent you from moving efficiently. You'll wear out sooner, and fatigue is a major precursor to caving injuries.
• Tell your caving companions and trip leader about any medical conditions you have, what they should watch for, and how they should assist you if needed.
• Know what to do if you get separated from your caving group.

While caving:
• Cave at an appropriate pace. Pushing physically and mentally is why many of us go caving, but overdoing it can put us at risk individually and as a group.

• Keep yourself fueled and hydrated.
• Layer up or down so you can move efficiently and maintain a comfortable body temperature.
• Let your trip leader know if you're reaching your limits or experiencing difficulty.
• Pay attention to landmarks that will help you find your way out.

Trip Leader Responsibilities

You carry an extra burden if you are the trip leader. Not only are you responsible for choosing the cave and route and coordinating the trip, you are responsible for making sure that everyone on the trip is properly prepared. Hasty preparation of your caving team members probably means you're pushing them to do things they're not ready for. Start new cavers off with easy trips, and build up to more complexity as their skills and physical abilities improve. You can reduce risk and improve the success of your caving trips by doing the following:

In advance of the trip:
• Know the capabilities of the trip members.
• Choose caves and routes appropriate for the participants.
• Inform trip members about the cave and the nature of the cave trip (difficulty, duration, etc.).
• Ensure that every member of the caving group has proper equipment and personal supplies
• If the trip will include vertical caving, meet with (or have a trusted assistant meet with) each trip member to ensure that they have functional and properly tuned vertical gear and that they can perform essential skills.
• Make arrangements for your surface (safety) watch. Ensure that person knows your trip plans and when and who to call for assistance. Communicate surface-watch information to trip members.
• Know if the cave has flooding or bad-air hazards. Watch weather and plan accordingly. Don't venture into flood-prone caves unless you have a clear weather forecast—not only for the cave entrance but for the entire watershed that feeds the cave.
• Develop plans for what to do if trip members get separated. Where will you regroup? How will you communicate if some team members need to leave the cave or alter their route? (You can easily encounter these situations if you have fast cavers and slow cavers moving at different paces and planning to regroup at some location, or if you're surveying or conducting research or exploration in multiple groups.)

At the cave (or the start of the hike to the cave):
•Ensure that each trip member is properly equipped and supplied.
• Review the trip plan.
• Ensure that you have all necessary group gear (rope, rigging, task-oriented equipment).
• Remind trip members what to do if they become separated from the group.

In the cave:
• Set an appropriate pace. Moving through the cave too fast will put the slower members of your group at higher risk. Emphasize efficiency of movement rather than outright speed.
• Monitor trip members for signs of fatigue, hypothermia, illness, or injury.
• Incorporate rest and refueling breaks.
• Point out landmarks along the route so that others could find their own way out if necessary.
• Rig properly. Provide for edge safety. Protect abrasion points. Demonstrate good vertical technique. Avoid haste! Hasty rigging is too often inefficient or allows unnecessary rope damage at friction points.
• If a teammate is injured, follow protocol. Assess scene safety first. Stay calm, think, and perform smoothly. Establish a clear chain of command and work as a team to resolve the issue. Expect emotions to run high. Stay positive and be the calm and reassuring voice in the midst of chaos. (A calm, reassuring, positive voice is the single best rescue tool, and it can resolve most incidents without the need for escalation.)

Expedition and Project Caving

Cavers engaged in multiday expeditions and/or long-term exploration and mapping place themselves in environments that could make rescue very challenging. Their cave routes could include significant depth with multiple challenging pitches, long constrictions (horizontal or vertical), sumps requiring technical diving, extended bolted climbs, and digs requiring shoring and stabilization. These are not the environments where we should be taking new cavers; even experienced cavers should ensure they're well prepared for the physical, psychological, and logistical challenges they'll face. Since call-out rescue would be difficult to obtain and conduct in these environments, the cavers themselves need to employ a high level of self-sufficiency. The National Cave Rescue Commission (NCRC) highly recommends that expedition and project cavers obtain wilderness medical training and take a small party assisted rescue (SPAR) class. These classes prepare cavers to deal with many illness- and injury-related incidents without the delays and complexities of a call-out rescue and help them to know when to attempt self-rescue, when to do small party rescue, and when to call out for more help.

Other Considerations for Technical Caving
• Anticipate that virgin or little-traveled passage will have more loose rocks and a higher risk of rock fall,

that hand and footholds will be prone to breakage, and that chock-stone features could fail under your weight. In heavily traveled passages, other cavers have probably "cleaned" the route for you. If you're working in less traveled areas, you should be more cautious.

• Rig your trade routes in anticipation of a rescue—or at least ensure that they are suitable for multi-person loads. This makes it much easier to assist an injured colleague through technical sections of passage. This can include making modifications to constrictions in advance rather than waiting until a rescue or assist is needed. Rescue-worthy rigging and passage modification have the added benefits of speeding up travel through these areas and reducing the effort and complexity of travel (and thus reducing the risk of injury or fatigue-related problems).

• Pre-position cave rescue equipment, food, water, shelter, and insulation at logical locations in the cave. A warming kit near your dig or bolting site, and extra rope near vertical pitches, can be invaluable. The types of equipment you'll need will depend on the nature of the cave, how easy it would be to obtain equipment and supplies from the surface, and the objectives of your caving activities. We encourage you to be thoughtful and to plan for reasonable contingencies.

• If you are modifying cave passage, particularly if through digging or blasting, make sure you have qualified personnel guiding those efforts. Spend time evaluating the rock or other material you'll be removing and think about what happens to overlying material once you remove something. You may need to shore up areas with wood or rock (much as would occur in a mine).

• Long trips underground require us to deal with human waste. Ideally, you'd pack it out, but this may not always be feasible. If you dispose of human waste in the cave, be very careful you don't inadvertently contaminate your underground water sources. You'll need to be very cognizant of the cave's hydrology and take measures to prevent spread of waste-born disease on footwear, clothing, or skin (hands). If you need to drink from in-cave water sources, filter or purify your water.

• Fatigue can be a huge issue for expedition and push cavers. Manage it by balancing cave pack weight versus number of trips, pacing yourselves, and breaking large groups into smaller units (with people who move at similar speeds) to minimize delay at vertical pitches and constrictions. It's also important to plan for (and take) rest days when needed. Pushing too close to your limits is an invitation for an accident.

Caves can be challenging and unpredictable. Cavers can mitigate risk through preparation, training, and thoughtful planning. Photo by Chris Higgins.

• Finally, know who to contact if you need rescue assistance. In expedition and project caving, your best rescue resource may be other cavers associated with the mission who are on scene and either on the surface or elsewhere in the cave. Most rescue teams, even if they specialize in cave rescue, are unlikely to have any significant number of members who are well prepared for the extremes they would encounter doing a rescue from deep within a cave system. Encourage your expedition/project caving companions to obtain cave rescue training, ask competent colleagues to be on call during your cave trip, and consider installing wired communication so that you can request surface resources in a timely manner.

Vertical caving skills such as ascending, rappelling, performing change-overs, downclimbing, and passing knots should be practiced extensively in a controlled environment before attempting in a cave. Photo by Chris Higgins.

Agency/Cave Management Rescue Preplanning:

Organizations that manage caves will benefit from planning and preparing for potential cave rescue incidents. At a most basic level, this involves knowing the cave's level of complexity, the competency of people who tend to visit the cave, the cave's history of accidents and lost person events, and who to call upon to perform rescues in the cave. For easy caves, this cursory information may be sufficient, but for complex, lengthy, or vertical caves, a more concerted preplanning approach is advised.

Consider restricting cave access. Gates and permitting systems that screen out ill-equipped and inexperienced persons/groups can significantly mitigate potential in-cave injuries, and they have the added benefit of protecting cave resources and wildlife. Responsible cavers will not be significantly inconvenienced by having to obtain a gate key or complete a permit application.

Develop or obtain accurate cave maps. Most natural resource managers are well acquainted with topographic maps of surface features, and these maps are essential tools for surface search and rescue efforts. Cave maps are a bit more complex—they represent three-dimensional spaces that may overlap or intersect and that have varying passage dimensions and formation types. Effective management of cave rescue incidents depends upon good maps. Caving groups (grottos) are often very willing to assist with cave mapping projects, and modern mapping tools and software allow us to produce accurate and functional cave maps.

Cave rescue personnel must be competent in both caving and rescue skills; and aboveground rescuers are not automatically the best choice for underground incidents. Know where to get these people. Invite them to visit your cave, get to know it and its rigging challenges, and understand your incident management system. You can accomplish this by establishing working relationships with local cavers/grottos and rescue agencies. Prepare cavers to work effectively under your chain of command. Prepare rescuers to be effective in the cave environment (insist they be properly equipped and able to move effectively in-cave). If you are an agency that both manages caves and performs cave rescues, invest the time and funds necessary to ensure that your personnel are properly trained and equipped for the unique requirements of cave rescue.

If you're accustomed to managing aboveground incidents, anticipate that cave incidents will have less efficient communications, require a higher level of inter-task collaboration, and that personnel may need to shift from one task to another as the mission unfolds underground. A search team may initiate medical treatment, then be absorbed into an evacuation task force. They will all rely on the communications system established and staffed by others, and they will likely need the support of rigging personnel to overcome obstacles.

Test your incident management procedures using mock rescues in your caves. You will probably find that you need to tweak your management structure for it to work effectively for cave incidents. Anticipate the need for wired communication systems (UHF and VHF radios have limited range underground). Establish entrance control to manage and document personnel ingress and egress, and to keep persons not involved in the rescue from interfering. Adapt search techniques to the cave environment. Have a cave rescue cache suited to your cave. Anticipate that some rescue equipment may be best staged in the cave, but rotate it out periodically for inspection and cleaning. Seal in-cave equipment to protect it from moisture and decay. Rotate out water and food items and any expired medical supplies.

Develop specific rigging preplans for major access routes in cave. Test the plans and refine them. This will save critical time and enhance safety during actual rescues.

In some cases, a cave destination accessible to healthy cavers may be impassable to a litter. Know this in advance. In many cases, it will be acceptable to remove the patient from the litter to get them through a restriction. Your preplan should identify appropriate alternatives.

Some passages will be so restrictive that you'll have to modify them in order to get an injured person through them. Identifying theses passages in advance is important. If the passage is on a major route, we recommend that it be modified in advance so that a rescue could be performed if needed. If the route is used infrequently, or would be easy to modify in the event of a rescue, have a plan for what needs to be done and ensure that you have the tools and resources (and skilled personnel) readily available. If the restrictive route can be avoided, plan an alternative exit path.

The NCRC, while not a cave rescue team itself, trains hundreds of persons in cave rescue techniques annually and maintains caches of specialized cave rescue equipment. Agencies and cave management organizations can call upon the NCRC to help them identify trained personnel as a part of preplanning efforts, and its cave rescue equipment can be made available for incidents. We encourage rescue planners to contact their NCRC Regional Coordinator well in advance of actual incident needs, so that appropriate call-out and equipment sharing protocols can be implemented. Coordinator contact information is available at NCRC.info.

Vertical Caving Notes

If you travel almost anywhere else in the world, cavers use standardized personal vertical systems and are trained to specific standards before their caving associations allow them to do much in the vertical environment. Not so in the United States. Here we tend to build our own unique ascending systems out of whatever parts are available (or shiny), and it's not uncommon for someone to begin vertical caving with no formal single-rope-technique (SRT) training whatsoever. It's not our intent to force standardization upon American cavers, but we'd like to make an appeal for a few things that can significantly improve personal SRT safety.

First, use only static kernmantle rope with a tightly woven sheath when rigging fixed lines for in-cave vertical pitches. Limit use of dynamic (rock-climbing) ropes to actual lead climbing activities and never depend on hardware store utility rope. Cave ropes tend to be stiff (which some people don't like), but that stiffness results from the rope's dense sheath, which improves abrasion resistance and actually makes climbing with a caving ascending system easier and more efficient. Invest in good rope, treat it well, and you'll be able to use it safely for many, many trips.

Use a real caving ascending system. Cave environments are challenging, and ascending systems cobbled together out of miscellaneous rock-climbing and/or rescue equipment are unlikely to serve you well. The NCRC strongly recommends each caver obtain one of the following systems: frog, Mitchell, Texas, or single or double bungee ropewalker. These are arguably the most common systems for caving. They should incorporate two gripping points of attachment (toothed ascenders) connected to the main rigging point on the wearer's harness.

If you're using the frog system (which has become common in the U.S.), get a real caving harness. Trying to adapt a rock-climbing or alpine harness for use in the frog system generally results in an inefficient (and therefore higher risk) ascending system.

In all of these systems, we encourage you to incorporate a pair of cowstails. These are short lanyards that connect to the main point on your harness and have a carabiner at the other end. They serve as safety lanyards for traverses and approach lines, and in some systems they do double duty as the connection to one of the system's ascenders. The short one is typically about 2/3 of the length of your forearm, and the long one should reach from your harness to about the brim of your helmet. The exact lengths depend on your body configuration and the type of ascending system you're using.

Seek expert guidance on how to tune your climbing system to your body. There is no standard length for cowstails, footloops, or other ascending system components. You need to adjust them to match your torso, leg, and arm lengths. (In the authors' many years of caving and rescue experience, our observation is that most U.S. cavers, even those with lots of vertical experience, have poorly tuned systems. This makes climbing and other simple SRT actions inefficient and can make SRT rescue skills nearly impossible to perform. Attend an NCRC or NSS Vertical Section SRT class for expert assistance with system tuning.)

Use descent devices designed for caving, such as the rack or microrack, or bobbin-type devices similar to the Petzl STOP or Simple. Practice with them on stiff, muddy caving rope and learn how to lock them off. Too many people try to use rock-climbing rappel or belay devices (like ATCs or GriGris) for caving. This is a potentially dangerous situation, as the gear simply isn't designed for the extremes of the cave environment and may not function effectively in your time of need.

When you clip into a horizontal line (such as a traverse or approach line), clip in with a carabiner to the rope rather than just a toothed ascender. Toothed ascenders are not designed for transverse loads, and if cross-loaded they can detach from, or even sever, the rope under shock load. This is precisely the situation in which we often see them used improperly—a caver will ascend to the top of a pitch, then clip one of their ascenders into a horizontal line leading away from the pitch. If they fall during the transition from climb to traverse, they will shock load their ascender in a cross-loaded configuration. In cases where the horizontal line is anchored at both ends, it is better to clip in using a cowstail carabiner (with gate facing away from the rock). If that line is on a slope, a caver can clip in with their cowstail carabiner (to take the load) and ascender (to capture progress as they move upslope).

If you are providing new cavers their first vertical experiences, rig for contingencies. Use a rope a bit more than twice the length of the pitch, and connect it to the anchor using a tied off Münter hitch (or similar) with the extra rope at the top of the pitch. Then, if a person becomes stranded on rope, you can release the hitch and lower them to the ground.

Summary

The best cave rescue is one that is never needed, and a close second is a rescue that can be performed quickly, with minimal personnel and as little disturbance to the cave as possible. Thoughtful planning for caving trips, coupled with personal investment in physical conditioning and caving skill building, can do much to reduce risk to cavers. While every caver should take personal responsibility for their own preparations, trip leaders have additional responsibilities and should invest the time to ensure that their caving trip participants are ready for whatever is planned for them. Start new cavers off with easy trips, and work up to greater challenges as their skills mature. Expedition and project cavers need to treat rescue as their own responsibility, within reason. They put themselves in places that would be very challenging for most rescue teams to access, so they need to plan and prepare accordingly. Agencies and other cave rescue managers are encouraged to treat rescue preplanning as an essential element of the resource management responsibilities. At all levels, planning and preparing in advance of the trip or incident is the key to success.

The Rappel Test

A Test You Can't Fail

Scott McCrea NSS 40839 & Andy Armstrong NSS 45993

Thud! "Uggh." I heard it above me in Cyclops Cave—the sound of coverall-covered flesh smacking limestone. Fortunately, the caver had fallen backward, wedging himself across the top of the canyon. He had a death grip on his rack, which was still rigged to the rope, but no longer attached to him. For one of a number of possible reasons, he had become detached from his descender, his only point of connection with the rope.

Stories like this are not uncommon in *ACA* reports. Though not frequent, this type of accident is a recurring theme throughout the years of *ACA* statistics. In 1991, in one of the best-known examples, Chris Yeager fell 23 meters to his fate in Cueva Cheve in Oaxaca, Mexico. The next caver down the rope found Yeager's rack still rigged in at a rebelay.

In both of these cases, the caver experienced a freak occurrence of a cross-load or rollout failure. The Cyclops caver was in the process of crossing a simple, non-free hanging rebelay. He rigged his rack, fiddled with the bars, and removed his cowstail from the rebelay anchor. When he sat down on the rack, he quickly realized it was no longer attached to him, but by then it was too late. Somehow, in the fiddling and reaching, his screw-lock carabiner had become unlocked. Then, in the process of load transfer at the rebelay, the rack eye was able to lever open the carabiner gate. Fortunately, in this instance the caver's quick reflexes and the geometry of the pit were enough to save the day.

Metal rappel devices connected to metal D-links on a harness by another piece of metal hardware (usually a carabiner) represent a chain of three hard links. When such a chain is subjected to cyclic loading (weighting and unweighting), it can often end up in less than ideal configurations. In the situations described above, the carabiners became unlocked, either in the process of cyclic loading or at some time before the accident. When a carabiner is unlocked, a descender can often push in on the outside of the gate and open it, usually while unloading the descender. If this is not discovered while it is happening, then the descender can slip right out of the carabiner when it is reweighted.

When a chain of three hard links gets re-weighted, catastrophe can result—either from an unlocked gate, or from complete failure of the gate by lever action even when the carabiner is locked. This happens when the chain gets cross-loaded or twisted during the unweighting. When the cross-loaded or twisted chain gets loaded again, the descender (especially a full-size rack) can exert a lever force on the carabiner gate, breaking it or the locking sleeve while the carabiner is locked. In this issue of *ACA*, there is a report (on page 72) of a caver in Kentucky breaking the screw lock sleeve on his rack carabiner and falling the last 10 feet of a 97 foot rappel.

Because of the risk of rollout failure, many cavers use a screw link instead of a carabiner as their rack connection. A 7-mm oval maillon rapide is an especially popular choice for this connection because its dimensions are too narrow to allow a cross-load. These links are rated to 25 kN, which is comparable to many carabiners used for the same purpose, and they can be lightly wrenched shut. It is important to note that while a small screwlink is a good solution for a rack, it is dangerous to use a small screwlink as a bobbin connection. Bobbins are made to be attached with a large-stock carabiner, and screwlinks can move around in the opening and actually cause the latch to open. Other ways of preventing rollout include using double carabiners for the rack connection or using a cowstail clipped into the rack as a backup.

However, even if you take all of the precautions described above to protect your descender attachment, there are many other ways that your descender can fail. One of these is a backward threading of rack bars known as a "suicide rig" or a "zipper." Other ways to screw up when loading a descender include but are not limited to; failing to close a bobbin, loading a descender that is attached to a gear loop or belt loop, attaching to the incorrect side of a rope rigged for a pull-down, or even just slipping at the edge and immediately falling into an out of control rappel.

Fortunately, there is a test that can prevent any and all of these situations from being deadly: a rappel test. A rappel test involves maintaining a second point of attachment until the descent control device has been "tested." The rappel test is a rappeller's preflight checklist. The test proves that the rappel device is rigged and functions properly. The test catches many mistakes that may lead to serious accidents. By temporarily adding a second point of attachment, a rappel test allows us to test the integrity and operation of our descent control device, allowing it to fail without serious consequence. Any failure of the descender or its attachment will result in load transfer to the second point of attachment, thus preventing a fall down the pitch.

With repetition, the rappel test becomes an automatic part of rappelling technique. When it becomes standard operating procedure, then you can be sure that it will be there when you need it, when something goes awry with gear or human judgment.

There are five simple steps to a rappel test:

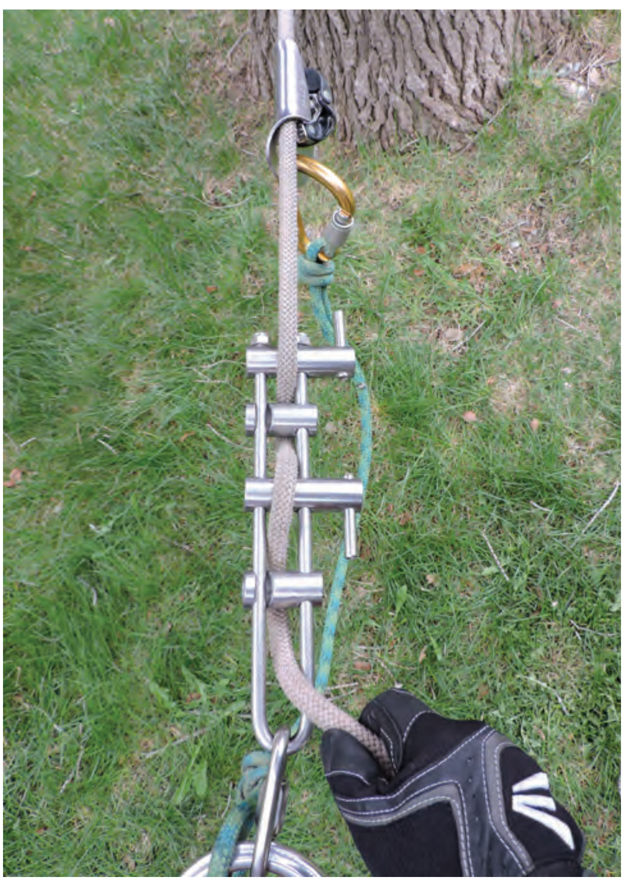
1. Attach
2. Rig
3. Test
4. Stow
5. Go

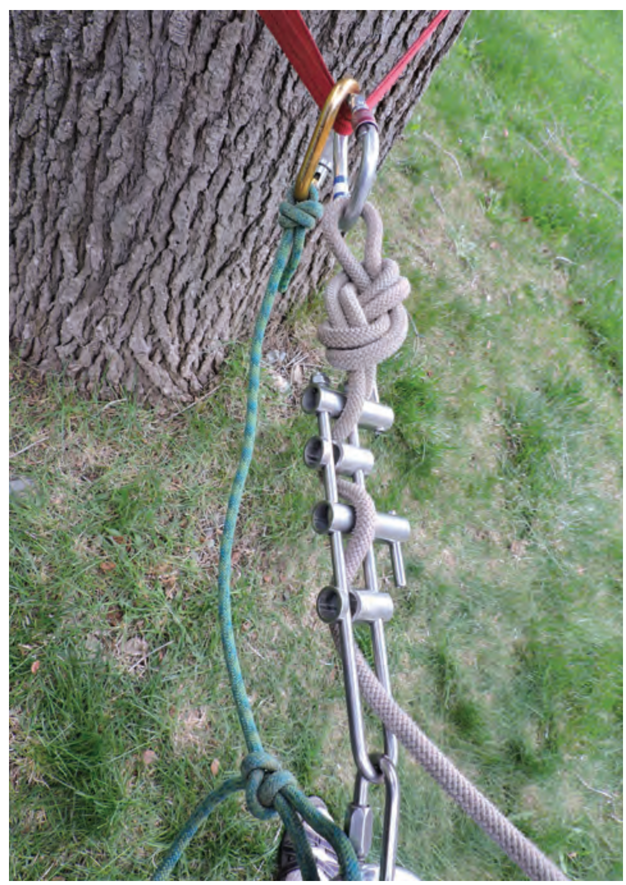
First, attach a safety device. This will save the day if any of the above-mentioned problems occur. The safety device is a fail-safe that is not loaded and its tether should have some slack. If the slack is lost, a step up in a footloop may be necessary to gain slack again.

The two primary types of rappel test safety devices are a quick-attach safety, or "QAS," and a cowstail. A QAS is a rope grab (most commonly a handled or Petzl Basic-style toothed ascender) attached to the harness with a tether. A QAS can double as the upper ascender of a climbing system, or it can be a separate, extra ascender. This second point of attachment can be provided almost anywhere, including mid-rope as during a changeover. Alternately, a cowstail may be used at pitch-head anchors, rebelays, and loop knots. Simply clip into the anchor or knot to provide the second point of attachment.

Second, rig the descender. The rappel test will catch problems and mistakes with any type of descent control device—rack, figure-eight, bobbin, ATC, Gri-Gri, ID, Scarab, Münter hitch, and so on. This is also a good time to triple-check harness buckles, carabiner/screwlink locks, and carabiner/screwlink orientations and to grab the pack and rope you left laying on that rock.

Third, load and test the descender. Verify that a tiny amount of rope (1–2 cm is plenty) properly slides through the descender. Check all descender-to-harness connections. Check carabiner gates, look-





The second point of attachment in a rappel test can be provided either by a rope grab attached to the rope above the descender (left), or a cowstail clipped into an anchor or rebelay (right). Photos by Andy and Bonny Armstrong.

ing for cross-loading or levering. Be careful to maintain slack in the QAS. Once proper configuration and operation are confirmed, stop and maintain control of the descender during step 4. A soft or hard lock of the descender may be necessary here.

Fourth, stow the safety device (QAS or cowstail). Maintaining predictable gear organization increases safety and efficiency. Being able to stow (and draw) a QAS with one hand is a valuable skill and can be accomplished with thoughtful gear organization and practice. Ideally, any device considered a QAS should be operable with only one hand.

Fifth and finally, unlock and rappel with cautious confidence.

Rappelling is one of the only times that many North American cavers will routinely commit to a single point of attachment to the rope. It is prudent that we take a little extra care to test and confirm the integrity of our system before committing to that single point. A rappel test should be performed every time an unloaded descender is to be loaded. If a descender is unloaded at a rebelay or ledge, the caver should first complete a new rappel test before continuing.

Take the rappel test every time. Make it a habit—even on those low-angle slopes and short drops. It's a test that, if taken properly, is impossible to fail.

Suspension Trauma Underground

Roger Mortimer, MD NSS 26529

In this edition of *American Caving Accidents* (*ACA*), we see several instances of someone getting stuck on rope. In some cases, they required assistance to continue on. We don't know the symptoms felt during the Ellisons case (page 95), but we read that the person in Carroll Cave felt anxious and passed out (page 67). People can safely spend hours and even days in a harness, but just minutes spent by someone who can no longer move can be very dangerous.

Losing consciousness on rope can lead to suspension trauma. The current understanding is that pooling of blood in the legs leads to lack of blood flow to the brain and other organs. Some people are skeptical of this concept. It is a rare event, so it's hard to make lists of cases to study. Harnesses, practices, and attitudes have changed over the years, making it difficult to compare cases over the long term. Unfortunately, there is no accepted definition of what makes a case of suspension trauma.

The list of deadly cases is thankfully short. There are other near misses though, some of which get publicity and probably some that do not. Classic symptoms are those one would feel before fainting such as nausea, light-headedness, or feeling flushed. These would be accompanied by lower blood pressure, pallor, and increased heart rate followed by a decreased heart rate.

Some people are more at risk than others—at least for the pre-fainting symptoms felt in a lab setting. Gender makes no difference, but increased weight increases risk. An alpine or caving harness is safer than just a chest harness or waist belt. Pre-existing dehydration or hypothermia increase risk. Pain may be an independent risk.

Because of a concern that the harness itself was blocking blood flow, the syndrome has been called "harness hang syndrome" and "harness pathology." These are poor terms. The major blood vessels in your legs run near the top of your thighs, a little closer to center. When you are sitting in a harness, this is the very area that has no compression at all by the harness straps.[1] Learn how to take a pulse at your femoral artery. Try it again the next time you are on rope. It's still there. The femoral vein runs right next to the artery.

If death on rope is not scary enough, there are also reports of death upon rescue that have gotten a lot of press in rope circles. These have been attributed to return of blood flow that had been blocked by the harness. One of the cases of immediate death after rescue was a young woman who fell rock climbing and was suspended for four hours.[2] She died a "few minutes" after rescue. This was, however, in the day before seat harnesses were used. She was suspended by a chest harness alone. Another case of an immediate death after rescue was reported in *ACA*.[3] In this incident from 1992 in Banshee Hole in Tennessee, the person was suspended for four hours, then died upon rescue. He too was using a chest harness alone to climb. In both cases of death upon rescue that have been reported, neither was even wearing a seat harness. That makes it even more difficult to implicate the harness in this problem.

What's happening? European physicians noted unexpected deaths on rope as early as 1972. Soon thereafter, French cavers observed that people who died on rope did it very quickly. Both groups noted that there was not trauma to explain these deaths. The French initially thought that hypothermia was to blame, since 10 of the 12 were in waterfalls, and it likely played a large part, but it was more than that.

The French decided to ask some volunteers to climb up a rope then pretend to be unconscious so they could see what happened.[4] Their first two volunteers became truly unconscious in 7 and 30 minutes. They decided to try again in a more controlled setting with more medical back up and had someone pass out in 6 minutes. They concluded that this was more than just hypothermia.

Follow up tests suggest a state of shock in these patients; that is, they cannot get enough blood into the brain. The longer someone stayed unmoving on rope, the more blood shifted from core circulation and got stuck in the legs. One can measure the legs expanding while the amount of blood in the chest shrinks.

The problem is that blood is getting trapped in your legs instead of returning to the heart to be recirculated. Your heart pumps blood to all parts of your body, but then this blood has to return. For blood physically above the heart, this is easy. Gravity just pulls it back down. Your legs though are trickier. There is no extra heart down at your ankles to pump everything back uphill. Instead, your veins have a succession of one way valves. Blood filling these veins is at low pressure. As you move, your leg muscles squeeze the veins and blood is pumped past the one-way valves eventually back to the heart.

The issue really is a lack of movement. Anyone hanging passively, from hypothermia, trauma, exhaustion, or even just pretending to be unconscious, loses the venous pump sending blood back to the heart. Instead, this blood pools in the legs, leaving less blood for the heart to circulate to the kidneys, the heart itself, and most importantly the brain.

So why would someone have problems after hanging too long? Since blood is pooling in the legs, it is not circulating back to the heart and lungs where oxygen is replaced. Muscles can function without oxygen for a remarkably long time but not forever. Muscle cells eventually die. When they do, both potassium and muscle enzymes can leak out of muscle cells. In the short term, potassium is dangerous to the heart and in the long-term muscle enzymes are dangerous to the kidney. In another 2005 case reported in *ACA*, we find a man suspended who had to be hospitalized for mild acute kidney failure because of muscle enzymes.[5] He was treated in the field to prevent potassium affecting the heart.[6]

Normally when there is not enough blood to circulate, the body's response is to faint. Falling down allows a return of good blood flow to the brain. The body's mechanism is to drop the heart rate and blood pressure even more so that a person loses consciousness and goes to ground. In most scenarios, this is good. But for the person in a harness, on rope, the ground is not an option because you are held upright. Instead, a brain already starved for oxygen and nutrients is deprived even more, with potentially catastrophic results.

Exhaustion, hypothermia, poorly functioning equipment, and water are all risks for suspension trauma. Photo by Chris Higgins.

In 2011 at Ellison's Cave, two people died on rope.[7] One rigged the Warm Up pit in the water then descended. He did not reach bottom and indicated he was having trouble. Communication was nearly impossible. While waiting for outside help, another man descended to try to help but could not and got stuck himself. How long they were suspended is hard to say, but the estimates are about 45 minutes for each before all communication ceased. Autopsy reports say they died of suspension trauma, but that is a debatable point. The time frame is consistent with both a suspension trauma death and hypothermia from being in the waterfall, but certainly the hypothermia put them at higher risk for an on-rope faint given their decreasing movement.

In the March 2016 Ellison's Cave incident in this *ACA*, a man made it 100 feet up Fantastic Pit, in the water, before having to stop. This was a perfect set up for a suspension trauma death, much like the ones described by the French. He was exhausted and cold and likely dehydrated. In this case though, the man's partner was able to climb up and perform a pick off. This may well have saved his life. At the 2011 Ellison's incident, the pick off (if that was even the intent) did not work, and a second person died. A pick off is something that is difficult to do unless practiced constantly. Kudos to the 2016 partner for doing it successfully. One hundred feet up Fantastic Pit, it may have been the only option. Most of the time, there are better ones.

In Carroll Cave, a person ascending a ladder felt faint and then passed out. Given that she was actively climbing at the time, it is unlikely that she suffered from blood pooling in her legs. However, once she fainted but remained upright, she was at high risk for consequences. Cavers there quickly used a winch to pull her up the rest of the way.

Faced with a suspension emergency, we as vertical cavers need to have a plan. OSHA insists on the worksite that there be a plan for saving someone stuck on rope. Cavers need to be prepared as well. In the Carroll Cave incident described in this issue of *ACA*, they had a plan and implemented it quickly. That person walked away doing well.

Of course, the first line of defense is prevention. We need to use appropriate gear and practice the rope work we will do underground. Preparation goes a long way. Failing that, we need to be able to lower someone stuck on rope while they are still well. This only works if there is enough rope at the top of the drop to allow this. Really, we need to be rigging with any excess rope at the top where it can be useful, not at the bottom where it can be hit by falling rocks. Another option is then to raise the person up. This is physically harder and also technically more difficult. In almost all cases it is preferable to lower. Of course, this only works if you have a plan on how to convert a fixed line to either a lower or a haul. Currently, the NCRC is teaching both techniques in its Small Party Assisted Rescue (SPAR) class, which is highly recommended to anyone leading a vertical caving trip.

Simpler than converting a fixed line to lower or haul is to rig for lowering. Few of us have ropes that will double Fantastic Pit but in many cases, we have enough to leave a lot on top of a pit. By rigging with something releasable like a tied off Münter hitch, we can convert to lower almost instantly. This may not work well in all cave settings, but it certainly can work in training situations where the risk of a novice having problems is much higher.

So, what do we do once we rescue someone who has been stuck on rope? An older recommendation was to treat this form of shock differently from others by keeping the patient semi-upright. This was supposed to prevent blood from returning too quickly to the heart. Follow up studies of this recommendation found that it was baseless.[8] Anyone taken down from the rope should be laid down immediately like any other patient.

The same early recommendations said to leave the harness on to prevent a too quick a return of blood flow, but as previously discussed, a caving harness does not affect blood flow. Leave it on or take it off; it doesn't matter.

What to do if it's you? First of all, don't let it be you. Practice your rope skills, don't rig in waterfalls, and don't let yourself get hit in the head by a loose rock. And don't pretend to be unconscious on rope!

If circumstances do lead you to be stuck but still conscious (dehydrated, migraine, injured), there are a few things that may help. Keep moving! Pedal your feet like you are riding a bicycle. Even better, push against resistance, like against your footloops if you are using a frog system.

If, like the woman in Carroll Cave, you feel like you might pass out, arrange yourself to be as flat as possible. This may be difficult in a narrow cave shaft. Studies of people in industrial harnesses have shown that a strap that elevates your legs prevents pre-fainting symptoms. Preventing fainting would then prevent the consequences of fainting while suspended upright. Depending on their length, the footloops of a frog system may replicate this. Users of ropewalkers will need to disengage foot cams then use a supplementary strap to raise the feet. As in all things, practice makes easier. At your next vertical practice, see what you carry with you that would serve this purpose in a pinch.

American Caving Accidents, like *Accidents in North American Mountaineering*, has been a valuable resource for understanding what is happening. For any rare phenomenon, we need to gather cases from a wide variety of sources to make sense of it all. As a Society, we should be proud of this valuable work. When many cases were first reported, their significance may not have been immediately clear. In retrospect, they became important. Please keep reporting any cases of trouble on rope to *ACA* with as much detail as possible. It is a service not just to cavers but to everyone else who uses rope.

Practice your vertical work and rig away from the water. Consider rigging for a lower whenever you can. Certainly, keep excess rope at the top of a drop—not at the bottom. If you think you might do a pickoff some day, practice—a lot. Do not create a second victim! If someone is stuck, get them down immediately. Lay them flat like you would any other first aid patient. Take off or leave the harness as fits the situation.

Suspension trauma is thankfully rare. Don't let it happen to you, but be prepared for it happening to anyone else on your trip. Be safe!

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Small Party Assisted Rescue

An Emerging Cave Rescue Philosophy

Andy Armstrong NSS 45993

Small Party Assisted Rescue (SPAR) is a discipline and a philosophy that stems from several guiding principles. It builds from the idea that the most important task in a cave rescue is to move the patient to the entrance of the cave, as quickly and as safely as possible, arriving in stable or better condition than that in which he was found. In many cases, the best way to accomplish these goals is for the patient's own caving party to begin, conduct, and in some cases, even complete the rescue with the personnel and gear that are available to them.

The concept of Small Party Assisted Rescue was created by the National Cave Rescue Commission (NCRC) to combine into a single discipline the ideas of "Self-Rescue" and "Small-Party Rescue." Self-rescue refers to rescue by the affected cave team without calling in outside resources, and small-party rescue refers to any rescue that can be accomplished by a small team, typically consisting of six or fewer people. The "A" in SPAR implies that the patient is able to assist with his own rescue. A SPAR patient can often assist by crawling or scooting through the cave, ascending or descending ropes, or even providing some extra help in hauling himself on some rescue systems.

Throughout the years, cavers have often rescued themselves. In many cases, self-rescue emerges as the best way for cavers to help an injured or ill team member. In many areas in North America, even a callout rescue will still be a small-party response by necessity. What has changed over the last decade is recognition of these facts. The idea of SPAR has gained greater acceptance from the organized rescue community as a valid and often preferred response to caving incidents.

As a leader in the field of cave rescue training, the NCRC has developed and begun teaching a SPAR curriculum in a three- to five-day format. These courses provide formalized training that cavers can use to conduct SPARs with a greater level of technical competence. These classes are currently in high demand, and spaces often fill quickly. NCRC SPAR courses have prerequisites of basic knowledge in knots and single-rope technique (SRT), and students must demonstrate proficiency in both in order to participate. The primary audience is cavers, but the courses have also become popular with canyoneers, climbers, cave search-and-rescue (SAR) teams, industrial rope technicians, bat biologists, and mine explorers.

A SPAR response is often necessary when cavers are in remote locations, too far for organized cave rescue teams to respond and be effective in a timely manner. In many situations, because of the patient's condition or the environmental conditions in the cave, waiting many hours for rescue is not a realistic option. For example, many alpine and high-latitude caves are much too cold for cavers to survive for extended periods without specialized bivouac gear. Even in the U.S., rescues to these caves and to remote locations within extensive cave systems often require a multi-hour response time—if there is a rescue team available at all.

In any caving incident, the patient's medical situation should drive the decisions as to what rescue actions to take. This includes the decision of whether to even attempt a SPAR. Self-rescue is only appropriate in specific medical circumstances, and a SPAR response may not be appropriate when the patient has severe injuries, is unconscious, or has a possible

NCRC instructor Gretchen Baker demonstrating a minimal gear traveling haul. Photo by Andy Armstrong.

Glen Kuehner operates a stacked counterweight system to haul Andrej Micyck over the edge of a pitch. Photo by Andy Armstrong.

spinal injury. Care must be taken to avoid "rescue fever," or any emphasis on the rescue roles or techniques themselves over the patient's well-being.

Many medical situations lie outside the scope of SPAR and require a carry-out litter rescue. These can include unconsciousness, spinal injuries, severe shock, severe hypothermia, pelvic injuries, and many others. Litter rescue is not SPAR. Litter rescues require many people and can take many hours or days. If a patient's medical condition requires him to be carried out in a litter, cavers should be dispatched to the surface immediately to request assistance. Remember that the "A" in SPAR stands for "assisted." If the patient is unable to assist, then the rescue is likely outside the scope of SPAR.

Immobilizing a patient in a litter can harm them. Litter transport can lead to suspension trauma, hypothermia, and physical injuries. It also increases the risk of rescuer injury, complicates vertical problems, requires more gear, takes more time, and causes more damage to the cave environment. Considering all these factors, there must be a legitimate medical justification for the decision to immobilize and carry a patient out in a litter.

According to *American Caving Accidents* (*ACA*) statistics, the most common mechanism for caver injury is falling. The most common caving injuries are to distal extremities, such as lower legs and forearms. Fortunately, these types of injuries can often be evacuated using SPAR techniques. Even a caver with two injured limbs is often able to provide some assistance and may not need to be carried out.

As already mentioned, a patient's medical situation is the greatest factor in determining what rescue actions to take. In reality, most cave rescues are medical interventions that require a technical response. During a rescue, the patient's condition can change, warranting a change in response. Rescuers should consider the health and well-being of the patient every step of the way.

The ability to accurately assess the patient's condition requires skills that can be developed through training. Cavers should consider enhancing their medical training by taking a Wilderness First Aid (WFA), Wilderness First Responder (WFR), or Wilderness Emergency Medical Technician (WEMT) course. These courses provide intensive training on medical treatments in austere environments. Medical "wilderness" is often defined as being two or more hours from the hospital. When underground and surface travel times are combined, it becomes apparent that most caving takes place within medical wilderness. Only when wilderness medicine philosophy is married with SPAR philosophy can we expect good outcomes for patients in SPAR responses.

Critical thinking is vital to the SPAR mindset. Caver-rescuers must be situationally aware and think critically about their situation, carefully weighing each variable. These variables include patient condition, team condition, distance to the entrance, available gear, and the physical obstacles between the injured party and the cave entrance. Cavers conducting a SPAR must continually monitor each variable and adapt to changing conditions as the rescue evolves.

SPAR is not mutually exclusive with callout rescue. There can be a hybrid response somewhere between the two. In many cases, a rescue can begin as a SPAR response until responders arrive. Cavers can be dispatched to the surface to call for resources immediately after the injury or at any point later in the evacuation. Sometimes, even if the caving party is unable to deliver the patient all the way to the surface, they can at least move the patient a considerable distance toward that goal. Any amount of distance covered by a SPAR response will make the evacuation that much easier for responders when they arrive.

With SPAR, the overriding philosophy is more important than the actual techniques. While much of a SPAR response will be non-technical, it is the technical vertical problems that require the most training and practice. For a technique to be considered appropriate, it must be operable by a small team of rescuers. Ideally, SPAR vertical rescue techniques should be operable by a single rescuer. Some hauling and lowering techniques that meet these criteria are counterweighted hauls, in-line traveling hauls, Münter hitch lowers, releasable redirects, conversion of a loaded line to lower, movement of a patient through rebelays, and pickoffs. The current NCRC SPAR curriculum focuses on these systems and challenges cavers to accomplish all of them in realistic situations with their own minimal gear.

Out of necessity, SPAR rescue systems are built with an absolute minimum of gear. SPAR systems use whatever gear is available to the caving party, which is often a meager cache made up of small rescue pulleys and prusiks, components of personal SRT systems, and whatever can be scavenged from rigging that exists in the cave. Techniques that require specialized gear not normally carried by cavers will be unavailable as options in most real incidents. SPAR philosophy encourages cavers to think preventively as rescuers to make SPAR responses possible, reasonably safe, and reasonably efficient. This mindset requires cavers to plan and prepare for rescue not only mentally, but also with adjustments to their vertical systems and to what they consider standard safety gear to be carried on every trip.

The current NCRC SPAR curriculum challenges cavers to build safe, effective rescue systems with only their SRT gear plus three extra carabiners, one rope grab device, and one pulley. If each member of even a two- or three-person caving party carries a rescue kit like this, the possibilities really start to open up for what can be built and operated underground. Rope, webbing, and hardware that could potentially be used in a rescue can be conserved by following a minimalist rigging mindset from the outset of the caving trip. For example, gear used in rigging one location is not available for use somewhere else in the cave when an emergency occurs. The rescue-ready SPAR philosophy encourages rope-only anchors where appropriate instead of needlessly using webbing and hardware. A carabiner that seems superfluous while rigging an entrance pit could be worth its weight in gold deeper into the cave when an accident happens.

Students operating a rappelling counterweight haul system during a SPAR class in Nevada. Photo by Bonny Armstrong.

By using concepts from traditional cave rescue pared down to their essentials, in tandem with a wilderness medicine mindset, cavers can often effect a successful cave rescue on their own. In any cave rescue, we must remember that the rest of the patient's life lies on the other side of the cave entrance. Our ultimate goal is to get the patient out of the cave as quickly and safely as possible. In many caving incidents, a SPAR response will be the best way to achieve this outcome.

Using Contingency Rigging to be a Safer Caver

Gretchen Baker NSS 50323

"I can't go any higher," said Sue.* She had ascended about 15 feet and had only 5 feet to go to reach the top of the drop.

"Take a rest, and then try again," I replied. This was Sue's second time ascending. The first time had been in a tree in my yard. She had done fine then, so I attributed this pause to nerves and her first edge problem. She had just rappelled this drop without any problems and had wanted to climb back up so she could get in more rappelling practice.

After a minute, Sue asked, with a hint of panic in her voice, "You can get me down, right? Because I'm not going to be able to go up anymore." She looked very worn out and uncomfortable. "I have a medical condition I'll tell you about when I get down."

"Yes, I can get you down." I had talked many people up and down drops, but I had a sense she was not going to move anymore on her own. I took a big breath, scampered to the top of the climb, and then released the contingency rigging I had used to anchor the rope. Sue was back down on the ground in a matter of seconds. I rerigged the rope and rappelled down to her to make sure she was okay.

Sue was lying on the ground, color coming back into her face. After a couple minutes, her breathing was nearly normal. "I have POTS," she said. Sue explained that POTS stands for Postural Orthostatic Tachycardia Syndrome. This syndrome meant that when she changes her position, she sometimes faints, basically due to blood pooling in her extremities. Sue had been on some medication but stopped it recently because it was making her blood pressure too high.

Sue hadn't told me about this potentially dangerous condition when she had asked me to teach her rappelling. It was only through years of rescue training and some canyoneering that I was even in the habit of using contingency rigging.

When I first started vertical caving, I most often rigged by tying a figure eight on a bight at the end of the rope, connecting it to my wrap-three-pull-two webbing anchor around a tree, and tossing the rope into the pit (always with a knot at the end!). Sometimes I would use a high-strength tie-off (tensionless anchor), again tying a figure eight on a bight at the end of the rope, then wrapping it a few times around a tree and connecting it with a carabiner. The rest of the rope went down the drop. These ways worked fine most of the time. But over time I learned some other methods of rigging. Why put all the rope down into the pit? Extra rope wouldn't do any good down there. In fact, it might get dirty or have rocks fall on it and damage it. Why not leave extra rope at the top of the drop? That way, if someone had trouble, it would be easy to rig up a haul system and help them out. Or, if there was enough rope, rappel down to them on the second strand and assist.

Leaving extra rope at the top of the pitch is partly contingency rigging. But with a little change on how you tie off, you can get someone having trouble on rope down even faster. My favorite way to do that is to tie a Münter hitch and then lock it off. Some people do this with a Münter mule, others with a Münter and then a half hitch followed by an overhand, some with two half hitches. Any of these ways locks off the Münter so it can't move. It's a solid rope to rappel and climb on. However, if someone has trouble on rope, like a new climber, someone with a medical condition, or a caver having difficulty in a waterfall, the Münter can be unlocked, and the person can be lowered to the ground quickly.

You can also make a high-strength tie-off into contingency rigging by putting just the amount of rope you need into the pit (with a knot on the end!), then wrapping the middle of the rope around the tree several times and clipping into a figure eight on a bight. If someone has trouble, you simply unclip the carabiner, unwind the rope until the friction is right, and then lower them using the extra rope you have on top. Using a rack or figure eight that is rigged and tied off is another way to do contingency rigging.

Using contingency rigging means that you need only one person to get the stuck person to a safer place. It doesn't take any extra gear (caveat: you will need to use a large carabiner to tie the Münter, since small carabiners may lock up the Münter). It's a classic example of using your head and training to make a situation better.

Back to the situation at hand. I explained to Sue that if she had been stuck on rope and I couldn't get her off rope and she went unconscious, she could have died within five minutes due to suspension trauma. Recent publications on this (e.g., Mortimer 2011, and Mortimer this issue page 22) show how time is of the essence to get people off rope when they aren't able to help themselves.

I told Sue that if she wanted to be on rope again, which included not only caving but also rock climbing, she must tell the people she was with of her con-

dition beforehand so they could plan appropriately. If they didn't have the knowledge or resources to get her off rope within minutes in the event that she became unconscious, then she shouldn't go with them. Fortunately, Sue made a full recovery from this incident. She is still interested in caving.

A little more research on POTS shows that this syndrome may not be as rare as first thought. Statistics estimate that between one and three million Americans may have it. The current diagnostic criterion is an increase in heart rate of 30 beats per minute or more within the first ten minutes of standing. Symptoms can include a decrease in blood pressure when standing, fatigue, headaches, nausea, and even chest pain. POTS is most often seen in women from age 15 to 50, but it can affect anyone. Learn more here: www.dysautonomiainternational.org.

Next time you rig a pit, cliff, training site, or anything else where someone will be on rope, consider how you could get a stuck person off rope quickly. Playing the "what if" game in your mind will help you to be better prepared if an emergency occurs. That's where contingency rigging comes in. If you plan for an emergency when you rig your ropes, and then someone has a problem on rope, then you don't even need extra gear to make the situation better, as you've already set up your rope in anticipation of an emergency.

A Münter hitch is an example of contingency rigging that can be used as a lowering device in case of an emergency. Here it is shown tied off with a mule and an overhand knot. Photos by Andy and Bonny Armstrong.

* not her real name

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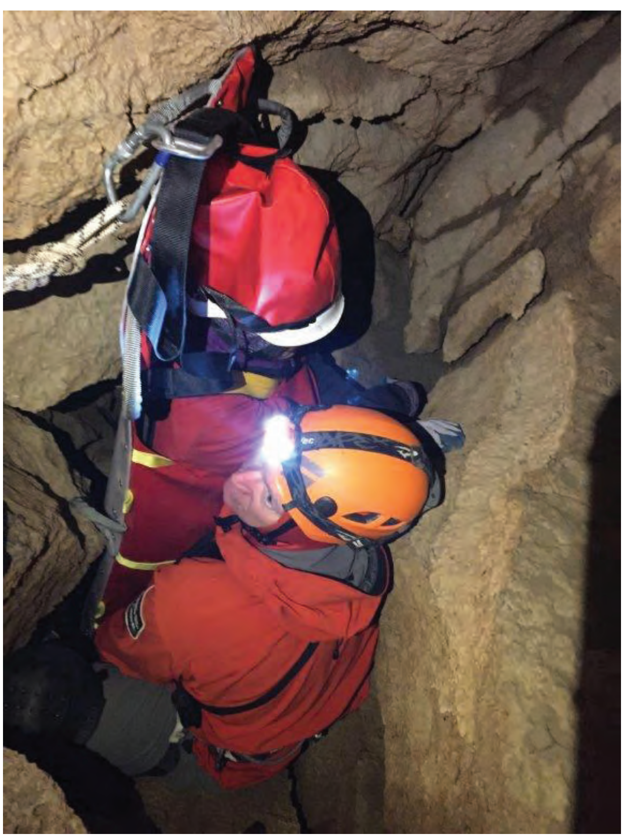
Cave Rescue North of the 49th

The Canadian Experience and Results

Christian Stenner NSS 61663

With caves spread across the vast Canadian north and caving clubs and societies in almost all of our provinces, caving has become a unique and popular pastime for thousands of Canadians. Caves are concentrated in certain areas, however, and it is these that have the largest concentrations of active cavers and where cave-rescue capabilities have evolved. This article will focus on organized cave rescue in Canada with a focus on the West (Alberta/British Columbia Cave Rescue Service) and the East (Société québécoise de spéléologie). The Alberta/British Columbia Cave Rescue Service (ABC-CRS) coordinates cave rescue training and response in Alberta and British Columbia through two parallel organizations formally recognized as search-and-rescue (SAR) groups in their respective provinces. In Quebec, the provincial caving society, the Société québécoise de spéléologie (SQS) maintains a group of members trained in cave rescue who can provide rescue response in Eastern Canada. Both groups comprise volunteers who fit within a national framework for search and rescue.



Moving a patient in a vertical crevice in Maligne Cave, Jasper, Alberta. Photo by Greg Horne.

The Framework

Canadian SAR services are a shared responsibility amongst federal and provincial/territorial governments in collaboration with municipalities, volunteers, the private sector and other partners. This wide-ranging list of authorities and partners, combined with Canada's expansive geography, diverse topography, and contrasting climates, make elements such as cooperation and collaboration essential to the successful provision of SAR services.

The primary authority for a ground SAR incident in Canada is a Provincial/Territorial responsibility—generally delegated to the police service of jurisdiction, or with Parks Canada within national parks. Although SAR volunteers are not directly accountable for the provision of SAR services, they are delegated responsibility in certain situations. Volunteer SAR teams provide operational SAR response capabilities to primary operational authorities (tasking agencies).

The History

The British Columbia Speleological Federation (BCSF) was incorporated in 1978. In 1984, recognizing the need for organized cavers to reduce risks and develop a self-rescue capability, members of the BC caving community informally established BC Cave Rescue (BCCR) as a training and cave rescue response service. Phil Whitfield, NSS 12901 RL,FE was instrumental in the creation of organized cave rescue here and served as the Cave Rescue Coordinator in British Columbia for many years since its formation.

After a fatality in Canada's deepest cave, Arctomys, in 1991 and the subsequent recovery operation, BCCR was recognized as an instrumental component in the rescue framework. In 1992, a Memorandum of Understanding signed by BCCR, the Provincial Emergency Program, the Royal Canadian Mounted Police and the BC Ambulance Service recognized BCCR as the lead organization for cave rescue in the province. Since that time, BCCR has operated as a formally recognized search-and-rescue group under the BC Provincial Emergency Program.

Across the border to the east, in Alberta, the provincial caving society of the time didn't want responsibility for rescue services. This was unlike the model in BC and in Quebec where the rescue service was a subcomponent of the organized caving federation. As such, the Alberta Cave Rescue Organization (ACRO) was formed separately in 2001 by cavers and members of Alberta SAR groups.

ACRO and BCCR have become closely associated, more formally since 2007, and adopting a common logo and using the name Alberta/British Columbia Cave Rescue Service (ABCCRS) in 2011. The relationship was further solidified during exercise "Dark Squeeze," a massive interprovincial cave-rescue exercise at Gargantua cave, under the Alberta/BC border. A memorandum of understanding (MOU) between the societies was signed to formally share a common membership list, logo, public name (ABCCRS), and policies and procedures.

The combined group is capable of responding to cave rescue emergencies anywhere in Western Canada, and could even be a resource to the Northwestern United States and Alaska. My counterpart in British Columbia, Doug Munroe, has used the phrase "Cave rescue is by cavers, for everyone," to describe our service, reflecting the organized caving community's commitment to the public, which includes all who venture into caves to explore.

Separated by 3,500 kilometers to the east, our friends in the Société québécoise de spéléologie had been evolving their own caving society and rescue capability. The SQS formed in 1970 and soon after formed L'École québécoise de spéléologie (The Quebec School of Speleology). The school began instructing in technical caving topics, including rescue, and provides a core group of trained cave rescuers within the SQS that can respond to caving emergencies in Quebec and Eastern Canada. Indeed the skills taught have also proved valuable in providing self-rescue capabilities to the SQS expeditions in Central and South America.

Patient movement during exercise "Dark Squeeze" in Gargantua Cave, Alberta. More than 100 people participated. Photo by Corey Hochachka, Trogphoto.com.

Training

In 1987, BCCR offered a week-long training seminar in cave rescue organization and techniques, similar to the NCRC seminars. The seminar, 80 hours in length, is now offered biennially. In 1995, BCCR began to offer annual training workshops in accident prevention and small-party self-rescue techniques, and since 2007, consecutive Companion Rescue and Rescue Response Workshops have been delivered over two weekends each spring in both BC and Alberta. Since ABCCRS training began, over 800 individuals have participated, and, almost all of the most active cavers in the area and over half of all the individuals within the area's caving societies have been exposed to accident prevention and rescue preparedness training. Training to members in Incident Command System 100 is offered online to members for free and government grant funding provides training in the ICS 200-400 levels including training the trainer courses.

The SQS operates its own training and rescue division through the Quebec School of Speleology. Through various two-day courses SQS members can receive training in basic SRT, rigging and advanced SRT, pickoffs, and rescue response. The training system is progressive and requires the basic courses (V1A, V1B, and V2) as prerequisites for the V3A rescue training.

As alpine caving techniques used in Canadian cave exploration have moved toward a more European style of rigging, using thinner ropes and with more reliance on rebelays and deviations, so have our rescue techniques. In recent years we have shifted to include the European methods such as those presented in the *Cave Rescuer's Manual* published by the Spéléo Secours Français (SSF). An increased emphasis on counterweight techniques and the incorporation of bobbin-style descenders and cammed ascenders into rescue raising/lowering systems has been a big shift for us. A benefit we see is that using items in rescue systems such as the Petzl STOP and cammed ascenders that northern cavers are already familiar with reduces training time and increases proficiency in creating rope rescue systems underground. The SQS cave rescuers had been using those techniques throughout their existence, owing to close ties with the European caving community.

Operations

Thankfully, rescue responses in Canada have been infrequent. Tracking our incident history separately from *American Caving Accidents* to account for incidents in Western Canada only, we can find 71 incidents of rescue response or small-party rescue, of which 24 required an organized rescue response. Though, with much caving happening outside of the organized caving community, statistics on injury are likely under reported as they are in any other jurisdiction. Rockfall is the incident type of highest frequency, which may be a result of the loose nature of some of our alpine caves.

Type	No. of Incidents
Caver Fall	13
Trapped/Stranded	8
Difficulty on Rope	6
Rockfall	18
Lost	3
Flooding	2
Hypothermia	0
Illness	1
Dislocation/Joint Injury	4
Exhaustion	1
Drowning	0
Stuck	5
Bad Air	1
Equipment	4
Other (overdue)	5
Total	71

Result	No. of Incidents
Fatality	2
Injury & Response	10
Response, no injury	12
Injury & Companion rescue	24
Companion rescue, no injury	14
No consequence	9
Total	71

In order to organize our information and incidents, the Alberta Government has provided the software platform D4H Technologies free of charge to all of the provincial volunteer teams. With it we can track incidents, training events, member information and qualifications, our equipment, and more. The platform is web based and so can be accessed remotely, and through an integration with Twilio it also allows us to do mass notification to our callout list via SMS, phone, and e-mail.

Engagement

Recently we have been doing more in the way of presentations to the SAR community on the challenges and complexity of cave rescue, along with how we are organized and trained. This is necessary as we operate so much differently from the regular volunteer ground SAR teams, which have different standards and operating procedures. This has included presentations at our National SAR conference, SARScene, regional conferences, and at the Banff Wilderness Care Conference.

A big factor in getting our message out has been a social media communications strategy. Through our Facebook and Twitter accounts we post information of interest to stakeholders and information on our own activities. It has been interesting to see the difference in demographics in our followers on the two platforms, and we have different content on each as a result. Our Facebook followers tend to be members of our teams, interested individuals and members of other SAR groups. Whereas our Twitter followers tend to be the official accounts of other SAR and caving groups, media organizations, emergency management related organizations and companies, rather than individuals.

Sustainability

One of the greatest challenges for us and indeed many volunteer agencies is sustainability, especially when it relates to funding. The Alberta/BC Cave Rescue Service is funded almost entirely by the recreational caving community in the form of training registration fees, donations from individual cavers, and contributions from the BCSF Glenn Peppard/Rick Blak Memorial Fund and the VICEG Rennie/Clark Memorial Fund.

Maintaining caches of specialized equipment and funding training courses for members so they are not paying out of their own pockets is the main funding requirement. Charging a small fee for rescue training workshops has allowed those events to be break even or slightly better, and the occasional corporate donation allows the sporadic purchase of a new or replacement equipment item.

ABCCRS maintains an extensive cave rescue equipment cache on central Vancouver Island, BC, and Calgary, AB, with satellite equipment caches at Kamloops, Prince George, and Crowsnest Pass. Prepacked rigging kits and rope kits, along with initial response team kits, are available along with various models of stretchers. Recently we are transitioning to the Petzl NEST cave rescue stretcher, already in use by the SQS.

Each province has a set of two Drummond low-frequency cave radios (185 kHz/35 kHz) capable of intercommunicating through several hundred meters of limestone. They can be used for underground to underground or underground to surface communications or to establish precise surface locations above underground sites in a rescue situation. An additional radio packaged for diving underwater through sumps is available.

Conclusion

Maintaining a capability for cave rescue in Canada is a challenge due to the vast territory, dispersed resources, and scattered people. But, we have a system that has proven itself in the callouts we have so far been required to undertake. Key to the success has been to integrate rescue responsibilities and training within the caving community. With that, rescue and risk management considerations are likely to be at the forefront of cavers' minds, thus helping influence people to make good decisions underground. Though, more people are taking to the outdoors and to the underground. With that we hope the infrequent nature of cave rescues is maintained in the future and the need for our services continues to be limited.

Current information and details of scheduled training events can be found at http://www.cancaver.ca/bccr and at http://www.speleo.qc.ca/

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Modernizing Canada's Search and Rescue Governance and Policy Framework: Discussion Paper. Ottawa, ON: Public Safety Canada.

Teams practice transitioning a patient between counterweight raise and lower systems, and a tyrolean traverse during an 80-hour seminar, Gold River, British Columbia. Photo by Christian Stenner.

PTSD and Cave Rescue: Who Rescues the Rescuers?

Tom Wood NSS 65725

I will die. You will die. Everyone we know will die. No one here gets out alive, as Doors front man Jim Morrison warned us way back in the sixties.

In our minds, we all know this to be true. But in our hearts, how many of us are truly prepared to deal with death or trauma while doing something we love—be it caving or cave rescue?

I've been a caver most of my life and a mountain rescuer for the last 18 years. I do most of my rescuing in the mountains of Colorado with the Alpine Rescue Team. I've participated in hundreds of rescues and done more than my share of body recoveries. But when I began my career in non-paid professional rescue, I was told that if I couldn't handle the carnage that sometimes accompanied search and rescue, I should do everyone a favor and just quit. "Suck it up buttercup," was the prevailing psychological advice that was dished out (in spades) back then.

But as time went by, I saw more and more of my fellow rescuers struggling to come to terms with the things they did and saw while trying to help others who were having a bad day in the mountains. Many, after being doled out that same crap advice I mentioned earlier, didn't feel inclined to "suck it up" and simply threw in the towel, walking away from the very people who could help them the most—their peers. And when it was my turn to struggle with the psychological aftermath of a traumatic recovery, I learned firsthand of my rescue team's reluctance to actively engage in "that touchy-feely, let's-all-hold-hands-and-sing-Kumbaya kind of malarkey." I learned the hard way that this attitude sprang mostly from institutionalized tribal rituals ("That's what I was told when I became a rescuer 40 years ago.") and ignorance ("Problem? What problem?") rather than from any intentional meanness or disinterest. We just didn't know any better at the time.

I came to realize that though we had no problem administering physical first aid to someone who became injured during a search or rescue, we were woefully ill-equipped to render psychological first aid to our members after a difficult search or rescue.

The Unique Nature of the Cave Rescue Discipline

Though they share many similarities, there are also some stark differences between non-paid professional cave rescuers and those who are paid professional rescuers. In fact, one might even go as far as calling all volunteer rescuers the invisible branch of first responders, especially when it comes to available resources for mental health.

Just in terms of patient contact time, the professional rescuer in an urban environment can measure their patient contact time in minutes, while non-paid professional cave rescuers may spend hours or even days with their patients. It's hard to imagine that this doesn't play a role in how cave rescuers bond with, empathize with, and are affected by the enormous amount of time they may spend with someone who is having the worst or last day of their life.

Generally speaking, professional rescuers have easier access to professional mental health services as part of their jobs. Many states include treatment for PTSD as a part of Workers' Compensation programs for their paid emergency responders, but volunteer rescuers are not typically covered.

Firefighters and other paid EMS workers work together on a daily basis, often spending days together on shift. This makes it easier for coworkers to observe and track "normal" post-traumatic stress reactions and intervene when it appears that the reactions have devolved into full-blown disorders. But non-paid professional cave rescuers are, by and large in the U.S., volunteers who do a lot of living in between cave rescues. It may be weeks or months between rescues, and this can make it difficult to know when someone is having a tough time after a difficult rescue. And when cave rescuers crawl into a cave for a rescue, the repressed memories and stifled emotions of their non-rescue lives are traveling right there with them. That thin veneer that protects us from our buried anxieties on the surface is more easily cracked when we are faced with the adrenaline, fatigue, and stress that are a part of every rescue or recovery.

It's important to make note of the fact that there is a difference between cavers who, because of an unforeseen event, are thrust into the role of cave rescuer versus the folks who crawl into a cave fully prepared to execute a rescue or recovery. Many times, the accidental cave rescuer is bereft of the post-rescue support network afforded to the trained cave rescuer working under the authority having jurisdiction (AHJ). Any time "civilian" cave rescuers are exposed to the carnage or stress that make up most cave rescues, it is difficult (or maybe impossible) to follow up with those individuals to check in on them. In these situations, it's important for the AHJ to have an accurate accounting of the personnel involved with a rescue or recovery and make those individuals aware of the post-rescue resources that could help them cope with any post-traumatic stress reactions that might manifest themselves in the days or weeks to follow.

Caving often forces us to conquer our fears and push our mental and psychological envelopes if we want to succeed. But the very same character traits that make us good cavers and cave rescuers can also make it difficult for us to cope with or even talk about Post Traumatic Stress Disorders.

Our good, bad, *and* ugly reactions to the trauma that we are exposed to as cave rescuers are all interlocking pieces of the same complex psychological jigsaw puzzle.

Laura Demarest, a 34-year-old project caver from Bloomfield, Indiana, has spent the last four years trying to piece together her own complicated jigsaw puzzle after a good friend suffered a heart attack and died during a routine 2013 caving trip in Indiana.

"We were just walking along in chest-deep water, hauling scuba gear. We were two miles into the cave, without a care in the world," she said. "When I looked back and saw that Tim was face down in the water, I thought it was just a prank. I was very confused and thought maybe it was a seizure as I tried to drag him back to a small gravel bar. We did CPR for 3 or 4 hours. No one wanted to be the one to say it was time to stop. When we finally did, we just sat there for hours. Awaiting rescue. With our dead friend."

As it goes with many recoveries, Demarest remembered that her very first reaction was one grounded in anger. "On the way out of the cave, I wanted to grab the cave formations I saw and break them. I had a lot of anger about the way the recovery was handled. I did eventually get past that."

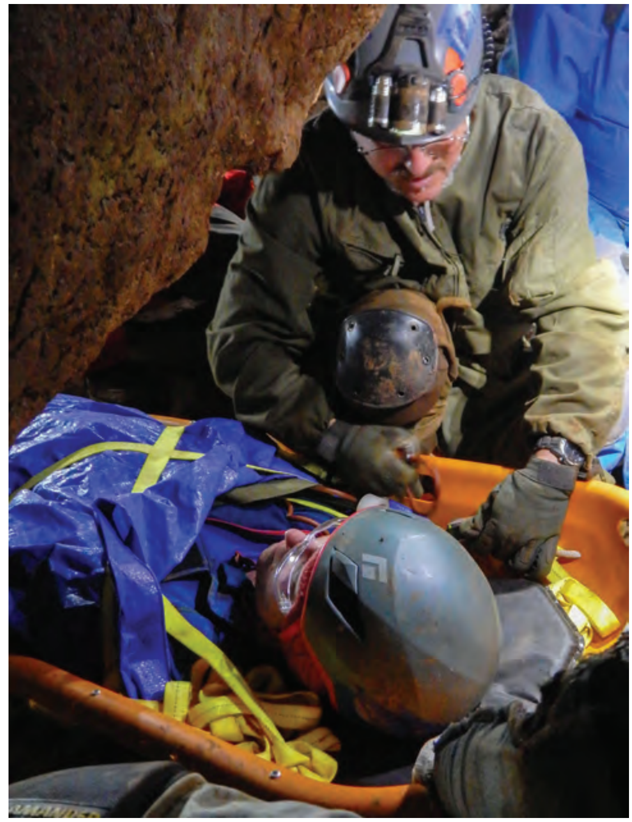
But then came the guilt. "I felt bad because I was still here and Tim wasn't," she confided.

"I was raised to believe that until you reached a saturation point, it wasn't okay to show emotion. My family was never really about lying down on a couch and talking through problems. We were raised to pull ourselves up by our own bootstraps. But I've found that sometimes that is just not enough."

That same stoic, blue-collar work ethic and no-nonsense, Mid-Western upbringing that made Demarest such a strong and driven caver also made it difficult for her to share the feelings of worry and dread that plagued her on subsequent caving trips.

"I became a horrible mother to the folks I was caving with. I worried every time one of them coughed suddenly, or even leaned back suddenly. Anything weird that went on with someone (in a cave), I assumed that they were going to die. It was taking the fun out of caving for me. I'd get teary-eyed on trips and hang out in the back so no one would see," she said.

Though it did help her to find out later that there wasn't really anything that anyone on site could have done to change the outcome, it wasn't until she decided to pursue cave rescue training through the National Cave Rescue Commission (NCRC) that she began to put the pieces together.



Cave rescuers often spend hours, or even days, in close contact with those that they are rescuing or recovering. This extended contact time can sometimes leave lasting scars when an outcome turns tragic. Photo by Michael Patton.

"Cave rescue training was my medicine, as hokey as that sounds," she said. "My Level 1 NCRC training brought up a lot of feelings. I had to surrender control, had to fight through it. I wanted to become a human Swiss Army knife. It really helped being around others who'd been through it. It was helpful to be surrounded by my cave rescue peers."

In late 2016, that cave rescue training paid off when Demarest and a group of six other experienced cavers were trapped by unexpected rising waters for 36 hours during a survey trip. And while for many cavers, a second cave trip involving a rescue might have triggered some debilitating emotional responses, it had the opposite effect on Demarest. "You have all that shit in the bottom of your pack for years, but you never think you'll use it. But suddenly you do and it's worth it. My cave rescue training gave me enough confidence to stay put. I've gotten stronger as a result." While waiting for the water to recede, Laura said she felt the tug of anxiety when she heard the sound of dripping water, which sent her mind racing back to the time she spent alone with her

Members of the Chattanooga-Hamilton County Rescue Squad work to free a young girl stuck in Raccoon Mountain Caverns. Photo by Buddy Lane.

friend's body. Demarest once again credited her cave rescue training as being the reason that she was able to maintain her composure and actively work to keep up the morale of her fellow cavers during that second rescue.

Triggers, such as the one Demarest mentioned, are huge factors when one looks at the perpetuation of Post-Traumatic Stress Reactions. Smells, sounds, and even movie advertisements can all force unexpected reactions to tragedies that we as rescuers thought we had long since buried.

Just ask veteran Utah caver Andy Armstrong.

The 2016 release of the film, *The Last Descent*, which tells the story of the epic and ultimately tragic 2009 Utah Nutty Putty Cave rescue attempt of John Edwards Jones, kicked the lid off a Pandora's Box chock full of emotions for Armstrong.

"This Nutty Putty thing is never going away for me. I keep waiting for it not to be weird. You can't move on when it just keeps coming up," he said.

Armstrong thought that he had his feelings under control until he saw the ad for the film on the back of the December 2016 issue of the *NSS News*.

"When I talk about this to people who don't understand the context, I worry that it might make me look angry or petty after seven years. I don't have any interest in seeing the movie," he said.

Armstrong added that he didn't fault those who wanted to see the film and described his dilemma as a no-win situation. "If I were to see the movie, I would worry that they wouldn't portray the events accurately, and that would upset me. The only thing worse than seeing that would be to see it portrayed accurately and then have to relive the events." Based on his observations after the Nutty Putty rescue, Armstrong feels that he is not the only caver or rescuer struggling with the devastating aftermath of that particular incident. "There are people we just don't see anymore, especially the cavers who responded to that rescue without any [previous] rescue training. A lot of people who were tearing themselves up have gone away from caving or rescue. With no support on the back end, they ended up stuck in a loop."

Most mental health professionals believe that this post-rescue/recovery support is essential for the folks who want to continue doing the things they love—be that caving or cave rescue.

Tim White, a lieutenant with the Chattanooga-Hamilton County Rescue Squad and the Southeastern Regional Coordinator for NCRC, remembers the first recovery he performed as a cave rescuer back in the early 80s. "I was not psychologically prepared, and nobody told me what to expect," he said. "In those days, the rescue service seemed to lose a couple of members after each recovery. Back then, we were mostly cavers who happened to do some cave rescue. The only advice we got was, *This might be hard*. Now, I feel we do a better job at training our members and they are more mentally prepared. But we still have a ways to go," he said.

"We also used to wait for folks to reach out for help if they were struggling. Now we try to be proactive and reach out to our members first," he added.

But just what constitutes a "normal" reaction to a traumatic event? That can differ from person to person, and there is no such thing as a universally accepted set of behaviors or time frame when it comes to dealing with trauma.

Allen Padgett, cave rescue veteran and coauthor of the vertical cavers' bible, *On Rope*, has developed his own coping strategies to deal with the unhappy endings over the decades.

"One of my coping mechanisms is to *no*t know or remember the subject's name. It simply becomes another body in a zippered bag," he said.

"Another is to either call or send my father (who was a Methodist pastor) an e-mail describing the entire operation. This allows me the chance to put substance to my emotions and speak of them. My father died over 10 years ago. After any traumatic call I still send him an e-mail. Somehow it does not bounce back so I feel like he still gets them. Luckily a few tears won't short out a keyboard."

Disassociation is a common coping mechanism for rescuers, but one that is sometimes impossible to attain given the nature of the call. Sometimes, we have to get up close and personal with our subjects and/or their families. This too can contribute to lingering feelings that we'd rather not face.

Padgett knows this all too well.

"One of the worst [recoveries] was one where I never laid a hand on the body," he said. "I was the agency representative for the Georgia Department of Natural Resources and it fell to me to communicate with the family. The subject was stuck on rope in a deep cave waterfall (Incredible Pit in Ellison's Cave), but we had not yet retrieved the body and confirmed death. I kept my professional face on when, over the phone, I told the mother that her son was indeed deceased. I will never forget that scream that followed. After telling the father as well, I was able to end the call. At that point I walked away from the command post and said a prayer for them all, then cried my eyes out. I walked a bit and came back to handle my responsibilities for the rest of the rescue."

Padgett estimates that he has been on 46 recoveries and has avoided any lingering negative emotional damage to his psyche—so far.

"But the next one may be the straw that breaks the camel's back. No nightmares now, but I can picture in my mind's eye every one of the 46. Those images cannot be unseen."

Padgett credits a routine that he's developed over the years as the reason he's been able to keep the wolves of despair at bay.

"Luckily over the years I was able to decompress after each one. I would take a 'mental health day' and simply go for a long walk in the woods. No alcohol. No drugs. No fatty foods. No caffeine. Just eat well, get exercise and quality rest. Works for me," he said.

Padgett's strategy for success, though it may not work for everyone, pointedly avoids a common post-traumatic event coping mechanism: substance abuse.

Cavers and rescuers often have the reputation as being the kind of folks who work hard and play harder. But how does the layperson differentiate between someone having a good time versus someone who is seeking to escape the reality in which a traumatic experience has imprisoned them? How does one even know if someone is using drugs or alcohol for recreation versus alienation? Especially given the sporadic nature of interaction that is part and parcel of volunteer cave rescue?

In other words, how can we tell the difference between the unfortunate (but normal) post-traumatic reactions to tragedy and those that are the hallmarks of a debilitating post-traumatic stress disorder?

The Difference Between a Post-Traumatic Stress Reaction and a Post-Traumatic Stress Disorder

Post-traumatic stress reactions have no expiration date. They may affect us for a few short hours, or they may be with us for the rest of our lives.

Steve T. Davis, the Stewardship Chair of the Southeastern Cave Conservancy, still deals with some post-traumatic stress from a rescue he helped perform several years ago.

"The Valhalla tragedy has haunted me ever since it happened," he said.

"I rappelled down and helped with the recovery. My hands are shaking and my face is full of emotion even as I type this. I spent many hours in the pit digging and moving rock to remove the two guys. I recall clearly the smells and dealing with their body fluids. A bad scene. One of the hardest things I did was climb up the rope. Exhausted, having to rest too often and think about—well everything. I have been to Valhalla many times since then. Perhaps dozens. I have never been back to the bottom. I have taken many pictures hanging off the top and have done many other pits. Just not that one. I don't need to go back down there. Nowadays I blame it on me being too out of shape but that's not the real reason."

Davis said that though the memories of the Valhalla recovery can still evoke powerful reactions, they haven't stopped him from pursuing his passion—caving. "They're just memories I live with," he said.

It's a thin line between PTS and PTSD. So thin, in fact, that it may take a mental health professional to make an accurate diagnosis.

Dr. James Bender, with Deployment Health Clinical Center, had this to say about the two similar outcomes that traumatic events often beget: "It's easy to confuse post-traumatic stress (PTS) and post-traumatic stress disorder (PTSD). In addition to sharing similar names, there's considerable overlap in symptoms between the two conditions. Both PTS and PTSD are associated with feeling fearful and/or nervous, avoiding the activity or place associated with the traumatic event, and nightmares. However, there are significant differences in symptom intensity, duration, and treatment," he said.

The physiological indicators of PTS and PTSD *are* quite similar. Both during and after a traumatic event, your body prepares itself to meet the demands of our instinctive fight-or-flight tendencies. We breathe faster, our heart rate increases to get more blood moving to feed our muscles, and non-critical bodily functions like digestion are shut down. These are our primordial survival instincts, and they are often hard—if not impossible—to control. The cold sweats, shaky hands, nervousness and anxiety are the by-products of these almost involuntary responses to dangerous or stressful situations.

If you are a glass-is-half-full kind of person, you may draw some comfort knowing that one of the more positive outcomes of PTS is that these instinctive reactions may be warning you to behave more carefully in a similar potentially dangerous situation down the road. If you are a glass-is-half-empty kind of person, you might at least take some solace in the knowledge that these negative physiological effects of PTS are usually relatively short-lived and often diminish over time.

But when days stretch to weeks, then months, then years, and these physiological responses have progressed to the point where you are behaving recklessly, using alcohol or drugs to the point where their use threatens your job, your relationships, and perhaps even your sanity—then you may be experiencing true PTSD. This is the time to seek professional help and get an accurate diagnosis.

"PTSD is a clinically-diagnosed condition listed in the *Diagnostic and Statistical Manual of Mental Disorders*, the recognized authority on mental illness diagnoses. The fifth revision, released May 2013, includes the latest diagnostic criteria for post-traumatic stress disorder," said Dr. Bender.

"Anyone who has experienced or witnessed a situation that involves the possibility of death or serious injury, or who learns that a close family member or friend has experienced a traumatic event, can develop post-traumatic stress disorder, although most people don't. It's still not completely understood why some people who are exposed to traumatic situations develop PTSD while others don't," he said.

When someone is diagnosed with PTSD, treatment can range from intensive trauma-focused psychotherapy and cognitive processing therapy to prescribing medications like Sertraline and Paroxetine that can help manage the symptoms of PTSD.

But what happens when someone continues to struggle with undiagnosed PTSD? According to Dr. Sally Spencer Thomas, an expert on the topic of suicide with the Carson J. Spencer Foundation, our firefighters and first responders have suicide rates that are about the same as military veterans returning from combat. This startling statistic has prompted several states to look at how they can better provide for the mental health of our non-paid professional first responders. These efforts include getting PTSD treatment covered by Workers Compensation for *all* emergency responders, and working to better educate SAR leadership about the symptoms of PTSD. But unfortunately, many states are stuck within a rigid 48-hour time frame to report a psychological injury after a traumatic event, which unfortunately precludes anyone from seeking compensation for treatment from the cumulative effects of multiple traumatic events that so many first responders face.

The Role of Humor

"Life does not cease to be funny when someone dies any more than it ceases to be serious when someone laughs," said George Bernard Shaw.

Ask any cave rescuer if they've cracked a joke or laughed inappropriately during an intense rescue or recovery, and many will sheepishly admit that they have. This is known as gallows humor, and it is a common technique used to cope with terrifically tragic circumstances, both during and after the event.

"What helps people survive awful circumstances is their ability to detach and get beyond themselves. This is seen in heroism and humor," said concentration camp survivor Victor Frankl.

But humor can be a double-edged sword. Though it often can provide a pressure relief valve for some, it can also be hurtful to others who are struggling to cope with a traumatic situation. There is no guideline to reference that would tell us when humor is an appropriate or inappropriate coping mechanism. In fact, its very inappropriateness and spontaneity during the most stressful moments on a rescue or recovery is the thing that can sometimes make humor such an effective tool.

The Carson J. Spencer Foundation has turned the way we look at PTSD and mental health on its ear with its humorous (and surprisingly effective) ad campaign called "Man Therapy." Published in 2016, the white paper entitled, *Therapy for Men Who Consider*

Sirens Driving Music: Man Therapy™ for First Responders (https://mantherapy.org/pdf/First-Responder-White-Paper-July-2016.pdf) stressed the importance of targeting the first responder community about mental health education—using unconventional humor to draw them in. Given that the first responders at highest risk for suicidal behaviors tend to be white males of working age, "Man Therapy" targets those individuals and challenges them to start talking candidly about mental health. How serious is this issue? Very, according to the foundation's 2016 report. A 2015 *Journal of Emergency Medical Services* article that surveyed 4,022 EMS professionals from all 50 states revealed that 86% experienced what the authors call "critical stress" (acute or cumulative stress from the job), 37% had contemplated suicide, and 6.6% had attempted suicide.

So while humor may work well to set us at ease during stressful rescues or tease us into chatting about our mental health, it's no joking matter that we need to come up with a better way to help rescuers deal with the darker side of their lifesaving work.

Decon for the Soul

Most cavers have begrudgingly accepted the practice of decontaminating their caving gear after each foray into the bowels of the earth so that they might prevent or forestall the spread of White-Nose Syndrome (WNS). And so it goes for cave rescuers. If we want to keep enjoying our sport, and support those who help us after we have a bad day underground, we need to set up better post-rescue protocols to ensure that our rescuers are educated and truly prepared to recognize and deal with PTS and PTSD.

When it comes to combating PTS and PTSD, silence is a surefire recipe for disaster. Though there are many differing opinions on which awareness or coping strategies are most effective, most would agree that the first step in ANY successful program is to get the conversation started.

While some organizations employ Critical Incident Stress Debrief (CISD) tactics after a traumatic rescue or recovery, some mental health experts have expressed concerns about the effectiveness of this

Untrained recreational cavers are often drafted to help in cave rescues. It's important for them to receive follow-up calls after traumatic rescues or recoveries to ensure that they have the same post-traumatic stress resources available to them that are afforded members of organized cave rescue teams. Photo by Michael Patton.

type of follow-up. Some even go as far as warning that a poorly executed CISD may actually do more harm than good. In a nutshell, a CISD is usually organized and hosted by the AHJ after a particularly grisly or traumatic rescue or recovery. Typically, a person with training as an advocate or as a grief counselor will lead this debrief, wherein all participants are invited to attend and contribute their thoughts and feelings about the event. But often, the folks who need the most help will simply avoid a CISD for fear of appearing "weak" in front of their peers. Also, some attendees of CISDs said that attending that style of debrief acted as a trigger that set off some PTS from a completely different mission, but they were hesitant to mention their anxieties for fear of derailing the CISD "process."

Other agencies, like my rescue team, have adopted an approach that blends the CISD with a more one-on-one type of post-rescue follow up. This blended approach usually includes a one-on-one phone invitation to a small group meeting to the folks who were directly involved in the traumatic event from a team leader who was on site. This invitation is also a chance to informally check in with each member to see how they are doing. When the actual meeting is held (usually within a week following the event), only the folks who were directly involved can sit in on the closed-door meeting. And what is said in that room stays in that room. If more meetings are warranted, or follow-up professional help is called for, hopefully our members now understand that it is not a sign of weakness to admit that they've been affected by the trauma they've witnessed. Though not perfect, this method has been successful to date (on average, my rescue team responds to 10–20 fatalities annually, so we get more practice than we'd like when it comes to this type of outreach).

When it comes to finding a strategy to help rescuers who are staring down the PTS blues, most mental-health experts agree that one size does not fit all. There is no such thing as a surefire method that works for everyone, and the worst thing we can do is nothing.

Closing the Loop

Back in pre-9/11 America, most of us thought of PTSD as being something that only combat veterans dealt with. But as horrific as the events were on that fateful September day, they threw first responders into the national spotlight. Consequently, this led to them being examined under the microscope when they struggled with 9/11's aftermath. For the first time, we realized that soldiers and saviors were similarly affected by the tragedies they faced.

But there's a stark contrast in the thought processes and methods of soldiers versus those of the saviors. As any combat veteran will tell you, the military looks at each and every mission and assigns it a certain percentage of acceptable losses. But there are no acceptable losses in the world of civilian rescue. All losses are unacceptable to us, and I feel that this may explain the inability to accept a bad outcome. We simply don't allow that possibility to enter into our minds. Is it any wonder that when an outcome is tragic, it sends shock waves through our psyche? Every loss is unacceptable in our world. Call them subjects, casualties, or victims, it doesn't matter. In the world of SAR, we don't want to lose a single soul who needs our help. But sometimes we do, and that possibility is something that needs to be discussed just as readily as we celebrate and discuss the "save."

Like it or not, death and tragedy are a part of cave rescue. Not to say that every time we perform a traumatic rescue or recovery, we need to hire a psychiatrist to check in on our rescuers. But we DO need to educate cave rescuers about the difference between the good/normal reactions to bad outcomes and the bad reactions to bad outcomes. If we want to remain sane and healthy while doing cave rescue, we need to embrace the notion that death and tragedy are just as much a part of what we do as the happy endings.

By accepting this hard-to-swallow fact, perhaps we can shine a brighter light on our darkest moments and better equip ourselves to help the helpers.

Who rescues the rescuers? We do.

An Introductory Guide to Carabiners

A Critical Component of Your Vertical System for Ensuring Safety on Rope

Thomas Evans NSS 57831

What is this guide and why is it necessary? People that recreate, volunteer, or work in a high-angle environment frequently have little training in the nuances of carabiner form and function because instructors perceive this information as obvious or of little value. This has led to a population of recreational and professional carabiner users that know enough about carabiners to be safe on rope, but often do not get the most out of the equipment they use and own. In caving, this means that suboptimal use of carabiners is common, sometimes leading to accidents below ground. These accidents are preventable with minimal training. Therefore, the intent of this article is to help users get the most out of their equipment, thus preventing accidents from occurring in the first place. Presented here are the fundamentals of carabiner selection and use. This article can be used as a reference guide for new users and a reminder for frequent users. The intent is to facilitate more efficient and safe rigging through greater awareness of nuanced carabiner use.

Carabiner Anatomy

To understand the rest of this discussion, you need to know the parts of the carabiner (Figure 1). While the shapes, sizes, and varieties of carabiners are many, they all have the same or similar parts. Learn the parts of a carabiner so you can communicate with other users cogently.

Carabiner Markings and Certifications

Important information is stamped on carabiner spines manufactured for life safety applications (Figure 2). This includes carabiner strength when loaded along the long axis with the gate closed, when loaded across the short axis (gate loaded), and when loaded along the long axis and the gate is open (Figure 2, markings in the circles). The numbers are expressed in kilonewtons (kN), the metric unit of force. A kN is equal to 224.81 pounds.To convert between kN and lbs, multiply or divide by 224.8 or ~225. These markings indicate the minimum force the carabiner manufacturers will guarantee their product can hold without failure in the indicated configurations. Next to the strength markings are any national or international certifications if the carabiner has been certified to any (Figure 2, underlined markings). These markings indicate that the carabiner meets the minimum requirements of a given standards agency. Common markings include those from ANSI (American National Standards Institute), NFPA (National Fire Protection Association), UIAA (International Climbing and Mountaineering Federation), and CE (Conformité Européenne). Generally, if a carabiner has a marking from any of these groups, the carabiner is strong enough for life safety applications. None of these strength ratings and certifications, however, can inform you about carabiner strength when a carabiner has use wear or has experienced abnormal use or abuse.

Carabiner Shapes

Carabiner shape alters performance. Users should ideally use the right shaped carabiner for particular functions. Figure 3 shows the four most common carabiner shapes, and Table 1 explains their strengths and weaknesses.

Generally, the size of the basket, or top bar, controls how many items can be clipped in to the carabiner. The wider the top bar, the more items can be clipped in. Similarly, the shape of the top bar controls how well items stay in place. Rounded top bars like on HMS or Oval carabiners keep materials more or less centered on the carabiner basket, and not along the carabiner spine, which causes leverage of the top bar relative to the carabiner spine. D and Offset D-shaped carabiners have top bars that facilitate items slipping down the basket next to the spine. This variation in carabiner performance based on shape means that some carabiners are compatible with some items and not others. A more thorough discussion of this topic is in the next section, Concept of Compatibility.

There are many other carabiner shapes—some specifically designed for one function or another. Some carabiners have a twist, so are three dimensional. Each of these carabiners is a specialty model designed for specific functions. These unique carabiner shapes and designs are not explored here because there is not enough space to cover the many variations.

Concept of Compatibility

It is vitally important that carabiners be compat-

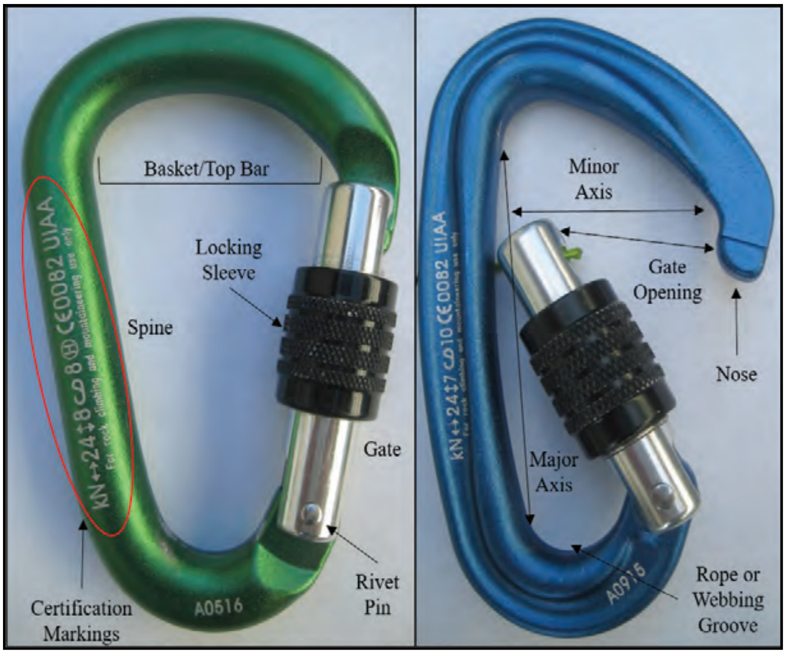


Figure 1. Carabiner anatomy. Photos by Thomas Evans.

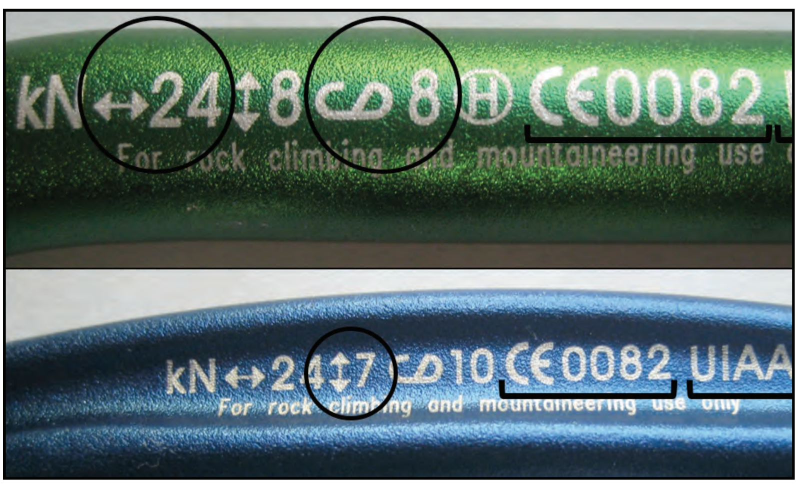


Figure 2. Carabiner spine markings; carabiner strength in kilonewtons when loaded along the long axis (top figure circled on the left), gate loaded (circled in bottom figure), and loaded along the long axis with the gate open (top figure circled on the right). Certifications are underlined with brackets in both images. These carabiners are certified to both CE and UIAA standards. Photos by Thomas Evans.

ible with whatever they are connected to. Compatibility can be thought of as the "harmonious interplay of connecting components,"[2] which really means that the two things that are connected work well together and thus have a lower probability of causing problems. For example, the Petzl Fixe pulley has fixed side plates and will tri-load D-shaped carabiners, but loads oval and HMS style carabiners in extension (Figure 4b-d). Similarly, the carabiners used to connect racks to harnesses can be incompatible with the rack frame. If loaded incorrectly, the rack frame can lever open the carabiner gate, and disconnect the rack from the carabiner (Figure 4e,f).[5] The incompatibility of racks with some carabiners has caused accidents, such as the May 2015 incident in Kentucky reported in this issue. This has prompted some to advocate the use of screw links to connect racks to harnesses.[3] Therefore, while the concept of compatibility is poorly known, it is of vital importance to rope users, because incompatibility problems can result in preventable fatalities.

Philosophy on What to Buy

Ideally, you purchase and use the carabiners that most appropriately meet your needs. Usually that is not how we start purchasing equipment. Most of us start buying gear before we really know what we are doing; we then spend decades slowly accumulating more gear as we learn more, gear improves, and we have more money. For many, our initial forays into gear purchasing occurs when we are young, so price is a large factor in our buying decisions. Purchase the most appropriate carabiner(s) for your intended use given your budget. Alternatively, use the carabiner most appropriate for the task at hand from among the limited gear you have. Often that is all you can do!

For those who have expendable cash, purchase the carabiner(s) that are the right tool for the job because there is no one carabiner that is perfect for all rigging functions. Your life, and the lives of others, is worth the extra money spent on purchasing the most appropriate carabiner(s) for a job. Therefore, a discussion of price is not included here. Similarly, I will not advocate for any particular manufacturer or carabiner type, because all the products produced by reputable manufacturers and certified to some standard are quality products. Note that some manufacturers intentionally cater to particular markets, so they have a reputation within those communities. For example, SMC makes many carabiners specifically for rescue and industrial use, while Petzl and Rock Exotica both make carabiners primarily for climbing and other sport applications. However, if you find a carabiner that meets your needs exactly, is certified to a relevant standard, and is from a manufacturer often associated with another discipline, buy it! They are all quality products.

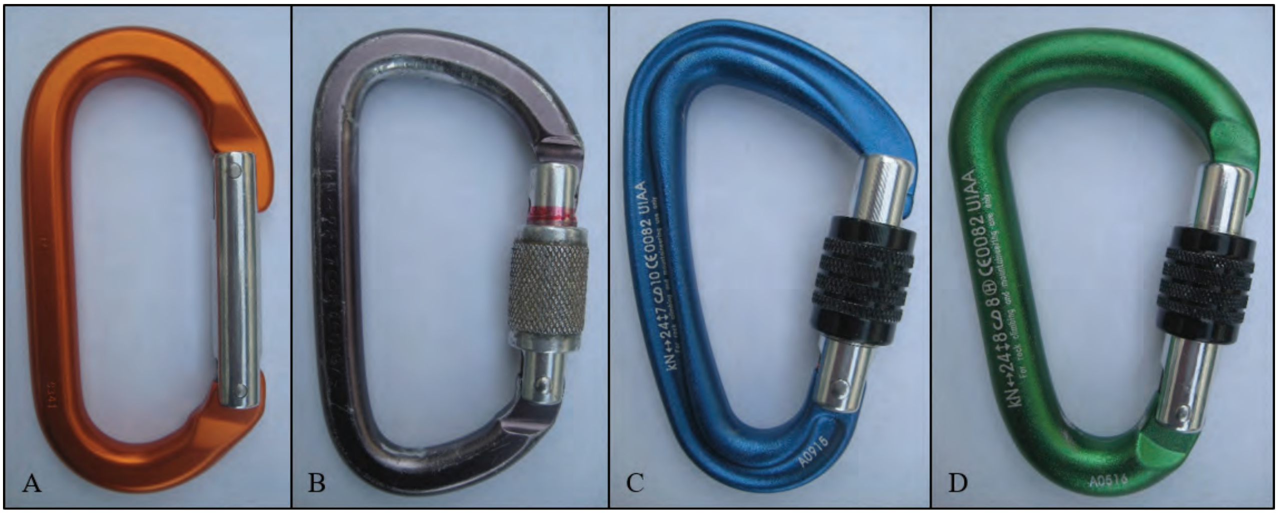


Figure 3. The four most common carabiner shapes; A) Oval, B) D, C) Offset D, and D) Halbmastwurfsicherung (HMS). Photos by Thomas Evans.

Carabiner Shape	Other Names	Strengths	Weaknesses	Common Applications
Oval		• Nearly the same strength even in different rigging configurations; more consistent strength when tri-loaded • Can hold more gear than a D-shaped carabiner • Flips/rotates easily when unweighted, minimal movement when weighted • Prevents load from shifting during loading (load always stays at bottom of the carabiner)	• Weakest of the carabiner shapes • Smallest gate opening • Heavier than other shapes • Harder to clip than other carabiner varieties because of the smaller gate opening size	• Mountaineering • Racking protection • Aid climbing
D		• Strongest of the carabiner shapes when loaded along the spine • Lighter than ovals and HMS carabiners of the same size • Larger gate opening than oval carabiners	• Strength is dependent on rigging configuration • Heavier than offset D carabiners • Smaller gate opening than Offset D and HMS carabiners	• Fixed rope anchors (e.g., caving, top rope anchors) • Rescue rigging
Offset D	Asymmetric D	• Larger gate opening than oval or D-shaped carabiners • Can hold more equipment than a D-shaped carabiner • Lightest carabiner for its strength and size • Narrow end holds software in place well	• Smaller gate opening than HMS carabiners • Smaller space inside the carabiner than an HMS • Strength is dependent on rigging configuration	• Quickdraws • Climbing anchors
HMS	Münter Pear Belay	• Can clip the most equipment of all the carabiner shapes • Largest gate opening of the carabiner shapes • Can clip larger items than other carabiner shapes	• Heavier due to their larger size • Weaker than D and Offset D carabiners	• Belaying • Rappelling • Climbing anchors

Table 1. Common names for the four most common carabiner shapes, including their strengths, weaknesses, and some example uses of each.

Usually choosing a carabiner to buy is as simple as picking your desired composition, shape, gate type, and size. However, sometimes a few carabiners are more or less equal, so a couple of additional rules of thumb are useful in helping to pick which carabiner(s) to purchase.

1. Smaller carabiners are often desirable due to low weight, but they are generally harder to use, and perform fewer functions well (less versatile). Be aware of these limitations, so you know what you can and cannot do with your equipment.

2. Larger gate openings make it easier to clip

Figure 4. Examples of compatibility and incompatibility of hardware. A) A compatible carabiner and pulley, B) An incompatible carabiner and pulley that torques the top bar when loaded, C, D) Compatible carabiner and pulley combinations that load carabiners along their long axis, and E, F) Example of how a carabiner gate can be levered open by a rack if the carabiner is gate loaded. Photos by Thomas Evans.

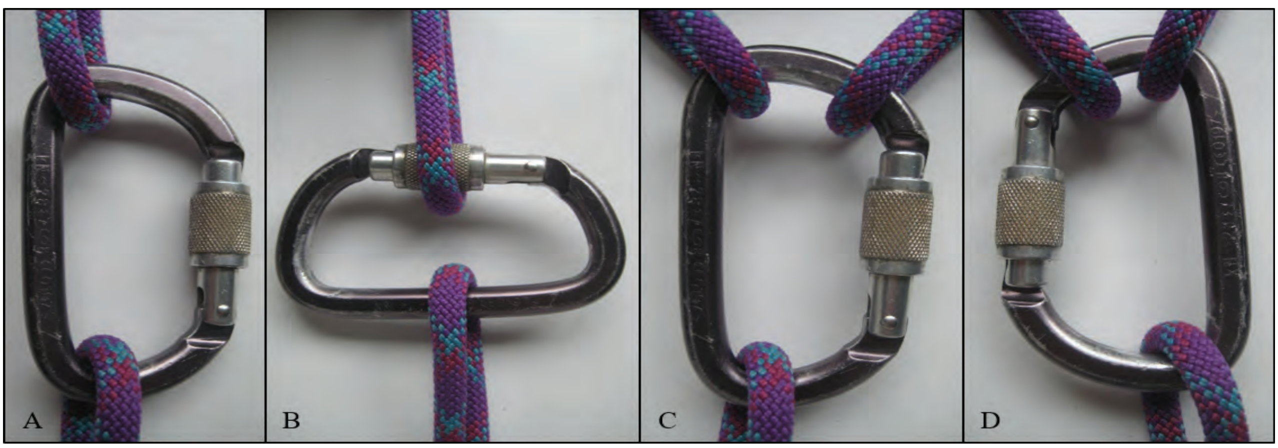


Figure 5. Examples of correct and incorrect carabiner loading. A) Carabiners are designed to be loaded in extension along their long axis, B) Cross loading, or gate loading a carabiner dramatically reduces its strength, C) Triaxial loading or tri-loading a carabiner, avoid this whenever possible!, and D) If tri-loading is unavoidable, orient the carabiner with the smallest end pulled apart, this orientation will retain the most carabiner strength. Photos by Thomas Evans.

many things into the carabiner. If you tend to clip many things into one carabiner, get carabiners with larger gate openings (Offset Ds, HMS).

3. Rounder bar stock and larger diameter bar stock works better for applications when a rope is pulled over the carabiner (such as pull down rappels, top roping, and so on). Pick carabiners made from these bar stock types if you pull ropes frequently.

Just remember, the piece of equipment that will protect you the most is your brain, not a piece of gear. So yes, buy quality carabiners. But more importantly, know how to use them!

Optimal Carabiner Use

Carabiners are only as strong as the brain that rigged them because carabiner strength is also a function of rigging geometry. Here are a few rules of thumb to improve your carabiner usage.

1. Use the right carabiner for the job! If given a choice between a few carabiners, use the carabiner with the most appropriate properties out of the choices available.

2. Carabiners are stronger when loaded along their major axis (Figure 5a), so load carabiners parallel to the long axis when possible. Cross loading or gate loading a carabiner (Figure 5b) is when it is loaded along its narrow axis (force applied to spine and gate). Carabiners are much weaker when cross loaded, so prevent cross loading whenever possible!

3. Triaxial loading, or tri-loading, is when a carabiner is pulled in three (or more) directions (Figure 5c). Because carabiners are designed to load along their major axis, tri-loading dramatically reduces carabiner strength, particularly for D-shaped and Offset D-shaped carabiners. HMS and Oval carabiners can tolerate tri-loading better, but triaxial loading weakens all carabiners. If tri-loading is unavoidable, orient the carabiner with the smaller end being pulled apart (Figure 5d); this is the strongest configuration.[6,7]

4. Carabiners are much stronger with closed gates. After rigging, double check to make sure nothing caught and kept the carabiner open (such as webbing).

5. Prevent gates from opening during use by locking carabiners (if possible) or facing the carabiner gate away from any object that could compress the gate. Face gates away from rock walls, the ground, limbs, or any other object.

6. When locking screw gate carabiners, screw them shut, then back them off a quarter turn so they are not impossible to unscrew when loaded. If, after loading, a screw gate carabiner is hard or impossible to unlock, load it again, and unscrew it a little. The deformation caused during loading can often make it difficult to unlock if the locking mechanism tightens when the carabiner is deformed. If a screw gate carabiner is impossible to open even when loaded, using a piece of webbing as a strap wrench may unlock the carabiner in a pinch.

7. To keep screw-gates locked during use, orient the screw gate down so gravity screws the locking mechanism down as the carabiner shakes when used.

8. Generally, do not overload your carabiners. Some people use their carabiners to pull down trees, haul cars, lift heavy loads, and so on. While carabiners will hold (usually), they were designed to hold only one or two person loads. So avoid overloading carabiners if possible.

9. Avoid dropping carabiners. The available data on dropping carabiners indicates that there is little to no strength reduction when dropping carabiners even long distances, though carabiners can sustain damage to the frame, gate, and locking sleaves.[4,6,8] It is good practice not to throw carabiners around or drop them. However, if one falls a short distance, feel free to use it. If one falls tens or hundreds of feet onto a hard surface, then it should probably be retired on principle even if no significant observable damage occurred.

10. Avoid hardware-to-hardware connections. When two pieces of hardware are connected, they can twist and apply torque to carabiner gates (Figure 4e,f). Obviously, it is common practice to clip hardware to hardware, particularly in caving, because we connect our ascenders and rappel devices to our harnesses with carabiners or screwlinks. Therefore, hardware-to-hardware connections are not horrible, just suboptimal, because there are greater opportunities for accidental incorrect use. When connecting hardware to hardware it is good to double check to make sure the components are in the correct orientations (that is not gate loaded or torqueing the gates) prior to loading, or use screwlinks, which do not have gate loading problems. This is why many cavers permanently attach their rappel device to their harness with screwlinks, because accidents have occurred when carabiner gates were incorrectly loaded or hardware was not correctly connected to harnesses before use.[1,3] The best orientation for a locking carabiner to connect a rappel device is with the gate facing the rappeller (so that it will not open by compression against a sharp lip) and with the gate facing down (to keep the gate locked).

Parting Thoughts

Being an intelligent carabiner user is the best way to ensure your safety. No matter what you buy, it is how you use it that keeps you safe. While it is important to know the parts of a carabiner, and what all the markings on them mean, it is more important to understand the strengths and weaknesses of different carabiner shapes, and what they are compatible with. Knowing these details will enable you to buy the most appropriate carabiner(s) or choose the right carabiner for the job from your existing gear. I encourage everyone to study vertical caving gear use and techniques, because improved equipment use may someday prevent injury to yourself or another caver, thus making a rescue unnecessary.

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Injury Prevention in Cave Diving

Peter Buzzacott NSS 64284

A Brief History of Cave Diving

Modern cave diving, as we know it today, began soon after the aqualung was invented in the mid-1940s. From the outset the potential for cave diving "accidents" was highlighted by Jacques Cousteau in his bestseller *The Silent World*, wherein he described suffering from gas contamination during record dives in the Fontaine de Vaucluse in south France. The first American cave diving fatality using SCUBA, (self contained underwater breathing apparatus), occurred in the early 1950's and the "sport" of scuba diving into caves gained popularity in northern Florida commensurate with the growth in popularity of recreational scuba diving in general. The NSS Cave Diving Section (CDS) was formed in 1973, in part with a farsighted focus on cave conservation but also in response to an escalating death rate among untrained divers in caves.

Borrowing lessons from the earliest NSS accident analyses, in 1979 cave diving pioneer Sheck Exley published *Blueprint for Survival*, a series of actual cave diving fatalities that were anonymized to highlight pertinent safety issues. At around this time, three rules for safe cave diving gained popularity, they being:

- Divers should not dive beyond a maximum of one third of their available gas before turning to exit the cave
- Every cave diver should maintain a continuous line back to the safety of open water
- The gas breathed should be appropriate for the depth reached

Two further rules were subsequently adopted:

- Every cave diver should have three sources of light capable of lasting the whole dive
- Every cave diver should be appropriately trained

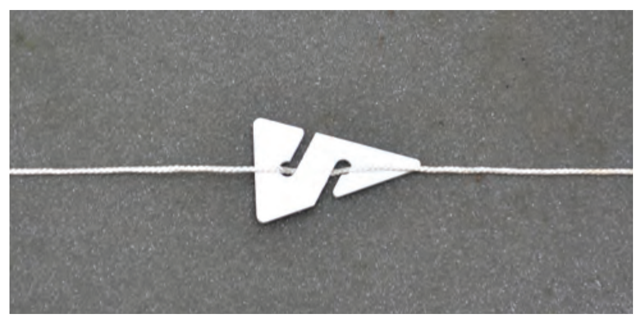
The CDS quickly took a leadership role in reducing the number of untrained and poorly equipped divers dying in U.S. caves. The now famous "Grim Reaper" sign warned untrained divers, including open-water diving instructors, to stay out of flooded caves, and these became a feature at the entrance to the most popular caves in Florida and, eventually, to many popular caves overseas. A system of route-marking evolved to reduce navigational confusion, aided by the introduction of the Wilson Line Arrow, invented by lifelong NSS member Forrest Wilson. This simple triangular marker, indicating the direction to the nearest exit, is now universally used and has, no doubt, saved countless lives in cave diving. Indeed, the improvement in cave diving safety this humble invention made cannot be overstated.

Cave Diving Today

We are living in a golden age of cave exploration. Each year many thousands of feet of newly surveyed passage are being added to existing US cave maps. Make no mistake, the "easy" stuff is long behind us and some of the dives being made today are at the leading edge of human endurance. Dives to depths of 300 feet are now more common than ever, and long, long scooter dives, with rebreathers and sometimes using underwater habitats to facilitate decompression, are taking divers to places no other human has ever been. Concurrently both the number of deaths per year in U.S. caves has fallen to around three per year, and involve between half and two-thirds trained cave divers.

Technology and training have evolved as well. The development of cave diving lights has kept pace with our civilization's technological revolution, and modern cave diving lights rarely fail. Scooters have longer and longer ranges and greater reliability, and closed-circuit rebreathers have become almost

Signs like this one are now common at entrances to underwater caves around the world. Photo by Peter Buzzacott.



Above, Forrest Wilson, inventor of the Wilson Line Arrow, scootering to the exit after a dive in the Devils System at Ginnie Springs, Florida, in 2017. Photo by Peter Buzzacott.

Right, the Wilson Line Arrow. Cave divers use a guideline to find their way out of an underwater cave. They use line arrows to be sure they are going the right direction; the arrow always points to the nearest exit. Cave divers got the idea from the "dry" cavers that used to put arrows on cave walls using smoke from their carbide lights. Photo courtesy of Forrest Wilson.

To learn more about Wilson, and his cave-diving innovations, see his Luminary Talk on the NSS website at www.caves.org.

common in cave diving, something I doubt the CDS founders would quite have imagined. Thousands of cave divers frequent the most popular caves, training is widely available and is largely standardized between agencies. Gases once considered exotic are now widely available, reels and other cave diving gear is better made than ever, and is widely available. Cave diving travel is more accessible than ever before, allowing U.S. cave divers to visit overseas caves and international cave divers to visit U.S. caves. A look back through recent issues of the CDS magazine *Underwater Speleology* finds articles on cave diving in Mexico, Canada, China, and other far-flung destinations.

Meanwhile, conditions in Florida caves have significantly deteriorated since the 1970s. Visibility is substantially reduced in many caves due to heavier agricultural use on the surface. Despite this, and despite the growth in diver certifications, the growth in more advanced diving, the growth in number of international visitors, the increase in availability of cave diving equipment and the exponential growth in cave diving videos on the internet, despite all this, the average number of fatalities each year is at a record low. If we are to reduce this number further then two things are certain; first, any improvements from here on are going to be incremental (and virtually immeasurable), and, second, to have any effect whatsoever things are going to have to continue to change.

The Future of Cave Diving

How might the next 10 or 20 years look for cave diving in the U.S.? Well, it seems likely that popu-

An NSS-CDS member using side-mounted tanks for a cave dive through low passages. Photo by Peter Buzzacott.

lation pressures will continue to impact water quality and cave divers have a significant role to play in highlighting what is happening underground to the decision-makers who will never see the beauty that we see. If we do not mobilize to become a force in water quality protection, then it is likely visibility will continue to degrade incrementally, year after year, almost unnoticeably for the newest members of the CDS but clearly apparent to long-time cave divers. This raises the question: should the CDS continue to invest time and resources into training cave divers when cave diver training is now widely available through much larger and better-resourced training agencies? Or, as some argue, should the CDS abandon cave diver training and focus entirely on conservation issues?

The current cave diver training manual is produced by another diver training agency. Most, if not all, cave divers will say the name of the training agency on the certification card is not as important as the quality of the instructor, and many cave diving instructors already teach for more than one training agency so would it really matter if the CDS stopped issuing certifications, if the same instructors used the same training manual to teach the same students? One argument made by pro-training CDS members is that the CDS once led the way in diver training and that we should continue to do so. Should we fully adopt metric for calculating gas volumes then? Should we require decompression training before certifying a full cave diver? Should we reconsider the rule-of-thirds when diving in pairs, or solo? We will not lead the way in training if we do not continue to evolve.

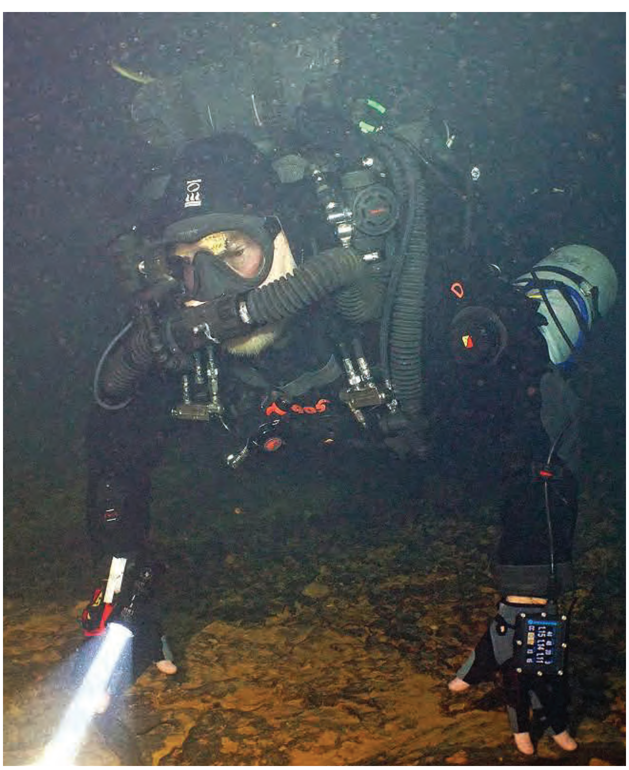
Recent research identified the leading causes of death in U.S. cave divers. It appears getting lost, running out of gas, or breathing an inappropriate gas remain leading causes of death. With the decompression stress associated with modern cave diving, calls to Divers Alert Network (DAN) from divers in north Florida with the “bends” are nowadays not considered rare. Another topic of serious concern from an injury prevention perspective are the number of old, out-of-shape cave divers taking medications for ongoing medical conditions, such as diabetes, hypertension, and heart disease.

Cave divers are aging steadily, as are the general diving population. A DAN study found that every four years the average age of their members increased by one year. Over the same period they found every four years the average age of diving fatalities increased by two years. Indeed, looking at the claims rates of insured divers it was clear that the risk of death (per 10,000 member-years) increased substantially with age. Perhaps this is an opportunity for the CDS to take a leadership role, in promoting health for cave diving.

Technology will no doubt continue to advance. For example, in 2014 the first dive computer appeared with in-built Near Field Communication (NFC) technology. NFC allows the transfer of information between a reader and a chip embedded in a card, such as when you swipe a key-card to open the door to your hotel room. It was predicted at the time that the most popular flooded caves might embed maps inside line arrows, thus allowing cave divers to place their dive computers over an arrow and see a map on the screen pin-pointing exactly where they are located. This is one example of how the existing system of route-marking and navigation might yet be improved even further.

In terms of decompression stress, there have been remarkable discoveries in decompression research in recent years. However, big ships move slowly, and science is a big ship indeed so while recent results in decompression science offer promise, it may be some time before practical advances are supported, for example in recommending certain foods to augment decompression, specific pre-dive exercise patterns, environmental preconditioning and/or inert gas optimization. Meanwhile, cave divers continue forging ahead, making dives that would have sounded impossible not that long ago. Perhaps that is an area the NSS-CDS could excel at? Decompression for cave diving. The NSS-CDS led the way when rebreather technology first gained popularity in US cave diving, by producing rebreather cave diving materials. The same is true for side-mounting, (where divers wear scuba tanks on the side rather than on the back). These are two good examples of the CDS leading the way in injury prevention, through training.

In closing, I would like to congratulate the NSS for producing 50 years of *American Caving Accidents* (*ACA*). There is little point to monitoring injuries and near-misses in an operational context such as caving and cave-diving unless that surveillance leads to reduction in risk. Cave diving instructors look to *ACA* for examples to share with their students, and cases are often discussed between divers in online forums. Over half a century, the NSS has amassed a dataset rich in potential to continue assisting the development of injury prevention interventions. What they might be, and how the CDS might implement them, remain to be seen (over the next 50 years).


NSS life member Lamar Hires using a Dive Rite Optima rebreather during a dive in Cannonball Cave, Missouri. Photo by Peter Buzzacott.

Floyd Collins: His Accident Started it All

Roger W. Brucker NSS 1999

In 1925, Floyd Collins, a Kentucky cave explorer, became trapped in 155-foot-long Sand Cave near Mammoth Cave, Kentucky. In the next 16 days, his horrifying predicament and the epic struggle by volunteers to free him became one of the most sensational news stories between World War I and World War II.

Any cave explorer should pay attention to this story, as it informed nearly all of today's cave rescue protocols. Indeed, our book *Trapped! The Story of Floyd Collins* by Robert K. Murray and Roger W. Brucker, Kentucky University Press, 1979, was required reading for some rescue-training courses because almost everything that could go wrong did go wrong during the 17-day ordeal. Here are the bare-bones facts of the accident and rescue attempt.

Floyd, 37, had been a successful cave explorer for many years. In 1910 he discovered Donkey Cave on his family farm. This 800-foot-long trunk passage had a crawlway near its terminal breakdown that led to some vertical shafts. He explored Salts Cave with others. He discovered Crystal Cave in 1918 on the farm. It revealed fantastic gypsum displays—crystals, delicate flowers, needles, and helictites. Crystal Cave's tourist routes extended a couple of miles. Through a tight crawlway and canyons, he discovered a couple of more miles of cave. Floyd's family dug a new entrance, cleared trails, built a ticket office, and put solicitors on the roads to stop and sell tickets to tourists. The cave was not the financial bonanza Floyd hoped. Too many commercial caves were open closer to town on the main road, and their road sales crews easily convinced tourists to visit closer caves—New Entrance to Mammoth Cave, Mammoth Cave, and Great Onyx Cave.

Floyd Collins in front of the Crystal Cave ticket office around 1924. Autographed photo by Wade Highbaugh, courtesy of Roger Brucker.

Floyd realized that to make money he needed a cave closer to Cave City. If he could leapfrog George Morrison, as George had done to Mammoth Cave when he found the New Entrance to Mammoth Cave closest to town, then he'd get rich. Slick George had siphoned off somewhere between one-third and one-half the revenue from Mammoth Cave for the past three years. Couldn't Floyd leapfrog George and find a cave closer and intercept paying tourists?

Floyd Collins contracted with three farmers who owned land near the intersection of the Cave City road and the Flint Ridge road. Any big cave there could be expected to spread beneath the farmers' land. Such a cave would be first in line, closer to town. By contract, Floyd would receive half the profit and the three farmers would split the other half. Furthermore, each farmer would room and board Floyd while he hunted for the cave.

Starting around January 20, 1925, Floyd scoured the landscape and selected a sandstone overhang at the head of a reentrant valley as a likely place for an entrance. He saw that the back wall of the overhang bottomed at the contact of the Girkin limestone, so digging there might open a passage into a cave below. He spent two weeks excavating, first finding a small grand piano-shaped room three feet high. He dug along the line of least resistance between breakdown blocks, hauling the soil out in burlap bags. His tunnel led to another small void. This cavity, the size of the interior of a small pup tent formed a turnaround room, and formed an acute angle that doubled back and down. He followed the easy way, down a chute that was barely man-size, descending at a 15° angle. At the bottom, he found a solid rock tube, roughly 18-inches in diameter, but blocked by breakdown.

He had blasted through small places before, so he placed dynamite under the breakdown and inserted a very long fuse, for it would take at least ten minutes to reach safety. He scrambled up the chute and heard the distant boom as he neared the entrance. As one familiar with blasting, he knew he must allow the fumes to clear.

Days later he returned with a rope to check the blast site and clear the loose rocks. The blast had opened the crawlway and he pushed his coil of rope and kerosene lantern ahead of him. The crawl opened on the lip of a pit. Floyd rigged the rope as a hand line and lowered himself to stand in the bottom of a deep pit. He said there were several leads out, but his lamp flickered. He'd forgotten to fill the lamp, but no big deal, he headed back the 150-foot route toward the entrance.

A few feet from the pit he came to where the blast had loosened the rocks. He rolled onto his back and pushed the lantern ahead of him—too vigorously—it tipped over and went out. He was in the dark, but did not panic—he'd once spent 18 hours in the dark in Crystal Cave groping his way out by feel alone.

He kicked with his left foot, causing a suspended rock to drop, pinning his left ankle in a V-shaped crevice. He wiggled and pushed, but the left leg became even more trapped. Other rocks fell, burying his feet and lower torso. Now he panicked! He clawed with his hands for purchase until he felt pain. Too bad he hadn't told farmer Bee Doyel exactly when he'd be back.

It rained that Friday night and Saturday. Doyle was used to Floyd's odd hours, so he finally set out early Sunday morning with partner Ed Estes and his son, Jewell. At the entrance to Sand Cave they found Floyd's coat hanging on a wall nubbin. His rifle was there. Jewell Estes, the kid, was sent into the hole to find Floyd. Jewel's yells summoned a faint cry from Floyd. "I'm trapped... Bring some tools...get my brothers." Doyel and Ed went to the Collins farm and alerted his father Lee and brother Marshall. One of the most bizarre rescue attempts began.

Several facts should be noted. The site where Floyd was trapped could be reached by only very small men—only four or five could reach him. Second, those few had to go down the chute head first to reach Floyd. Feet first, they'd step on his face! Third, only two were cavers — Floyd's brother Homer, and Floyd's friend Johnnie Gerald had caved a few times with Floyd. Skeets Miller, the young reporter from the *Louisville Courier-Journal* had never been in any cave.

It was hours before Homer brought food and water to Floyd. Hypothermia was already in progress and water dripped on Floyd's face. Well-meaning volunteers took food into the cave, but were quickly terrified by the tight quarters, so they stashed the food in the first room—then they lied about feeding Floyd.

Skeets Miller encountered Homer outside the cave early in the morning. The reporter quizzed the exhausted Homer, who urged Miller to find out the answers himself. Miller plunged in Sand Cave with a borrowed flashlight, slid headfirst down the chute, and landed on Floyd's face.

The problem was that working upside down in cramped quarters was exhausting work. Floyd's

Floyd Collins at the staircase entrance to Crystal Cave in 1924. Photo courtesy of Stan Sides.

body plugged the tube—there were few reachable rocks to move! The commercial manager of Crystal Cave suggested strapping a harness around Floyd's upper body, attaching a rope, and pulling him out. Floyd agreed.

The pulling attempt had Homer first in line and Skeets Miller second. Other volunteers were spread up the chute, through the turnaround room, and back the crawlway toward the entrance. They warned that the pulling would hurt—they feared breaking his leg bones. Floyd responded, "Go ahead. I don't care if you pull my foot off!" On the count of three the rope stiffened. Floyd's agonizing and unending scream and pleas to stop pulling unnerved Homer, who vigorously demanded they stop. Homer refused to allow another pull. It would kill his brother, he asserted.

Regular feeding and diversion of the water seemed to slow Floyd's weakening from hypothermia. Johnnie Gerald and Skeets Miller valiantly moved what rocks they could reach, down to his knees. Meanwhile several volunteers were supposedly enlarging the crawlway to the Turnaround Room and chute. Instead of passing the material out of the cave, they merely rearranged it. Some attempts to install wooden shoring in the areas with weak ceilings were feeble. The ceiling still dropped rocks on those who wriggled through the cave.

Skeets Miller had a bright idea: If he were given a small screw jack and a crowbar, he might jack up the rock that held Floyd's ankle fast. He tried and tried. The jack placed on the ceiling over Floyd's head pushed down on the crowbar thrust into the pile beyond Floyd's knees. The bar bent then sprang sideways. Several attempts left Miller exhausted. Floyd urged Skeets to get some sleep and return. Surely the jack would work next time.

Workers at the top of the rescue shaft. The sling holding the worker is attached to the hoist cable that lifted the bucket. Henry Carmichael is in the background left. Photo courtesy of Roger Brucker.

Alas, the ceiling of the cave beyond the turn-around room at the top of the chute collapsed. Several volunteers examined the collapse. They said it was hopeless to try to dig through the collapse. A miner, a self-styled expert, said a "tunnel squeeze" was bringing the entire cave down and would kill everyone. Simultaneously, on the surface a civil engineer had arrived with his crew of volunteers. They were from KYROCK, the Kentucky Rock Asphalt Company, a large quarry operation nearby, and Superintendent Henry Carmichael took charge. Now that the professionals were there, the incompetent bungling of the locals could cease and the competent professionals would soon free Floyd.

Carmichael set his crew to shoring the overhang, an entirely unnecessary task. He sent in a survey crew just before the "tunnel squeeze" report, who ran a survey line from the entrance to as close as they could get to Floyd. They were two stations short, in hindsight, but Carmichael didn't know that. He told everyone he would sink a shaft to get Floyd out in 30 hours, since, he said, all hope of reaching Floyd through the cave was gone. Johnnie Gerald complained he could still squeeze through the breakdown, feed Floyd, and work to get him out. When Johnnie called the U.S. National Guard General a "dumb son-of-a-bitch," he was forcibly ejected permanently from the site.

Carmichael's shaft was six feet square, a size dictated by the railroad ties used to brace the walls as the shaft descended. He set the location where a hoisting line could pass the drip edge of the overhang, some 15 feet horizontally and about 55 feet vertically from Floyd's apparent location. He forbid the blasting of big rocks the diggers encountered because he feared it would collapse everything and crush Floyd. Unfortunately, the drip line also conducted runoff from the hillside above to fall directly into the deepening shaft. Crews were organized into shifts so workers dug round the clock. They pounded big breakdown rocks into gravel by sledge hammer and chisels. No power shovels were allowed—the fumes could be sucked into the cave and kill Floyd. Water stood in the shaft on occasion, up to three feet deep. A pump was found and hooked up to drain it.

Two weeks later the shaft reached the level of Floyd, as indicated by the incomplete survey. Now the volunteers drove a horizontal tunnel 13 feet and broke through to where Floyd's lifeless head lay. His body was encased in gravel, apparently washed in. A miner was sent to identify the corpse, and his gold front tooth confirmed it was indeed Floyd. The lateral tunnel was collapsing so the decision was quickly made to leave the dead man in the cave.

These are the facts of the rescue attempt, but the story goes on, and on, and on. Four months later, Homer hired a crew of miners to recover his brother's body. They dug the shaft deeper, made a new lateral tunnel, and came into the pit behind the dead man. They brought out the decomposing body and the trapping rock. They did not explore the deep pit Floyd found.

As *The New Yorker* magazine recently observed, "When one person is trapped, in peril, or dies, that's tragic. When the world is about to be annihilated by nuclear blast, asteroid collision, or hostile aliens, that's entertainment." Stories like the entrapment of Floyd Collins in 1925, the sinking of the Titanic, the Hindenburg dirigible disaster, and several dozen more notable death news stories dramatized the need for competent, professional rescue teams. Undertakers used to be first responders. First aid and medical trauma teams were an outgrowth of wars. Fire fighting in Louisville, Kentucky, and other big cities took on a new rescue squad concept in 1924. Everywhere the need for rescue changed from a viewpoint that well-meaning amateurs—while better than nothing—were simply not up to the challenges of individual accident or mass disaster readiness.

Some experts worked their way up. Firefighters today all understand the difference between high-speed fire attack capability and the "fill the basement with water" old ways. Cave rescue capability profited by the lessons, but too slowly to save all cavers from death even today.

Innovations and specialties, such as combining teams and techniques, spread: EMS, high-angle, heavy lift, and underwater teams appeared. Forest firefighting is a full-time industry. Equipment, from expensive aerial ladders to foam suppression to tanker aircraft ran up the cost along with the capability. Regular training and incident commanders shortened response times and improved communications and techniques. Cross-training of modern search and rescue skills is widespread today. Today's cave rescue teams are located, trained, and on call in major U.S. cave areas. Caver personal safety is a part of every beginning caver's ongoing orientation. While the lessons of the Floyd Collins entrapment are applied daily, modern rescue is taught by the combination of all forms of emergency, disaster, catastrophe, and preparedness safety training.

What strategic principles should all cave rescuers should keep in mind? Here are a few:

1. Time is not your friend. The longer the time between call and adequate response, the more the risk and bad consequences escalate. Callout communications are vital, as are jurisdictional agreements.

2. Teams that train together rescue better. A good team knows the thinking and actions of other members. Cooperation and following the team leader is a given in most teams today. In the Floyd Collins accident, there were primadonnas, quarrelers, and lone wolves. Loud-mouth know-it-alls took over from the few competent individuals.

3. Promptly locate cavers familiar with the rescue cave. They already know things about the cave in question that will take you time to learn. Call out informed cavers immediately after the response team.

4. Always consider alternatives. The best plans may need to be changed when the unanticipated happens. It is better to call out more trained teams than risk wearing out the first responders. Hypothermia should be prevented even in routine cave rescues, so extra warmth provision is prudent preparation.

5. Efficiency in cave rescue is a prudent conservation of energy. Manage human and supply resources wisely for best results. Plan for backups and second and third alternatives. Flooded cavers? The flood usually recedes quickly.

These are not just my ideas. They are lessons learned from Cave Research Foundation (CRF) practice rescues and experiences of cave-rescue teams. I'm sure that seasoned cave-rescue workers will have their own list of strategic and tactical imperatives. CRF has organized dozens of caving expeditions annually, with 3 to 20 parties per expedition, over a 60-year period. It has an enviable safety record, if not a perfect one. Experienced cavers on hand is one factor in safe caving, and another is continuous safety instruction to new cavers.

The body of Floyd Collins after being removed from Sand Cave by W. H. Hunt's miners from Central City, Illinois. Photo by Wade Highbaugh, courtesy of Roger Brucker.

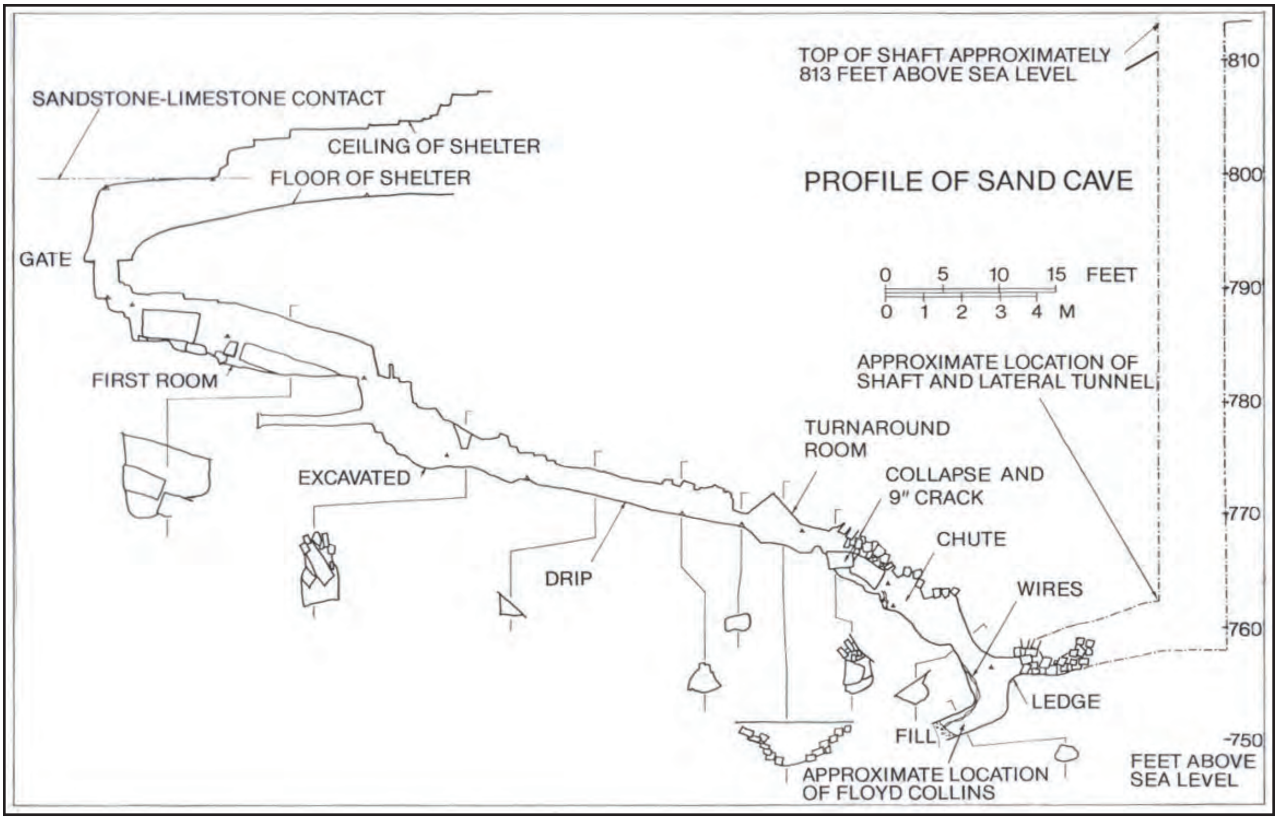
As part of the research for the book *Trapped!*, my son Tom Brucker (NSS 24892 RL, LB, FE) was part of a team that made six trips into Sand Cave to explore, survey, photograph, and thoroughly examine it. He has more than 50 years of experience caving in Mammoth Cave, and has his own observations on the Floyd Collins saga:

"Hindsight is 20/20. To a modern caver, Floyd's early tomb was spacious by crawlway standards. The space above the rock tube had enough room for a 6-foot-tall caver to turn around, and was wide enough for two friendly cavers to work. Once we learned the route, and the trick to passing over and around a large breakdown block, we could travel the length of Sand Cave in 15 minutes or less.

"As might be imagined, Floyd's comfort level and strength would have been improved by the steady delivery of hot water bottles or sacks of heated gravel, delivered by modern cavers. What more might have been done makes for interesting speculation because, in the science of cave rescue, no two incidents are ever the same.

"Had an experienced cave rescue team existed in 1925, they might have gathered above Sand Cave on day four. Evaluation of safety risks presented by Sand Cave, and of Floyd himself, might have taken all of one hour. Sand Cave was stable, fairly dry, and the tunneled crawlway actually occupied spaces in limestone breakdown. The cave exhaled 54°F air (typical for higher entrances in winter.) Floyd was conscious and was able to describe the captive rock.

"What is not clear today is whether more rock could have been removed beside and below Floyd to improve access below his knees. Miller describes lying on top of Floyd while trying to position a screw jack. Modern cavers are quite familiar with the odd contortions needed to lever breakdown apart. Would



Roger Brucker's profile map of Sand Cave, Kentucky. Courtesy of Roger Brucker.

five or six experienced cavers been able to place the jack, where the strong-willed Miller, with no cave experience, failed? Electric hammer-drills and microshaving might be useful. The persistence of the rescue team and quick testing of problem solving ideas is a well-known characteristic of successful rescue teams.

"The next question assumes that all rock moving efforts failed. How long would rescuers expect Floyd to survive in the cave? Floyd urged that he be pulled apart, perhaps losing a limb to the entrapping rock. Did the victim's "idea" stymie the rescue team? Would the application of a bottle of ether have quieted Floyd's pain and renewed the team's determination to pull Floyd apart?

"NCRC training teaches that the 'patient advocate' has a responsibility to feed back information to the rescue team. Homer Collins was just such an advocate. It would be highly unusual for a family member to be a rescue participant, but in this case, did the relationship hinder Floyd's last chance for rescue?

"Digging and drilling rescue shafts are not currently recognized cave rescue methods (yet they are known in mine rescues; for example, the 33 Chilean miners rescued after 40 days from 2,300 feet down by drilling a 28-inch shaft in 2010.) Once Sand Cave was surveyed (the survey was accurate if incomplete), that information could have prompted a rescue team to begin moving rock days earlier. Floyd survived seven to ten days wearing a leather coat, soft hat, and coveralls. Could he have survived longer with adequate warming, bright light, and additional human contact? Small improvements in comfort are significant contributors to successful rescue. And finally, digging might have accelerated had experienced cavers been present in Sand Cave and reported accurately on the stability of its roof and walls."

Cave Better, Cave Safer: Join the NSS

Curt Harler NSS 22735

The book you are holding is a review of 50 years' of work by NSS members to unravel and analyze the "why" of cave accidents in the hope of making caving safer for all. It is the ultimate source of data on caving safety and underground search and rescue.

By examining all manner of caving accidents that have occurred over the past half-century, the editors and writers present lessons learned in the hope that readers will benefit from the mistakes made by others. Should you be involved in a caving accident, we hope that the knowledge you gained by reading this book will help to inform your decision-making and enable you to more knowledgeably address the situation.

There is no guarantee that even the safest, most careful caver will not have an accident. That is why many cavers dedicate themselves to the mantra, "Cavers Rescue Cavers." Through the National Cave Rescue Commission (NCRC, http://www.ncrc.info/), cavers learn what is necessary to become first responders, and first responders learn what is necessary to be cave rescuers. As they advance their knowledge, many volunteer their time to train others at NCRC events. You will find gems of wisdom from these experts sprinkled throughout this book. We guarantee that you will re-read many sections as you become more deeply involved in caving.

As a member of the NSS, or through the purchase of this book, you support those who undertook this comprehensive effort to analyze cave accidents. If you are in a jam underground, you are far better off having rescue-trained cavers coming to your aid than well-intentioned responders who may never have been underground and must first learn to cope with a new and unfamiliar environment. The cave is better off, too, for having experienced and trained cavers performing a rescue or evacuation. Caves are fragile, and cavers know and respect all cave resources as they work to find or extract a patient as quickly and safely as possible.

If you are an NSS member, you are likely familiar with the goals of the NSS and the NCRC. If you are not an NSS member, then you may not be aware of the many reasons for you to join the United States' premier caving organization:

First, the NSS gives caving national clout. Local involvement is important. If you don't care about caves in your area, who will? Every time you venture into a new caving region, you ride the coat-tails of

Cavers enjoy access to Tytoona Cave in the NSS's Tytoona Cave Nature Preserve, Pennsylvania. This nature preserve is one of sixteen owned by the NSS. Photo by Dave Bunnell.

a network of cavers who are members of local NSS chapters, also known as grottos. Those cavers work to maintain access to caves across the nation.

NSS members support cave conservation. This assures that pristine caves will be here for your children and grandchildren to explore.

NSS members receive and help to create many fascinating cave-related publications, including the publication you hold in your hands, the monthly *NSS News*, the *Journal of Cave and Karst Studies*, and others.

Cavers love bats when not many others do, and bats are a necessary and important part of our ecosystem. Bats need champions! Through the NSS, cavers help to inform the public about bats and about white-nose syndrome (WNS) and to support bat-related research.

The NSS contributes to the acquisition and conservation of caves that all cavers can access. This includes caves like New River Cave in Virginia, Schoharie Cave in New York, Tytoona Cave in Pennsylvania, Sims Sink in Alabama, Great Expectations Cave in Wyoming, and a dozen others. As NSS members, those caves are our caves.

NSS members promote valuable ecological education outside the caving community. They work to help people understand where the water in their wells comes from and the key role that aquifers play in our drinking water. Cavers also help communities to understand how to protect their water in karst environments.

The NSS supports scientific research on caves, geology, karst, hydrology, and the like. Cavers are the keystones to supporting and maintaining cave research.

As an NSS member, you are part of an organization that collaborates with private landowners, advocating for positive, friendly relations between landowners and cavers to ensure ongoing access to caves.

NSS members have free access to webinars presented by the best and brightest in caving with the NSS Luminary Series of lectures.

The NSS and its grottos provide a unified voice for cavers through interaction with government agencies, acting as advocates for caves, caving, and cave critters. NSS members collaborate with dedicated people at the National Park Service, Bureau of Land Management, U.S. Forest Service, and state and local agencies.

NSS programs support spelean "arts and letters," which include photography, crafts, films, music, and more.

The NSS supports its caving members as they survey caves and produce cave maps (some of which are true works of art).

Great Expectations (Great X) Cave in the Great Expectations Cave Nature Preserve is a favorite among cavers for large rooms like The Great Hall and the fossil-rich Cephalopod Malt Shop. Photo by Dan Austin.

By joining the NSS, you will have opportunities to meet and learn from other cavers. Networking with experienced cavers is one of the best ways to learn proper caving techniques and get started in a great activity.

Joining the NSS affords new members a discounted registration on their first NSS Convention. Convention-goers rub shoulders with 1,000 other cavers from around the world while experiencing an inexpensive and fun event with great caving and free beer.

NSS membership saves you cash on purchases from the NSS bookstore and gives you access to the NSS Library and Archives.

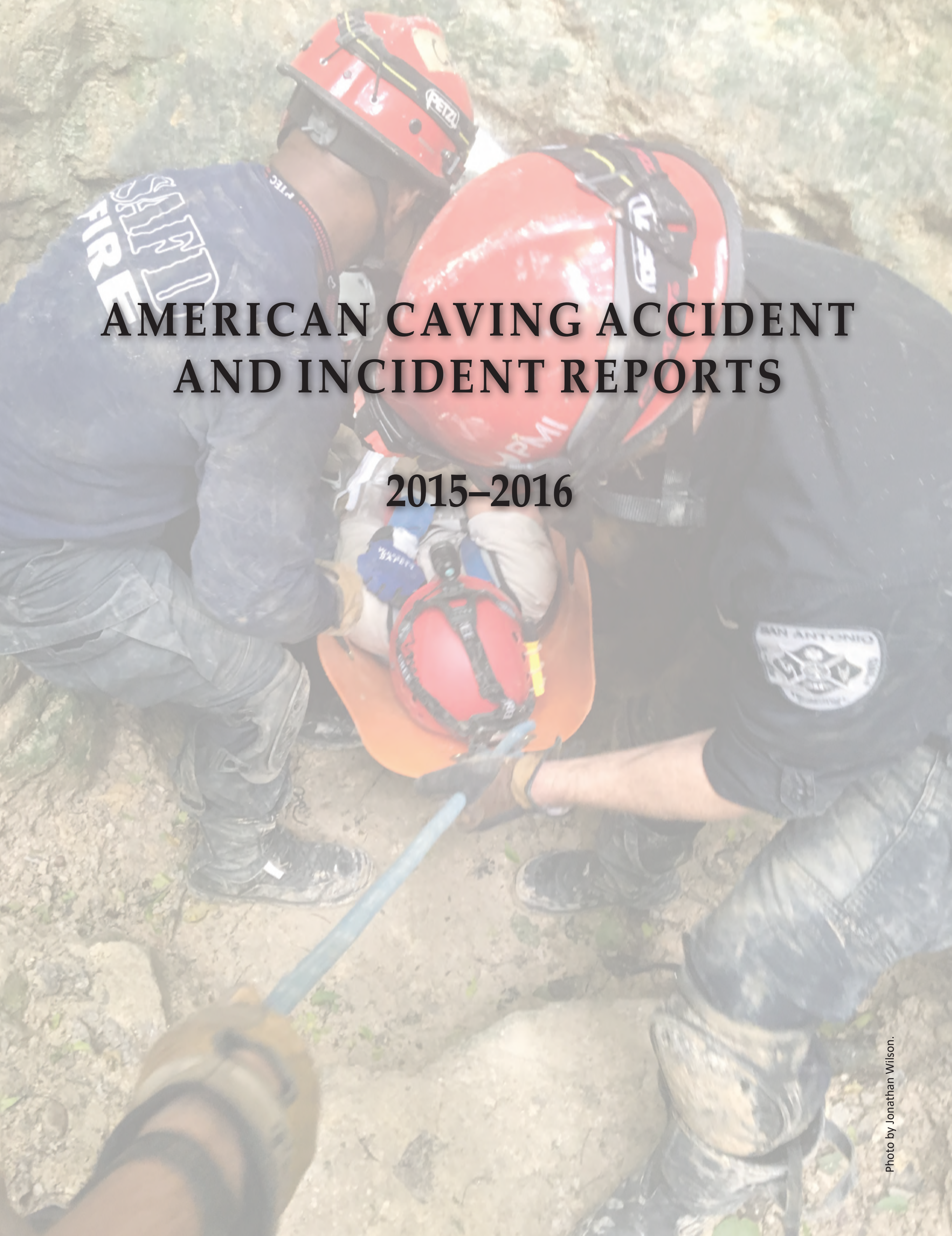
The NSS has special-interest groups focused on photography, conservation, vertical caving, geology, cave diving, and cartography. Each welcomes newcomers and provides a place where you can draw expertise from experienced people.

In addition to appreciating underground beauty, you may discover you have a knack for cave survey work, organizing cave clean-ups, researching conservation issues, or public advocacy. NSS membership allows members many ways to get involved!

Today, NSS dues are less than $5 a month. There is a reduced e-publication rate that will get you started. Believe me, the printed *Members Manual* and the *NSS News* alone are worth the money. Consider a life membership. It's a great value to both you and the NSS. Spread your payments over 10 years, and you'll never again have to pay NSS dues.

Remember, without your dues support, NCRC-trained cavers may not be there to haul you out of a cave in a professional manner. Worse, access to caves might be severely restricted. By supporting the NCRC and the NSS, you will be supporting two worthy organizations with a shared mission to support safety in underground environments. Reading this book is a great start.

An NSS member supporting cave conservation by staying on trail and registering their visit in Wen Cave, New Mexico. Photo by Ryan Maurer.



AMERICAN CAVING ACCIDENT AND INCIDENT REPORTS

2015–2016

Photo by Jonathan Wilson.

Descriptions of Incident Results and Types

American Caving Accidents has served as the journal of record for caving accidents in North America since 1967. The purpose of collecting and reporting caving accidents and incidents is to help cavers to educate themselves on the hazards of caving based on real-life incidents. These incidents, when reported accurately and in detail, should ultimately help readers to become safer cavers by learning through others' experiences.

Reports are collected through submissions by cavers involved in the incident or rescue or by those who otherwise have some credible knowledge of the event. Caving incidents brought to the attention of *ACA* by media reports are verified for accuracy by contacting involved parties directly when possible.

As with previous issues, caving reports have been divided into two categories: regular caving and cave diving. These categories are further classified by incident result or outcome and incident type (causes and contributing factors).

Some reported incidents are placed in a separate category called "caving-related." These include incidents in which a person needed rescuing from a cave that they did not intend to enter, incidents that occur on the way to or from a cave, incidents involving animals needing rescue from a cave, or other unusual circumstances. Because these incidents did not occur during normal caving activities but required caving gear, cave-rescue techniques, or cavers to effect a rescue, they are considered caving-related. Caving-related incidents are not included in the statistics.

DESCRIPTION OF INCIDENT RESULTS

Fatalities – Fatalities from caving are relatively uncommon; the average is about three per year.

Injury vs. No Injury – An injury is physical damage or harm inflicted on a person, usually by an external force. Examples include wounds, fractures, contusions, burns, and frostbite. Heart trouble, allergic reactions, migraines, and other conditions are not considered injuries and are categorized as an illness/medical issue incident type.

Aid vs. No Aid – For the purposes of this publication, aid is considered rendered in the following cases: if one or more persons needed the help of others outside of those in their caving party to exit the cave; if outside or additional assistance was requested; or if an ambulance or Life Flight was used to transport the patient to a medical facility.

DESCRIPTION OF INCIDENT TYPES

Acetylene-related – Acetylene-related incidents were more common prior to the 1990s, when carbide lamps were cavers' primary light source. Today, bright, yet relatively inexpensive LED lights are now favored among the majority of American cavers. No acetylene-related incidents have been reported since 1996.

Bad Air – Hazardous atmospheres in caves may be due to natural processes such as biological decomposition, ammonia from large bat-guano deposits, hydrogen sulfide from volcanic gas, and other factors. Human activities in and near caves, such as building fires, using engines, dumping chemicals, or blasting can also diminish air quality in caves. Caves with poor air circulation are more susceptible to developing pockets of bad air, especially in low areas where heavy, noxious gases displace good air. Two incidents of bad air are reported here. A caver encountered high carbon dioxide levels in a volcanic steam cave, and three Jamaican farmers died from noxious fumes produced by a water pump being used in a cave.

Caver Fall – Caver falls continue to constitute a large proportion of caving accidents. For simplicity, any fall by any person in a cave, regardless of their experience, is considered a caver fall. This includes the report of a five-year-old child who fell on a self-guided tour at Lava Beds National Monument. In this issue, there are 23 reports of people falling while on a caving trip. All of the falls resulted in injury or a fatality, and more than half of those persons required aid.

Difficulty on Rope or Ladder – This category was added to *ACA* in 1994 to encompass a variety of problems that may prevent a caver from being able to ascend or descend a rope or ladder. Causes for difficulty on rope reported in this issue are three cavers' hair getting caught in a rappel device, poor climbing technique leading to exhaustion, illness while climbing, and one case of claustrophobia while ascending an entrance shaft.

Drowning – There was one fatality by drowning in 2015. The accident involved a person visiting a cave in Guam that is featured in several online travel guides.

Equipment Problem – In previous issues, this catch-all category has included rigging, light, and rope failures; slipping ascenders; and misuse or lack of equipment. Seven equipment-problem incidents are reported here. A caver was burned by his backup light turning on in his chest pocket; a locking carabiner failed when it was cross-loaded; and another cross-loaded carabiner, which was found to also be unlocked, caused a near miss. Cavers in Montana dropped a gear bag that was not retrievable, so they improvised rigging their final rappel on a through trip. A new rope was severely abraded for unknown reasons, and two separate caving parties had their ropes vandalized at cave entrances.

Exhaustion – Three incidents are attributed to exhaustion, with the cavers needing outside assistance or support from their team members. The caver in the Cemetery Pit incident became exhausted due to poor ascending technique, so exhaustion is listed as a secondary cause.

Flooding – Flooding caused the temporary entrapment of three separate groups. The cavers in the Binkley Cave System incident spent more than 24 hours waiting for the water to recede. Flooding may have been the initial trigger in the Cascade Cave incident, but since most of the group made it out safely, the two cavers who stayed behind became stranded as the water levels continued to rise.

Hypothermia – Hypothermia is often a secondary outcome in caving incidents, often resulting from a caver being stuck, injured, or stranded in a cave. It is especially dangerous not only because of the physiological aspects, but because it impairs judgment, which can lead to mistakes and other accidents. No incidents are listed with hypothermia as the primary factor, but the patient in the Ellisons Cave incident was dangerously hypothermic when rescuers reached him.

Illness/Medical Issue – There are three incidents of persons becoming ill or having a medical emergency during caving trips. Two of the patients were able to walk out of the cave, the third was rescued from an entrance pit. Three cave-diving fatalities are attributed to medical issues, including a diver who became lost underwater, but found an unfamiliar entrance, only to die of a heart attack while trying to find his way out of the jungle.

Lost – A group of cavers attempting a pull-down through trip in West Virginia could not find their way through the system and needed rescuing. Less than a month later, three college students became lost while caving in Arkansas; they too had to sit and wait for rescue.

Lost Control on Rappel – This incident-type category was added in 2011 to cover incidents of persons losing control while on rappel. In previous issues, these incidents were listed under Caver Falls or Difficulty on Rope. While most out-of-control rappels also result in a caver fall, the contributing factor or cause is very different than those typical for caver falls. The only reported incident in this category is from Little Bitterroot Canyon Ice Cave.

Rockfall – Three incidents from rockfall are reported in this issue. In two of the incidents, the moving rock was due to cavers disturbing the rock as they moved through the cave. Injuries ranged from bruises and lacerations to a crushed foot and ankle.

Stuck – The only report of a stuck caver involved a youth on a guided tour at Raccoon Mountain Caverns.

Trapped or Stranded – This category describes incidents in which the caver or cavers are prevented from exiting the cave. There are eight incidents reported of this type. Reasons include not being able to cross back over a muddy ledge, waiting out high water levels, two incidents of not having the proper gear to ascend after rappelling or descending a rope hand-over-hand, not being able to get back through a tight, awkward bend in a crawlway, being trapped by an ice fall, running out of light, and not being able to exit due to rockfall blocking a passage.

Other – This catch-all category includes incidents that don't quite fit in other categories. Examples in this issue include persons overdue from a cave trip, muscle injuries, two fatalities from an ice cave collapse, and two deaths from unknown causes.

Cave Diving Accidents and Incidents – Five cave-diving incidents from 2015 and five from 2016 were reported. All of the incidents involved fatalities.

Note: All times in this publication are reported in military time.

CAVING ACCIDENT AND INCIDENT STATISTICS 1967–2017

Result of Incident by Year

Result	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
Fatality	5	3	1	0	4	2	5	0	8	1	6	1	1	3	0	2	1	3	3	4	3	4
Injury and Aid	4	3	2	3	6	4	9	11	10	6	5	5	8	10	11	10	6	16	6	10	15	11
Aid, No Injury	5	5	2	6	1	7	11	6	15	2	9	13	9	8	12	8	18	17	6	21	15	20
Injury, No Aid	6	1	4	2	2	5	8	5	6	5	6	5	5	6	4	12	13	17	18	10	15	14
No Injury, No Aid	0	2	4	0	2	2	8	6	1	6	8	4	6	4	7	15	14	14	25	19	16	12
Total	20	14	13	11	15	20	41	28	40	20	34	28	29	31	34	47	52	67	58	64	64	61

Incident Type by Year

Type	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
Caver Fall	4	3	4	2	6	4	8	9	9	9	5	6	7	9	10	6	12	25	19	25	14	20
Trapped/Stranded	2	1	0	3	2	3	5	2	4	2	5	4	5	8	3	4	6	5	2	6	2	6
Difficulty on Rope	1	4	2	0	1	0	6	5	1	2	3	3	5	2	2	7	7	10	4	1	1	0
Rockfall	4	2	1	0	1	4	2	1	6	2	3	6	0	0	2	11	8	7	10	11	17	7
Lost	0	1	0	2	0	3	4	5	6	0	1	2	1	1	3	1	3	5	4	7	4	3
Flooding	0	0	1	0	0	0	0	1	3	0	1	1	3	1	3	6	2	0	3	0	3	3
Hypothermia	1	1	0	0	0	0	1	0	3	0	2	0	0	0	1	1	0	0	0	1	2	0
Illness/Medical Issue	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	1	3	1	1	0	0	2
Exhaustion	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	2	1	0	0	1	1
Drowning	0	1	0	0	2	0	3	0	0	0	0	0	0	0	0	1	0	2	0	1	2	0
Stuck	1	1	0	2	0	1	1	0	1	1	1	1	0	1	0	1	3	2	0	3	1	0
Bad Air	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	3	2	1
Acetylene-related	0	0	0	0	0	1	1	1	0	0	0	0	1	0	0	3	0	0	1	3	0	1
Equipment Problem	0	1	3	0	2	2	2	4	6	3	3	2	3	2	4	1	4	6	4	11	15	14
Lost Control on Rappel	1	0	2	1	1	0	1	0	0	1	2	1	0	3	0	1	0	0	1	2	0	1
Other	2	0	0	1	0	1	4	0	0	0	3	2	4	4	3	2	1	3	7	2	4	8
Caving-related Incidents	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	0	0	0

Cave Diving Incidents by Year

Result	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
Fatality	4	0	0	2	0	4	1	8	9	2	1	4	2	5	2	0	2	3	7	7	5	9
Injury and Aid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aid, no Injury	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
Injury, no Aid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No Injury, No Aid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	1	2	1
Total	4	0	0	2	0	4	1	8	9	2	1	4	3	5	3	0	2	3	10	9	7	10

To submit a caving accident report, visit:

www.caves.org/pub/aca

89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	4	6	5	5	1	2	1	4	4	4	2	5	2	6	3	0	4	1	4	3	5	3	2	2	2	4	5
16	18	16	17	22	19	17	16	22	14	14	20	11	15	9	7	8	15	9	9	9	8	9	5	6	8	5	12
20	23	20	28	33	26	17	16	13	13	18	15	13	8	14	12	8	12	9	7	5	7	6	10	10	6	8	10
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21	9	12	16	3	20	12	11	4	8	3	1	2	4	5	1	1	1	1	3	3	2	3	1	2	5	12	5
72	64	66	76	67	77	57	54	47	41	47	41	37	35	40	23	27	36	27	25	22	29	27	27	25	30	37	42

89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
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1	1	2	1	1	2	2	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1	0	0	0	1	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	15	15	16	8	11	4	4	2	2	0	0	3	2	0	0	0	4	4	2	1	1	0	0	1	3	6	1
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6	8	4	5	4	6	6	3	2	3	2	3	3	2	1	1	2	1	0	3	1	2	3	2	1	2	7	5
0	0	2	1	0	2	0	1	1	5	2	11	2	9	4	20	9	8	4	6	3	15	9	13	11	7	4	4

89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
4	8	2	5	6	8	6	2	2	0	5	7	9	3	5	6	2	1	5	7	2	1	5	7	6	0	5	6
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	0	0
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1	0	5	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	2	0	0	0	0	1	0	0	0
5	8	8	7	6	9	7	2	2	1	7	8	9	4	5	7	4	2	5	8	4	1	5	11	8	2	5	6

Reported Accidents and Incidents for 2015

2015 Reported Caving Accidents and Incidents

DATE	CAVE	LOCATION	RESULT	INCIDENT TYPE
January 8	unspecified marble quarry	California	aid, no injury	illness /medical issue
February 14	Carroll Cave	Missouri	aid, no injury	difficulty on rope/ladder
February 15	Haunted Chasm Cave	California	injury, no aid	equipment problem
March 27	Skull Cave	California	injury and aid	caver fall
April 1	Decorah Ice Cave	Iowa	injury and aid	caver fall
April 5	unspecified cave	New Mexico	injury, no aid	caver fall
April 17	Dry Creek Falls Cave	Tennessee	no injury, no aid	difficulty on rope/ladder
May 9	unspecified cave	Colorado	injury, no aid	other, ruptured tendon
May 16	Kaibab Caverns	Arizona	injury, no aid	caver fall
May 17	Schoharie Cave	New York	injury, no aid	caver fall
May 23	Neffs Cave	Utah	no injury, no aid	difficulty on rope/ladder
May 26	unspecified cave	Kentucky	no injury, no aid	equipment problem
May 30	Neffs Cave	Utah	no injury, no aid	equipment problem
June 19	Jewel Cave	South Dakota	injury, no aid	caver fall
June 20	unnamed crevice cave	Ontario, Canada	injury and aid	caver fall
June 30	Timpanogos Cave System	Utah	no injury, no aid	other, bear spray deployed
July 5	Stephens Gap Cave	Alabama	aid, no injury	stranded
July 6	Big Four Ice Caves	Washington	2 fatalities, injuries	other, ice cave collapse
July 25	Marbo Cave	Guam	fatality	drowning
August 15	Scapegoat Cave System	Montana	no injury, no aid	equipment problem
August 20	East Crater Cave	Washington	no injury, no aid	bad air
September 6	Stephens Gap Cave	Alabama	fatality	caver fall
September 6	Rats Nest Cave	Alberta, Canada	aid, no injury	other (overdue)
September 10	Raccoon Mountain Caverns	Tennessee	aid, no injury	stuck
October 2	Scott Hollow Cave	West Virginia	injury and aid	caver fall
October 3	Pond Cave	Arizona	no injury, no aid	equipment problem
October 10	Lick Creek Cave	Montana	injury and aid	caver fall
October 24	Fort Stanton Cave	New Mexico	aid, no injury	medical issue
November 15	Lechuguilla Cave	New Mexico	injury, no aid	other, muscle injury
November 21	Cherylsbad Cave	Oklahoma	no injury, no aid	medical issue
November 25	Pozo de Montemayor	Nuevo León, Mexico	no injury, no aid	exhaustion
November 27	Pozo de Montemayor	Nuevo León, Mexico	no injury, no aid	equipment problem
November 28	Bisaro Anima	British Columbia, Canada	aid, no injury	other (overdue)
December 5	Cascade Cave	British Columbia, Canada	aid, no injury	stranded
December 20	unspecified talus cave	New Jersey	injury, no aid	other, attacked by bear
December 27	Cemetery Pit	Georgia	no injury, no aid	exhaustion/difficulty on rope

2015 Reported Cave Diving Accidents and Incidents

DATE	CAVE	LOCATION	RESULT	INCIDENT TYPE
January 17	Devils Eye	Florida	fatality	illness
February 25	Sistema Camilo	Quintana Roo, Mexico	fatality	lost/heart attack
April 26	Devils Eye	Florida	fatality	out of air
April 28	Sistema Dos Ojos	Quintana Roo, Mexico	fatality	unknown/diving solo
June 8	Volusia Blue Spring	Florida	fatality	out of air

2015 Reported Caving-related Accidents and Incidents

DATE	CAVE	LOCATION	RESULT	INCIDENT TYPE
January 3	unnamed cave	Kentucky	no injury, no aid	dog rescued from cave
March 5	unspecified cave	Missouri	no injury, no aid	dog rescued from cave
March 8	unspecified cave	Texas	injury, no aid	fell after exiting cave
June 6	ridgewalking	Oregon	aid, no injury	medical issue

Reported Accidents and Incidents for 2016

2016 Reported Caving Accidents and Incidents

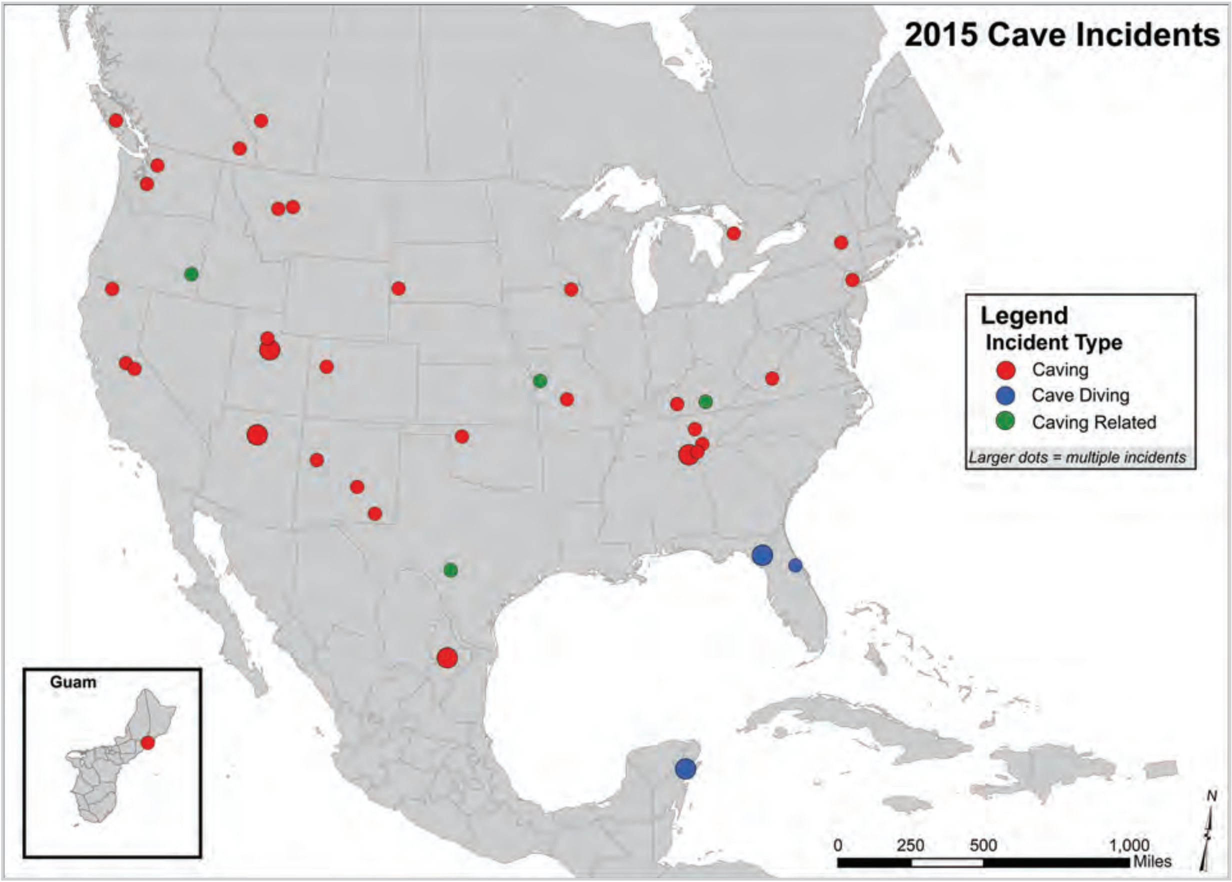
DATE	CAVE	LOCATION	RESULT	INCIDENT TYPE
January 1	Byers Cave	Georgia	injury and aid	caver fall
January 16	Jewel Cave	South Dakota	injury, no aid	caver fall
January 16	Tumbling Rock Cave	Alabama	injury and aid	rockfall
January 31	unspecified cave	Tennessee	injury and aid	stranded
February 6	Neffs Cave	Utah	injury and aid	other, dislocated shoulder
March 18	Neversink	Alabama	aid, no injury	stranded
March 26	Ellisons Cave	Georgia	injury and aid	difficulty on rope
April 17	Woman Cave	Arizona	no injury, no aid	difficulty on rope
April 25	Rats Nest Cave	Alberta, Canada	aid, no injury	trapped
May 7	Transect 80 Cave	British Columbia, Canada	injury, no aid	rockfall
May 8	unspecified cave	Kentucky	fatality	unknown
May 10	Pettijohns Cave	Georgia	injury, no aid	caver fall (3)
May 13	Tumbling Rock Cave	Alabama	injury, no aid	caver fall
May 20	Gourdneck Cave	Tennessee	injury, no aid	caver fall
May 26	Hidden River Cave	Kentucky	aid, no injury	flooding
June 5	Red Baron Cave	Utah	injury, no aid	caver fall
June 11	Buckner Cave	Indiana	injury and aid	caver fall
June 11	Little Bitterroot Canyon Ice Cave	Montana	no injury, no aid	lost control on rappel
July 2	Raccoon Mountain Caverns	Tennessee	injury and aid	caver fall
July 6	Laurel Caverns	Pennsylvania	injury and aid	caver fall
July 8	Upana Cave	British Columbia, Canada	injury, no aid	caver fall
July 9	Portage Valley ice cave	Alaska	injury and aid	trapped
July 12	Serendipity Pit	Tennessee	no injury, no aid	equipment problem
July 13	Conner Cave	Missouri	aid, no injury	flooding
July 21	unspecified cave	Minnesota	injury and aid	stranded
July 29	unspecified cave	Jamaica	3 fatalities	bad air
July 30	Simmons-Mingo Cave System	West Virginia	no injury, no aid	stranded
August 7	unspecified cave	New York	aid, no injury	other
August 10	Blowing Cave	Arkansas	aid, no injury	lost
August 17	unspecified cave	Tennessee	fatality	unknown
September 3	Carpenter-Swago Cave System	West Virginia	aid, no injury	lost
September 21	Eagle Cave	New York	injury and aid	unknown
October 16	Lillyguard Cave	Montana	aid, no injury	exhaustion
October 28	Waterfall Cave	Georgia	injury and aid	caver fall
October 29	Twin Sinks	Utah	no injury, no aid	difficulty on rope
November 24	Bloomington Cave	Utah	aid, no injury	exhaustion
December 2	Bisaro Anima	British Columbia, Canada	injury, no aid	rockfall
December 18	Binkley Cave System	Indiana	aid, no injury	flooding

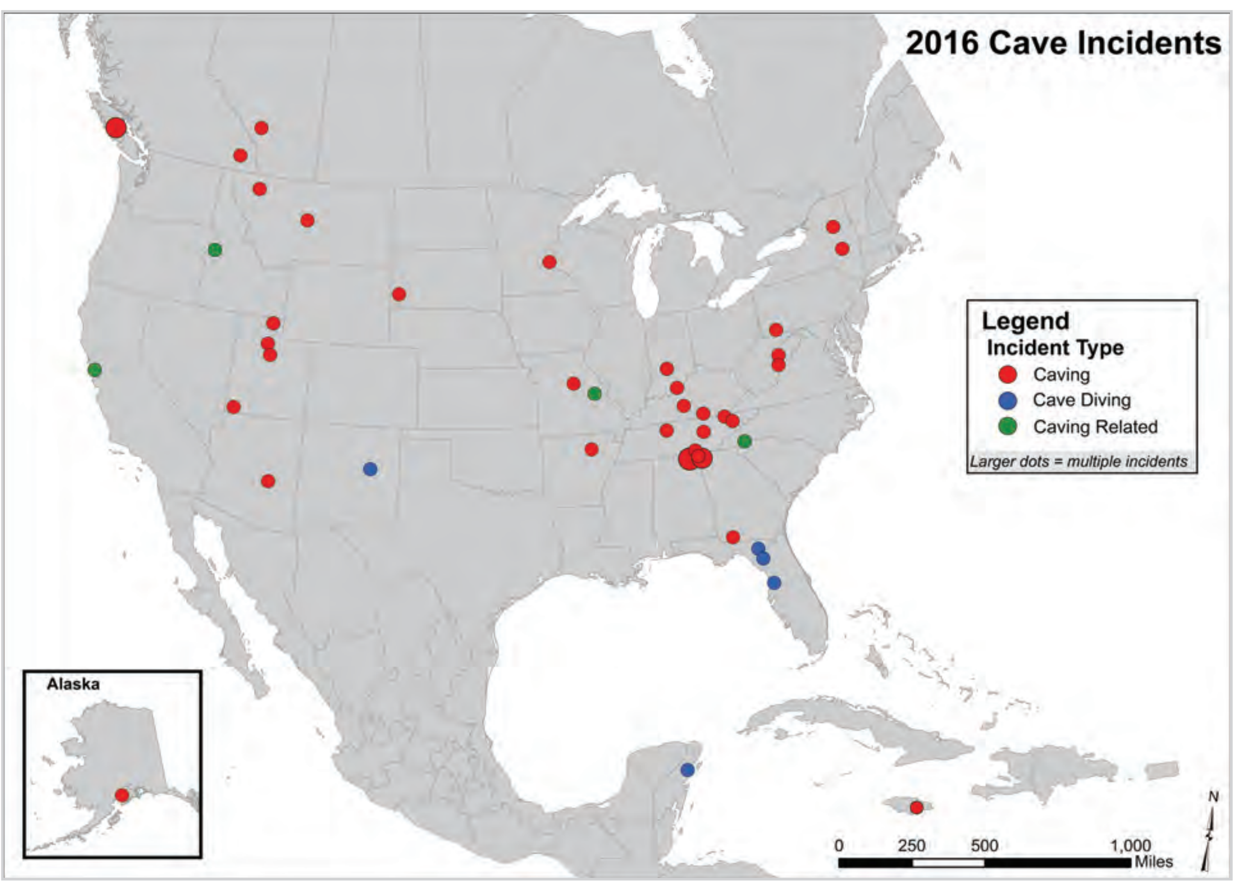
2016 Reported Cave Diving Accidents and Incidents

DATE	CAVE	LOCATION	RESULT	INCIDENT TYPE
March 26	Blue Hole	New Mexico	fatality	stuck
April 3	Ginnie Springs	Florida	fatality	medical
September 10	Orange Grove Sink	Florida	fatality	unknown
October 16	Eagles Nest	Florida	2 fatalities	unknown
November 27	Sistema Sac Actun	Quintana Roo, Mexico	fatality	lost

2016 Reported Caving-related Accidents and Incidents

DATE	CAVE	LOCATION	RESULT	INCIDENT TYPE
March 10	Meramec Caverns	Missouri	no injury, no aid	bad air
July 8	unspecified sea cave	California	injury and aid	stranded
July 26	unspecified cave	North Carolina	injury and aid	rockfall
July 29	unspecified cave	Idaho	aid, no injury	dog stranded in cave


2015 Cave Incidents
Legend
Incident Type
Caving
Cave Diving
Caving Related
Larger dots = multiple incidents
Guam
0
250
500
1,000
Miles
N


2016 Cave Incidents
Legend
Incident Type
Caving
Cave Diving
Caving Related
Larger dots = multiple incidents
Alaska
0
250
500
1,000
Miles
N

2015 CAVING ACCIDENTS AND INCIDENTS

8 January 2015
unspecified marble quarry, California
illness, aid, no injury

Long-time caver Ralph Squire has been working on cave digs in a marble quarry for more than 40 years. The entrance area is a pit that is climbed with a ladder. On 8 January, Squire's family found him in the pit, conscious, but hypothermic and unable to get out on his own. Local rescue crews packaged him and transported him to a hospital. The cause of his medical event is unknown.

1. Roger Mortimer, e-mail communication, 6 March 2015

Comments: One of the first rules of safe caving is to never cave alone. If a caver becomes sick or injured, it is helpful to have someone who can stay with the patient while others go for help. Even minor mishaps while caving solo can have dire consequences.

14 February 2015
Carroll Cave, Missouri
difficulty on rope/ladder, no injury, no aid

Dr. David Ashley, professor of biology at Missouri Western State University, teaches a Cave Biology class, which includes trips to a variety of caves around Missouri to collect biological data and analyze the data as a class project. A trip to Carroll Cave on 14 February consisted of Dr. Ashley, 10 students, two experienced cavers (one an EMT), and trip leader Bill Gee.

The entrance to Carroll Cave that the group used is a man-made shaft 120-feet deep and about 30 inches in diameter. The shaft has a ladder bolted to the wall with a stainless-steel cable running down it. Cavers usually hang a rope in the shaft so that they enter by rappelling and exit by climbing the ladder while attached to the rope with a harness and Croll. A building over the shaft contains a life-rated winch that can be used to haul a patient up the shaft. The winch is hand-cranked with a 6:1 mechanical advantage and has an automatic brake. Normal exit procedure is for the trip leader to climb the ladder first, and then wait at the top to help inexperienced people get safely off the rope and out of the shaft.

The caving trip and biological work was accomplished without incident in about seven hours. Gee climbed the ladder first. After he got off rope, the students clipped in and started climbing, assisted by the experienced cavers at the bottom. As soon as one person climbed a few feet, the next person clipped in and started up. A female student (30) was the fifth person to start. About halfway up the ladder, she complained of claustrophobia and difficulty climbing. A few steps later, she passed out, her Croll preventing a fall. Unfortunately, the EMT-caver was at the bottom of the climb and could not reach her to perform an assessment because at least one other student was on rope below her. The people above her rapidly completed their climb and were assisted off rope by Gee, who then lowered the winch hook into the shaft. Another student attached the hook to the woman's seat harness. Gee and another person then cranked the winch to bring her to the top. Gee had to climb into the shaft briefly to detach the student's Croll from the rope so she could be raised completely out of the shaft and into the building above it. By this time, she was alert enough to hang onto the winch cable while the operation was completed. She rested in the building for a few minutes and then exited by her own power to change her clothes. The remaining students finished the ascent without any further problems. The entire incident lasted about 15 minutes.

1. Bill Gee, Incident Report, 17 February 2015.
2. Bill Gee, e-mail communication, 17 December 2015.

Comments: The Carroll Cave Conservancy equipped the entrance shaft with the winch for an emergency such as this, and this group equipped each caver with a harness and safety to prevent a fall. While they should not be used to belay or catch a fall (which would be fall protection), toothed ascenders can be safely used as progress capture or fall prevention as in this incident. Cavers should weigh the time-saving benefits of certain techniques against the safety issues they may introduce. In this cave entrance, it saves time to have everyone climb at once, but doing so could lead to patient access issues in case of a medical incident or gear problem.

15 February 2015
Haunted Chasm Cave, California
equipment problem, injury, no aid

David Weaver and Steven Johnson (47) visited Haunted Chasm to retrieve a rope bag that had been

Above, a caver rappelling into Carroll Cave on rope. A cable is in place for emergencies. Photos by Bonny Armstrong.

Left, the Carroll Cave Conservancy's entrance to Carroll Cave. The winch can be seen along the back wall.

left behind on a previous trip. The cave begins with a 40-foot drop, then a tight squeeze followed by an additional 140-foot drop redirected off a nearby formation.

After bottoming the second pit, neither caver located the rope bag, so they turned around and headed out. Weaver ascended first; Johnson followed. Johnson successfully ascended the first 140 feet, and at the snug spot had to "carefully contort" as usual to get through the opening. Johnson is over 6 feet tall, and with the added challenge of squeezing with his vertical gear on, he found the ascent "tricky." Partway through the opening, he noticed a pain in his chest that he assumed was a scrape from a rock, or his Croll or spare light in his coverall pocket pressing against him.

Once the cave was derigged and both cavers were out, Johnson pulled his spare light out of his pocket only to discover it was turned on at full power. The light was a 1000-lumen Zebralight H602w, with a recent CREE emitter, and was very hot. It had been on in his pocket probably since the squeeze, or about 20 minutes. Johnson was wearing a synthetic top under coveralls; none of his clothing appeared damaged by the heat. He had, however, developed a 2-inch-diameter blister on his skin, under the clothing. Johnson commented that there was no long-term damage or unusual medical care, but that he does now sport a "sizable scar."

1. Steven Johnson, Facebook post, 15 February 2015.
2. Steven Johnson, e-mail communication, 5 January 2016.

Comments: Many switch configurations on modern lights are easy to inadvertently turn on while in a pack or inside clothing. Many of these lights can get quite hot! Prepare accordingly.

27 March 2015
Skull Cave, California
caver fall, injury and aid

A 5-year-old boy suffered head and other injuries when he fell inside the Skull Cave lava tube. Skull Cave is one of the many lava tubes open to the public for self-guided tours in Lava Beds National Monument. The accident reportedly happened near the back of the cave where a ladder leads down to an ice-covered floor. National Park Service (NPS) Rangers responded until emergency crews could airlift the child to a hospital.

Park staff are investigating the cause of the accident and considering if new safety features should be implemented. Safety features already in place in Skull Cave include "non-slip, corrugated steps on the ladder, as well as chain-link barriers in certain areas. Each step has rounded-up edges to keep cave visitors from slipping off to either side." Despite its popularity, with more than 25,000 visitors per year, this is the first known incident to occur in Skull Cave.

1. Mike Reynolds, "Child Rushed to Hospital after Fall in Park Cave," http://inside.nps.gov, 1 April 2015.
2. Tritan Hiegler, "Klamath Falls boy released from hospital: Park officials look at new safety measures," www.heraldandnews.com, 3 April 2015.

Comments: Sometimes safety measures that work for adults are inadequate for small children. Freak accidents can occur where thousands of others have safely trodden. This is similar to an incident from Jewel Cave, South Dakota, on 28 May 2013.

1 April 2015
Decorah Ice Cave, Iowa
caver fall, injury and aid

In the 1980s, unstable rocks in the ceiling of Decorah Ice Cave prompted the Iowa State Parks Department to install a gate, leaving only the first 50 feet accessible to the public. On 1 April, a woman slipped on the ice at the entrance and slid down further into the cave, breaking an ankle. Local police, fire, rescue, and ambulance crews responded to the scene and helped the woman out. She was taken by ambulance to a hospital.

1. "Woman rescued after slipping at Ice Cave," www.decorahnewspapers.com, 3 April 2015.
2. Jordan Kjome, e-mail communication, 29 December 2015.
3. James Hedges and George Knudson, "The Ice Cave at Decorah, Iowa." *The Annals of Iowa 43* (1975), pages 113-131.

Comments: In ice caves, it is often necessary to add additional ice traction to prevent slips. Some ways that cavers can enhance traction include crampons, elastic slip-on devices such as MICROspikes®, or 1/4-inch hex screws screwed into their boot tread.

5 April 2015
unspecified cave, New Mexico
caver fall, injury, no aid

A biology/caver team (Diana Northup, Debbie Buecher, Bob Buecher, and Eric Weaver) and three additional cavers entered an unspecified lava tube in El Malpais National Monument near Grants. The cavers were on the trip to take photographs for white-nose-syndrome research. One of the cavers, Kenneth Ingham (52), wore an internal-frame pack loaded with photographic equipment; he uses this pack because the frame can be used as a light stand. On his way into the cave, he moved along a ledge toward a step down when his pack caught a low spot, knocking him forward. He fell about 6 feet but landed on his feet, absorbing most of the shock and energy in his legs. He landed on the only flat rock in the area. The group completed the trip but after exiting, Ingham went to a doctor. The x-rays revealed no broken bones, but Ingham reports that he limped for several weeks after the trip.

1. Kenneth Ingham, personal communication, 13 July 2015.

Comments: Large packs, especially those that protrude above the helmet, can catch on cave ceilings, causing accidents and damage to speleothems. While pack size should usually be kept to a minimum, certain underground activities will always require large packs with lots of equipment. When undertaking these activities, extra care should be taken to manage the heightened safety and resource risks. Ingham was fortunate to have made such a safe landing. Even a 6-foot fall onto breakdown rocks could cause grievous injury, or even death.

17 April 2015
Dry Creek Falls Cave, Tennessee
difficulty on rope, no injury, no aid

Megan Carden (21), Heath Rowland, Chris Higgins, and Clinton Elmore entered Dry Creek Falls Cave, a very wet multi-drop cave. Their intention was to drop the first three pits and then climb out. Elmore wore a full 3-mm wetsuit and the others wore polypropylene for warmth. The group rigged a 50-foot rope for the first two short pits (a 15-foot pit followed by a 5-foot pit) and descended in water, without difficulty. Elmore then rigged the next drop, a 78-foot pit only 30 feet from the base of the previous drop, using a "questionable bolt" backed up by the rope from the previous drop, which was tensioned to distribute the load. Water was flowing into the pit from the top, but the cavers did not immediately know there was another waterfall entering the pit about 15 feet below the top.

Elmore descended through the waterfall and moved out of the spray and fall zone. Carden rappelled next. A short distance down, she was surprised by the force of the water. She tucked her head down and focused on breathing. When she felt a tug on her hair, she tried to stop her descent to assess the problem. The force of the water made it difficult to stop, and when she finally did, her hair was already pulled into her micro-rack descender almost to her scalp. Her hair was tied back at the start of her descent, but it came loose once she was under the full force of the two waterfalls. She attempted to do a change over, but since she was already so close to the rack, she couldn't stand up high enough in her footloop to unweight it. She called out that she needed help.

The group had another rope, which Higgins rigged to the same questionable bolt and then used to rappel to Carden. Higgins attached Carden to himself to help unweight her rack, and assisted her in switching to ascent. He then descended and joined Elmore while Carden ascended. By this time, Carden was cold and tired, and frogging up into the waterfall tired her further. With so much water coming down, she was unable to see anything around her. Suddenly, her ascender would not move up the rope and she wasn't able to see why. Reaching out to the wall, she found a projection and was able to pull herself out of the water enough to see that the two ropes were now twisted, stopping her ascent.

Higgins and Elmore could see that Carden had again stopped, so Higgins began ascending the second rope. The rope tangle stopped him too, so he rappelled back down to the bottom. Meanwhile, Carden had swung back into the waterfall and was able to untwist the ropes. Elmore and Higgins yelled over the falling water for Rowland to pull the second rope; their voices were heard and the second rope was removed. Elmore then ascended the primary rope but, as he approached the top, was surprised to see Carden still on rope. His weight on the rope had made it impossible for her to ascend past the lip. She was now hypothermic and exhausted. Elmore passed her with his Texas SRT system by attaching his cowstail to the carabiner on the bolt and his upper ascender to the upper rope (the backup anchor). Elmore then reached down to Carden, grabbed her D-ring, and physically hauled her up over the lip.

Because of the difficulty in climbing through the water, Elmore found a better anchor and rerigged the 78-foot pit for Higgins. Elmore then turned his attention to the hypothermic and exhausted Carden, first assisting her to ascend the 5-foot pit, then warming her with body heat and dry polypro. Higgins completed the ascent of the 78-foot pit and joined Elmore and Carden; by this time he was also becoming hypothermic. Higgins, Carden, and Rowland exited the cave while Elmore derigged and hauled ropes.

1. Clinton Elmore, Facebook post, 19 April 2015.
2. Clinton Elmore, e-mail communication, 19 January 2016.
3. Megan Carden, e-mail communication 27 December 2016.

Comments: Water can add an extra element of difficulty to any trip. The cavers were only expecting to do a quick in-and-out trip, so most were not fully prepared for extended exposure to cold water. Waterfalls can also make communication difficult in a vertical situation. These cavers were able to successfully work their way out of a difficult situation, and having an extra rope certainly helped.

9 May 2015
unspecified cave, Colorado
other (ruptured tendon), injury, no aid

Derek Bristol (46) and two other cavers hiked three miles to explore and push leads in a Colorado cave. Shortly after entering the cave, Bristol chimneyed up a 10-foot vertical slot through a roughly 9-inch squeeze that appeared to have a small opening above. The opening looked like a blind pocket, but the cavers decided to climb up and look to be thorough. With only a small wall pocket available for his left foot, Bristol was pushing hard off the front of his foot to overcome the friction from the tight spot. He felt a sudden pop followed by pain in the lower calf. Bristol was able to climb back down and return to his teammates. After he removed his left boot, it was apparent that he had suffered a full rupture of the Achilles tendon. Bristol was able to make the three-mile hike back with the use of a trekking pole and by walking only on the heel of his left foot.

1. Derek Bristol, Incident Report, 2 July 2015.

Comments: No one expects this kind of thing to happen, yet it could happen to anyone. Plan for the unexpected with your gear choices, trip plans, rescue gear, surface watch instructions, and so on.

16 May 2015
Kaibab Caverns, Arizona
caver fall, injury, no aid

Bob Zimmerman (63), Dave Hamer, and Kayla Arendt were setting their first survey station after traveling two hours into the cave to a lead. As Hamer and Arendt worked to set the station, Zimmerman attempted to pass them by climbing over a large boulder. In the process, a handhold broke and Zimmerman fell 10 feet, landing on his side and fracturing his left ulna (the longer and thinner of the two lower arm bones) just above the wrist. The cavers splinted his wrist and arm using a foam pad and duct tape. With a little assistance, Zimmerman was able to make his way out of the cave in only 2 1/2 hours.

1. Bob Zimmerman, Incident Report, 12 October 2015.

Comments: *American Caving Accidents* statistics show that most caving injuries involve the extremities. The ability to fashion a splint that is functional, safe, and comfortable for the patient from items in a cave pack is a valuable skill.

Safety Break #1

SPLINTING

Knowing how to splint an arm or leg bone from items in your cave pack is a valuable skill. A splint should help to stabilize an injury and protect it from the environment. Provide something rigid to immobilize the joints above and below a fracture, or the bones above and below the injured joint. Ensure you adequately pad any pressure points and secure the splint well enough that it can endure traveling through a cave. Check pulse and skin color to make sure things aren't wrapped too tightly. Lastly, add extra padding outside of the splint with available gear. Providing a cushion around the injury will help protect it and provide more comfort to the patient while exiting the cave.

17 May 2015
Schoharie Cave, New York
caver fall, injury, no aid

After a Northeastern Regional Organization's spring event, four cavers visited Schoharie Cave. On their way out of the cave, a female caver (23), who was wearing tennis shoes, stumbled over an underwater rock and fell forward. She caught herself with her (gloveless) hands, but cut one hand deeply between the thumb and forefinger and broke her wrist. The group was only 10 minutes from the entrance, so direct pressure was applied to control the bleeding and they exited the cave where better care could be given. The woman was driven to a local medical facility where she received stitches and a splint for her wrist.

1. Dylan Divito, Incident Report, 20 May 2015.
2. Dylan Divito, e-mail communication, 21 May 2015.

Comments: While we do not know that the tennis shoes caused the accident, appropriate footwear and gloves should be considered standard gear for any cave trip. Much as a driver might ask his passengers to buckle their seat belts, experienced cavers should hold trip participants responsible for adhering to reasonable safety standards.

23 May 2015
Neffs Cave, Utah
difficulty on rope, no injury, no aid

Caleb Ferbrache (30) led a group of cavers on a trip to the bottom of Neffs Cave near Salt Lake City. Neffs is vertically rigorous with nine drops requiring 690 feet of ropework to reach the bottom of the 1,163-foot-deep cave. Ferbrache was aware that there was a risk of his 6-inch-long beard being pulled into his descending device. He had intended to tie up his beard and secure it, but after completing the long, steep, uphill hike to the cave, he realized he had left his hair ties in his car. He decided to complete the trip to the bottom of the cave by remaining aware and cautious of the long hair on his face while rappelling.

He completed several rappels, but when he was about 100 feet down the 200-foot-deep Great Pit, his beard was pulled into his Petzl Stop descender. He quickly noticed what had happened, stopped himself, and tied off his descender. The beard was quite deep in the descender, but there was still about an inch that was free. His immediate reaction was to rip his beard out of the device. He used his hands to break hairs when possible, and other times had to pluck the hair from his face. It was a painful process, but he was able to free himself in a couple of minutes. Once he reached the bottom of the pit, he found a scarf in his pack, which he wore around his face for the rest of the trip. The team successfully made it to the bottom of the cave and then exited without any further complications. Ferbrache says he now wears a Buff® scarf as a hood, as it keeps his beard pressed close against his neck with minimal discomfort.

1. Caleb Ferbrache, Incident Report, 7 November 2016.

Comments: Ferbrache was wearing his ascending gear while on rappel, so if he had failed on his first attempts to rip the beard out, he would have quickly been able to perform a changeover, completely unweighting the descender.

26 May 2015
unspecified cave, Kentucky
equipment problem, no injury, no aid

On 26 May, a group of cavers was on a survey trip in a Kentucky cave. A male caver (27) with a light pack was rappelling down a 24-inch-diameter steel culvert using a six-bar SMC rappel rack attached to his harness D-ring with an Omega Pacific locking D carabiner. The carabiner and the harness D-ring were both locked. About 25 feet above the floor, the caver removed the sixth bar on the bottom of the rack and continued rappelling another 5 to 10 feet. Shortly after that, the caver became detached from the descent system and fell, landing unhurt at the base of the culvert. The rack was still attached to the rope about 10 feet above his head and the carabiner was still attached to the harness D-ring. In short, his carabiner had opened and become detached from the rappel rack.

Upon inspection after the incident, it became apparent that the Omega Pacific carabiner's locking mechanism had failed, allowing the gate to open mid-rappel when it became cross-loaded. This was obvious because the exterior locking cylinder had a notch missing. The notch was from where the narrow segment of aluminum inside the lock of the carabiner gate had pushed through the locker. The carabiner that failed had seen some abuse from several years of regular caving, but nothing out of the ordinary, according to the caver.

1. Anonymous, Incident Report, undated.
2. From an interview conducted by Tom Wood, 13 January 2016.

Comments: When using a carabiner as the attachment for a large-frame rack, if the D-ring is twisted relative to the rack while rappelling, torque can be applied to the carabiner gate, either by the D-ring or more likely by the rack, breaking the locking sleeve and opening the carabiner while loaded. This is known as a cross-load or rollout failure and may be at even greater risk of occurrence in narrow confines like a culvert or narrow pit, when the rappeller has something to push or twist against and may not have all his/her weight applied to the device. The rope itself may apply torque if it is sufficiently twisted and the rappeller is not turning. Or, the rappeller may also be able to apply torque to the rack by leaning into a loose bar or twisting the descender by hand.

Even if the safe practices of locking carabiners and rappel tests are followed, it is still possible to have a carabiner fail on rappel if it becomes cross-loaded and torque is applied. Replacing carabiners with quicklinks on certain rappel devices, namely racks, and particularly those racks with large attachment rings, may remedy this situation. The failure of the carabiner locking mechanism isn't specific to make and model of the carabiner or rack. Rather, the result of the torque applied by certain types of rappel racks to cross-loaded screw-gate carabiners that can cause them to fail. This accident has been duplicated by others, and the results can be seen in various online videos. Cavers can prevent this failure mode by being aware of it, using a connector that is not prone

Above, the carabiner from the May 2015 Kentucky incident, showing damage to the locking mechanism.

Right, a depiction of how the rack frame may have levered open the carabiner gate.

to it, using two carabiners as attachment, or clipping the short cowstail into the rack as a backup attachment while rappelling.

30 May 2015
Neffs Cave, Utah
equipment problem, no injury, no aid

Nick Steele (26) and three other Utah cavers participated in a trip to the bottom of Neffs Cave. The 1,163-foot-deep cave has a series of numerous vertical pitches that requires a considerable amount of rigging. The cave had been recently rigged by members of the Salt Lake Grotto, so this group was not rigging or derigging as they went. As the cavers were ascending back to the entrance, Steele was the second climber on a 100-foot pitch. As he ascended to a lip he could see the rig point above him and realized the carabiner between the webbing anchor and the rope was cross loaded. He cautiously made his way over the lip and ascended a few more feet to where he could safely get off rope. As he corrected the rigging for the next caver, he realized that the carabiner was also unlocked.

The first caver who had gone up the rope had not taken the slack out of the rigging when he got off rope. He had also left to start the next climb before seeing Steele load the system.

1. Nicholas Steele, Incident Report, 14 January 2016.

Comments: "Off rope" doesn't just mean off rope. When we call "off rope" at the top of a pitch, what we are really saying is, "I'm off the rope and out of the fall zone. I have checked all the rigging and have made sure that everything is safe, including carabiner loading and locking. I have checked that the rope is on all rope pads, off of sharp edges, and hanging free from snags and ledges. The rope is safe and ready for you to ascend." We must do a quick survey of all of these conditions before calling "off rope." Often, ropes get pulled off of rope pads and carabiners rotate when a caver is getting off rope at the top of a pitch. In this case, a quick look back would have caught the cross-loaded carabiner (likely rotated after unweighting), and would have been simple to remedy. While fixing the carabiner orientation, the unlocked gate would likely have been discovered and fixed as well. In his report, Steele mentions, "Because the cave was pre-rigged, I think our normal checks and normal way of thinking about rigging was altered a bit, which led us to be less cautious."

19 June 2015
Jewel Cave, South Dakota
caver fall, injury, no aid

On 19 June, five cavers entered Jewel Cave for a four-day camp trip in the newly established Western Camp. On the way to camp, the cavers approached an area known as the VACC (Victory After Continuous Contortions). The first three cavers entered the VACC, with Ian Chechet (29) going fourth. As Chechet approached the VACC, he began to climb up and over a boulder that cavers have been climbing over since 1982. He explains, "As I began to maneuver around the top of this rock (to the left), I put my hand on it to pull myself up. I maintained three points of contact while making this move. As I gently pulled against the rock, it started to shift, slowly at first. I tried to move out of the way, but it began moving faster and faster towards me. The only option was to let go of the rock to avoid being crushed. As I let go, I began falling backwards and eventually fell towards the floor headfirst."

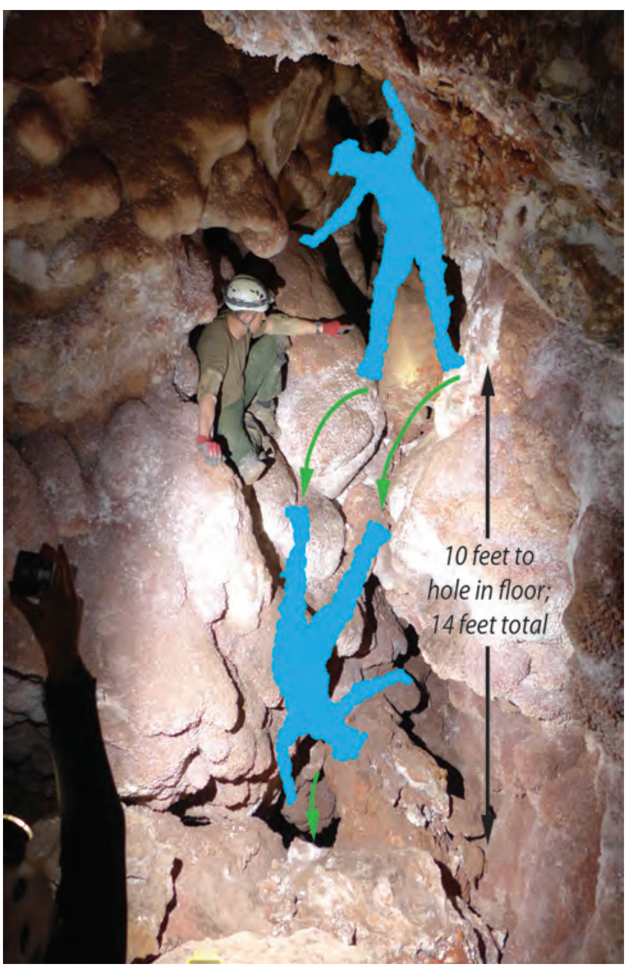
The rock rolled about 5 feet before becoming wedged. Chechet fell about 10 feet, then rolled downslope through a hole in the floor. He called for his teammates who quickly returned and assisted in conducting a medical assessment. He suffered numerous cuts and contusions to his legs, back, and elbows. The team advised him to sit and relax and allow the adrenalin to wear off to see if he noticed any other pain. After cleaning and dressing some of his wounds, Chechet thought he felt all right, but after a group discussion, the team decided to abort the trip. Chechet exited the cave unassisted but experienced pain in his left heel and shin on the way out.

1. Ian Chechet, Trip Report, 19 June 2015.

Comments: Unfortunately, rocks that have been stable and part of a trade route for many years can suddenly decide to move. Chechet's reflexes probably prevented greater injury. While likely a difficult decision for cavers that had planned for weeks and traveled hundreds of miles, it was prudent to abort the trip. A remote underground camp is not always the best place to assess the extent of and monitor an injury. Returning to the surface affords opportunities to recover in comfortable and sanitary conditions, along with access to advanced medical care should it become necessary.

Above, Ian Chechet points to the rock that shifted and caused him to fall in Jewel Cave. The green outline shows the rock's original location. NPS photo by Dan Austin.

Below, a diagram of Chechet's fall. NPS photo by Dan Austin.



20 June 2015
unnamed crevice cave, Ontario, Canada
caver fall, injury and aid

"I just dropped like a stone."

Seth Rowe (30) set out on a Saturday morning to hike the woodland trails in a conservation park in Singhampton, Ontario. He had not told anyone of his plans to visit an area of the park where several crevice caves are located. Shortly before dark, two hikers heard shouts for help and located Rowe, trapped 36 feet below ground in a crevice cave.

The entrance to the cave is about 20 inches wide and narrows to 15 inches. Rowe attempted to squeeze between the rocks, but when he got to his chest he realized he wouldn't be able to fit any farther. He put his foot on a piece of rock in an attempt to climb out of the crevice but the rock gave way. He slid down the passage and became stuck. Rowe was trapped approximately 36 feet down and 18 feet away from the cave entrance.

The hikers that discovered him contacted local authorities.

While rescuers worked to free Rowe, they supplied him with water, granola bars, and blankets. An air chisel was required to free him. On Sunday morning, 22 hours after he had first entered the cave, rescuers pulled him to the surface. He had suffered minor injuries after entering and then falling farther into the cave. The cost of the rescue operation was reportedly more than $46,000.

1. Robyn Doolittle, "Ontario man 'lucky' to be alive after 22 hours trapped in crevice," www.theglobeandmail.com, 21 June 2015.
2. John Musselman, "Ontario hiker who was trapped in cavern thanks rescuers," http://toronto.ctvnews.ca, 23 June 2015.
3. Greg Warchol, Incident Report, 24 June 2015.
4. "Clearview Township to cover cost of cave rescue," http://barrie.ctvnews.ca, 30 September 2015.
5. Christian Stenner, "Submissions for American Caving Accidents," 1 January 2017.

Comments: When finding a cave, as strong as the temptation can be to explore just a short distance solo, it is usually better to return later with a team—or at least ensure that someone knows which cave you have entered.

30 June 2015
Timpanogos Cave, Utah
other (bear spray deployed), no injury, no aid

During a public tour, a visitor accidentally discharged bear spray in the cave. The visitor had recently been hiking in Yellowstone National Park and still had his bear spray in its holster attached to his day pack. The visitor was asked by the ranger tour guide to wear his pack on his front to avoid inadvertently hitting low-hanging formations. Wearing his pack on the front placed his pack straps and the bear spray on his back. As the visitor ducked under a low spot near a large formation known as The Heart, the bear spray bumped the ceiling, causing it to discharge. Most of the spray was contained by the holster and the visitor's shirt, but the visitor's nephew, who was behind him, received some spray in his face. Other members of the visitor's family who were in the back of the tour group found it difficult to breathe as they then passed through the area.

When the group assembled at the next stop on the tour, the ranger leading the group was informed of the incident. The ranger led her group out of the cave and notified other rangers of the accidental spray. Other tour groups already in the cave were evacuated and tours were canceled for the rest of the day. Visitors affected by the closure were either rescheduled or offered a refund.

All doors to the cave were opened for the next several hours to allow the cave to air out. The concrete tour trail and handrails in the affected area were wiped down with isopropyl alcohol, as suggested by the bear-spray manufacturer. Tours resumed the following morning.

Visitors in the cave at the time of the incident reported some temporary itching and burning sensations in the throat but no lasting effects.

1. Bonny Armstrong, Incident Report, 30 June 2015.
2. Cathy Allred, "Bear spray causes temporary closure of Timpanogos Cave," www.heraldextra.com, 30 June 2015.

Comments: Inspection of the bear spray revealed that the safety device on the can was missing, unbeknownst to the visitor. Bear spray is considered a weapon and is therefore not allowed on cave tours. The visitor did not know this, and the ranger did not notice the bear spray on the visitor's pack.

5 July 2015
Stephens Gap Cave, Alabama
stranded, aid, no injury

Rob Cordle (34) and a friend visited Stephens Gap Cave without any caving gear. The cave has two large entrances, one is a walk-in entrance and the other requires a 143-foot rappel. While his friend climbed atop the Pedestal formation, Cordle climbed out along a ledge, tracking mud onto the ledge as he proceeded. When he turned to go back, he found that the mud made travel too difficult. He told his friend he needed help. Luckily, a group of cavers from the Huntsville Cave Rescue Unit happened to be arriving at the cave just then.

Michelle Edwards rappelled as close as she could to the stranded man and threw the bottom of her rope to him. He was able to pull her over to him and once on the ledge, she assisted him in putting on a harness. After attaching Cordle to her own harness, she rappelled with him to the floor of the cave. From there, they exited through the horizontal entrance.

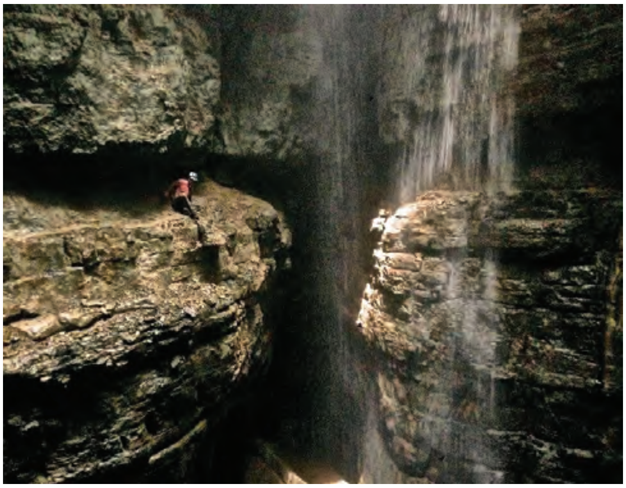
1. Holliday Williams, Incident Report, 28 September 2015.

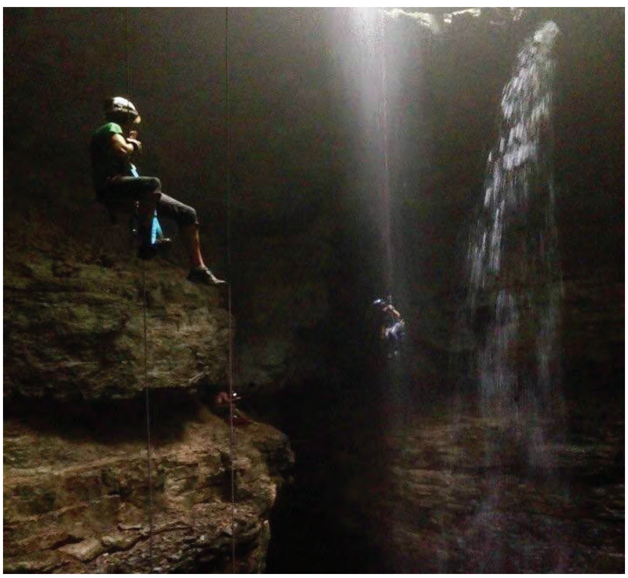
Comments: Although sometimes easier said than done, it is good practice to think about how you will get out of a situation before you put yourself in it. Some cave surfaces can be easily traveled when dry, and only become hazardous once tracked with mud or water.

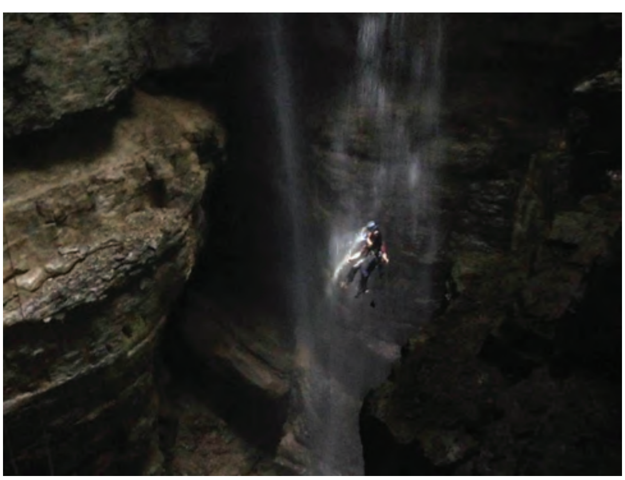
6 July 2015
Big Four Ice Caves, Washington
2 fatalities, other (ice cave collapse)

The mile-long trail that leads to the Big Four Ice Caves in Snohomish County, Washington, is a popular hike for thousands of visitors each year for its scenic appeal and cool, summer temperatures. The caves are the site of several past ice collapses, some of which have resulted in fatalities. A U.S. Forest Service sign near the caves states, "People have been killed and injured in and on the ice caves—be safe, not sorry!" but it is often ignored by visitors intent on entering the caves.

On 6 July, when the temperature was near 80^0 F, several people entered the cave. Eyewitnesses report they heard a loud crack, followed by falling ice and debris. Annalisa Santana (34) was killed in the collapse and her brother, David Santana (25), was critically injured. Survivors hiked back to the trailhead and drove 15 miles until they could get cell phone reception and call for help. At least three other people







Top, a caver is stranded in Stephens Gap Cave after tracking mud across a narrow ledge. Photo by Brad Brown.

Middle, Michelle Edwards (far right) tosses her rope to the stranded caver. Photo by Brad Brown.

Bottom, after fitting the stranded caver with a harness and securing him to herself, Michelle Edwards rappels with the caver to the cave floor. Photo by Brad Brown.

were hospitalized with injuries ranging from severe lacerations to broken legs. David Santana died from his injuries three months later.

1. Manuel Valdes and Phuonge Le, "Woman's body pulled from popular Washington ice cave: Warm weather this year in Washington has made the formation unstable," http://registerguard.com, 8 July 2015.
2. Travis Pittman, "34-year-old woman's body recovered from ice cave collapse," www.usatoday.com, 8 July 2015.
3. "Ice cave collapse claims another victim: Months after a Moreno Valley mom of four died in the tragedy, her brother has succumbed to his injuries," www.pe.com, 12 October 2015.

Comments: An 18-year-old woman, who survived the collapse without injury, told the Seattle Times she "... saw the warning signs outside but went in anyway, because I didn't see anything that seemed to point toward a collapse and others were already in the cave."

25 July 2015
Marbo Cave, Guam
fatality, drowning

Senior Airman Drew Bellairs (21) was on temporary duty in Guam when he and a friend decided to visit Marbo Cave. Marbo Cave is a popular swimming destination for both locals and tourists. It is one of the island's few freshwater caves and was an important water source for Japanese troops during WWII.

After swimming into the dark zone in the back of the cave, Bellairs told his friend he didn't think he could swim back out. His friend left for help but when he returned he discovered Bellairs had drowned. Attempts at resuscitation were not successful.

1. Pat Curtis, "Iowa National Guard soldier dies in accident in Guam," www.radioiowa.com, 27 July 2015.
2. Kyle Daly, "Airman drowns," www.guampdn.com, 27 July 2015.

Comments: Marbo Cave has been the site of at least one previous drowning.

15 August 2015
Scapegoat Cave System, Montana
equipment problem, no injury, no aid

Brian Gindling, Daryl Greaser, and Kathryn McClaine entered the Green Fork Entrance of the Scapegoat Cave System to attempt the first through trip and exit the Kathy's Icebox Entrance. After eight hours of cold and wet travel, they encountered a canyon, less than 2 feet wide that separated the two main sections

The gear used to improvise rigging of the last drop of a through trip in the Scapegoat Cave System. Photo by Brian Gindling.

of the cave. The only way to avoid the water in the bottom of the canyon was to crawl along very thin ledges on either side. While they squeezed through this section, a cave pack was inadvertently dropped into the water where it sank before the cavers could retrieve it. The pack contained all of the rope, webbing, and carabiners needed for the vertical exit.

The cavers were wet and cold and decided they would continue a quarter mile to Kathy's Icebox rather than turn around. They hoped to find rope and rigging materials along the way, left from explorations that had entered that side of the system. When they reached Kathy's Icebox, they had collected four locking carabiners, 40 feet of 6-mm cordelette, 30 feet of a rat-chewed 11-mm static rope, 7 feet of seat belt webbing packstraps, and a 10-foot-long Spectra® climbing sling to use for the 100-foot-deep drop. Although cavers usually rig to bolts and rappel the entire length, some sections can be downclimbed. Gindling explains, "I first attached a carabiner to the bolt and used the cordelette with the pack strap attached to the bottom to climb down the first section and onto an isolated pillar of rock peeling off the cliff. I then used the sling around a breakdown rock and attached the rat-chewed rope for the rappel off the pillar."

1. Brian Gindling, Incident Report, 15 November 2016.
2. Brian Gindling, e-mail communication, 17 November 2016.

Comments: The ingenuity and resourcefulness of the cavers led to a successful outcome. During a rescue or an incident like this one, it is good to remember that multi-drop caves often contain an available gear cache. To help prevent situations such as this one, distribute essential gear among several packs to limit the severity of the situation if one pack is lost.

20 August 2015
East Crater Cave, Washington
bad air, no injury, no aid

The summit craters of Mount Rainier contain the world's largest network of volcanic steam caves. In August 2015, an expedition was conducted to study and explore the caves. The caves are formed in the summit glacial ice cap by heated gases emerging from fumaroles in the volcano crater. The research team consisted of fourteen cavers who camped in the summit crater for six days. The team was well equipped with gas monitors, passive respirator masks, rescue and safety equipment, and an accompanying medical doctor. A full self-contained breathing apparatus (SCBA) was available 3,000 feet below the summit at a lower camp on the mountain. On the fourth day at the summit, a team of two experienced cavers, Christian Stenner (35) and Nicholaus Vieira (34), was exploring and surveying chambers connecting to two large entrances close to the summit. The ground was a thin layer of mud and loose rocks slanted steeply downward at 50 degrees. Stenner was moving down to pick a survey station when his feet slipped out from under him. He fell, sliding out of control down the slope and over a lip, finally coming to a stop a few feet from the bottom of the chamber.

Stenner explains, "My heart rate had shot up along with my breathing. At first I thought my pulse was elevated because I had just taken a fall and the breathing was due to the altitude. Nick couldn't see me. He shouted to ask if I was ok, but I couldn't answer. My labored breathing had escalated to gasping and as I looked around I saw that the ice wall of the chamber met the floor in a pile of boulders. I realized that my gasping was because I was in a pocket of bad air, and as I had that realization, a slight panic set in. I turned around to face the slope. It was steep. With my brain and body now in oxygen deficit I hesitated; at that moment I didn't think I had the energy or capacity to climb. Feeling like I was about to pass out, I made the choice to try. Otherwise I was suffocating. I grabbed onto the rock wall in front of me, dug in with my feet and with a burst of effort was able to scramble up about 4 or 5 feet. It was just enough height, and the air there just good enough, that I felt like I wasn't going to go unconscious. Even so, I huffed and puffed at this level for a minute trying to gain the strength to talk or climb further. I finally had enough breath to form words, and told Nick that I was ok and also to 'get the gas monitor.' Where he was, 15 to 20 feet above, the gas monitor came to life with multiple alarms, for 18.9% Oxygen concentration and 3% CO_2 concentration. Nick announced the monitor results and that we had to leave. I climbed up to him, and we both proceeded to exit the cave. The monitor stayed in alarm until we were almost to the entrance."

1. Christian Stenner, "Caving in the Crater: The Canadians on the 2015 Mt. Rainier Fumarole Cave Expedition." The Canadian Caver, number 82, pages 8-21, Fall 2016.

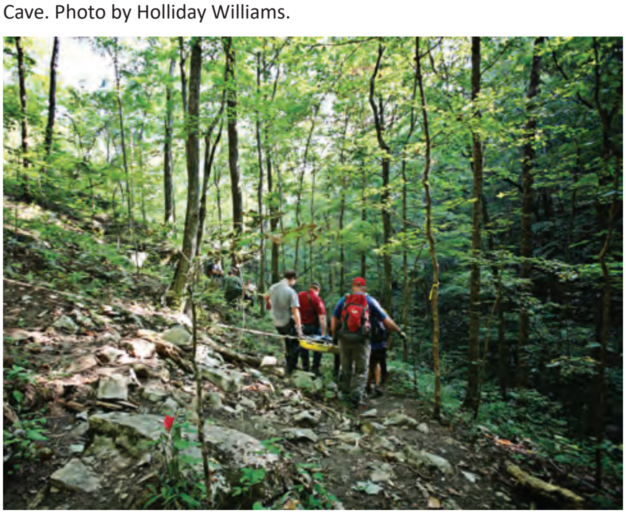
Comments: Though the team was well-equipped and prepared for volcanic gas issues, the gas monitor was not in the possession of the lead member and was not on at the time of the incident. Having it on may have provided early warning and immediate notification of the bad air.

6 September 2015
Stephens Gap Cave, Alabama
fatality, caver fall

After obtaining permits, Patrick Werszner (18) and his girlfriend hiked to Stephens Gap to see the cave and have lunch. During their visit, Werszner climbed onto a formation called the Pedestal. He fell off and was killed from the 50-foot fall.

Local cavers who were just arriving to rappel the cave's vertical entrance assisted local authorities with the body recovery.

Cavers assist agency personnel on a body recovery at Stephens Gap Cave. Photo by Holliday Williams.



1. Kelsey Kern, "Update: Name of teen killed in tragic Jackson County accident released," http://whnt.com, 6 September 2015.
2. Adam Ganucheau, "Despite dangers, caving in Alabama soars in popularity," www.al.com, 13 September 2015.
3. Holly Williams, Incident Report, 30 October 2015.

Comments: When near exposed edges, it is a good rule of thumb to stay more than a body length away from the edge unless clipped in to a safety line. If one needs to approach the edge, it can be done in a prone position instead of standing.

6 September 2015
Rats Nest Cave, Alberta, Canada,
other (overdue), aid, no injury

Two novice cavers entered Rats Nest Cave for an unguided recreational trip. Access to the cave is controlled by a cave-guiding company, which granted a permit. The permit recorded the planned underground route and pre-arranged call-out time. When the cavers failed to meet their call-out time, the guide company dispatched a guide to check for the cavers. The cavers' vehicle was still in the parking lot and there was no sign of them at the entrance. The guide company called for Alberta/British Columbia Cave Rescue, and a callout was initiated to form initial response teams to search the cave.

The two cavers had changed their planned route and their call-out time, but had not communicated that to the company and call-out person. They emerged safely under their own power just as the rescue callout had commenced. The callout was stood down within minutes, but twelve cave rescuers had already begun a response.

1. Christian Stenner, Incident Report, 7 September 2015.
2. Adam Walker, personal communication, 7 September 2015.

Comments: The permit procedures established by the guiding company collected good information meant to assist any potential rescue callout. Any changes to call-out times or procedures should be clearly communicated to whoever has responsibility as surface watch.

10 September 2015
Raccoon Mountain Caverns, Tennessee
stuck, aid, no injury

A 7th grade student on a school field trip became stuck in Raccoon Mountain Caverns. The young girl reportedly slipped and got her leg caught between two rocks. The Chattanooga-Hamilton County Rescue Service Cave and Cliff Team responded but did not supply any additional information.

1. Valeria Sistrunk, "Young girl is rescued from a cave during a routine field trip," www.wdef.com, 10 September 2015.

2 October 2015
Scott Hollow Cave, West Virginia
caver fall, injury and aid

A group of six cavers entered Scott Hollow Cave, intending to do a four-hour trip to the Double Waterfall area. The group consisted of five cavers from Baltimore, Maryland, and was led by local caver Kyle Mills. An hour and a half into the trip, one of the Maryland cavers fell while negotiating a climb down breakdown. The 18-year-old man fell 10 feet, landing in an awkward position. Mills, who is a certified Wilderness First Responder (WFR), assessed the patient and found that he had broken both bones in his lower right leg. First aid was administered and the patient was moved to a more comfortable position. Two people left the cave to summon help. They placed a call to 911 at 1630.

Agency rescue groups were notified as well as local cavers, the Blacksburg Cave Rescue Group, and members of the VPI Cave Club. The first rescue group entered the cave at 1800 and brought a Stokes litter to begin packaging the patient. The next group entered at 1935 to lay wire for field phones, establishing communication from the cave to the surface. More help began to arrive at the surface.

Rescuers began moving the patient shortly before 2100. At one point 51 people were in the cave. Tony Smith was appointed Underground Coordinator and, with assistance from Steph Petri, soon coordinated the rescuers to efficiently move the patient through the cave (this was no small feat, as the patient weighed close to 250 pounds). The patient was at the entrance shortly after midnight. The final obstacle was to haul him up the entrance culvert. Carl Amundson directed this part of the operation and the patient was on the surface by 0100 with all rescuers out of the cave 45 minutes later. The patient was transported to a hospital and released on 5 October.

1. Ed Saugstad, "Incident in Scott Hollow Cave," *The West Virginia Caver*, December 2015, volume 33, number 6, page 9.
2. Kyle Mills, "Scott Hollow Cave Trip Report," *The West Virginia Caver*, December 2015, volume 33, number 6, pages 10–12.

Comments: The efficient, successful outcome of this rescue speaks to the commitment to rescue training in the area by local agencies and by cavers attending National Cave Rescue Commission (NCRC) trainings. Many of the rescuers involved regularly cave together and have trained for rescue together. Having a WFR in the caving party allowed for a reliable medical assessment to be performed and communicated to the surface as quickly as possible.

Safety Break #2

FIELD PHONES

Like the cockroach, surplus army field phones can probably survive a nuclear holocaust. Why is this important? Some of the places cavers go underground are more than just a hop, skip, and a jump from the entrance. Commercially available radios generally don't work in caves. Should there be a rescue in the depths of the cave, the use of wired field phones will reduce the amount of time it takes to send messages in and out. If it takes eight hours to travel from the entrance to the incident location, then it takes 16 hours for a runner to make a round trip. Once the field phones are in place, communication is quick, easy, and more accurate.

A TP-25 Field Phone from the Czech Republic.

3 October 2015
Pond Cave, Arizona
equipment problem, no injury, no aid

Larry Zimmer, Mike Van Note, and Joel Laws visited Pond Cave for a day of exploring and surveying. Zimmer tied a rope to a nearby tree to use as a handline for a 10-foot pit just inside the cave's entrance. At the end of the day, Zimmer and Van Note decided to check one more passage as Laws headed out. When Laws reached the bottom of the pit, he pulled on the rope to take out any slack and was surprised when the rope fell down the pit, landing at his feet.

The pit lacked good handholds, but Laws was able to climb out after a few attempts, taking one end of the rope with him. On the surface, he found a section of the rope and a carabiner still tied around the tree. The rope had clearly been cut. There were also fresh hatchet marks on the tree and on others in the area. Laws rerigged the rope so the other cavers could climb out.

After the cavers had exited safely, the three noticed two young kids (about 7 and 10 years old) with a hatchet chopping at the base of trees across the valley. When an adult joined them, Laws went to speak with him. Laws explained what had happened and how serious it could have been if the rope had been absolutely necessary. The adult questioned the kids, but they denied any involvement. The adult apologized to the cavers.

1. Joel Laws, Incident Report, 10 January 2016.

Comments: In areas where entrance ropes have the potential to be molested, it can be good practice to leave someone on the surface as a rope guard. Another technique in larger pits is to rig a rebelay just below the lip where it cannot be accessed from the surface. This ensures that a rope compromised at the surface will not break while a caver climbs out. However, it can be difficult to determine when these measures might be necessary. The team in this incident had no reason to think their rope would be in danger.

This rope, rigged as a handline at the entrance of Pond Cave, was cut by children with a hatchet. Photo by Larry Zimmer.

10 October 2015
Lick Creek Cave, Montana
caver fall, injury, aid

A group from the University of Great Falls was visiting Lick Creek Cave. About 50 feet into the cave, the passage splits, offering a choice of a slick and slightly exposed 10-foot climbdown or a slightly confusing hands-and-knees crawl. About 40 cavers were in the cave at the time doing a restoration project, and they recommended the hands-and-knees crawl to the students. The university group chose to do the climbdown, even though the rope ladder they were expecting was missing. While doing so, one student slipped and fell a few feet. He bruised his knee and sprained his thumb. The injured student decided to continue, and the group explored the cave until he became uncomfortable and asked to leave the cave. The group was not able to get all the students back up the climb and didn't know the alternate way out of the cave. One restoration caver led the group and one followed the group to the entrance through the hands-and-knees crawl. Once outside the cave, the group hiked 0.7 miles back to the car. The injured individual was assessed by an athletic trainer, who determined that no further medical attention was necessary.

1. Amy Grisak, "Montana cave gets a facelift," Great Falls Tribune, 14 October 2015.
2. Ian Chechet, e-mail communication, 29 October 2015.
3. Jake Clark, e-mail communication, 7 March 2016.

Comments: Trip leader Jake Clark mentions that it would have been wise to have an extra rope along for when ropes expected to be in the cave are found to be missing or damaged.

24 October 2015
Fort Stanton Cave, New Mexico
medical issue, aid, no injury

A team of four cavers visited Fort Stanton Cave to collect samples in conjunction with Dr. Victor Polyak's paleoclimate research. The team entered the cave at about 1045 and made its way to the Trophy Room (more than one mile from the entrance) without incident, arriving just before 1300. The team completed the sample collection and started out of the cave at 1515.

Shortly after beginning the return trip, Steve Peerman (65) felt weak and dizzy, and called for a rest. After a brief rest, they continued out of the cave, but Peerman found that his heart was racing and he was very weak. He realized he would need help and sent the two youngest cavers (Justin Peinado and Chrissy Allen) out to summon assistance, while he and Evelyn Townsend started slowly making their way out of the cave.

Peerman could go only a short distance before having to rest. It took four hours to get almost through Crystal Crawl, where other cavers met them and helped them get to 20 Steps (0.44 miles from the entrance), where they were met by a rescue team. The EMTs immediately put Peerman on a heart monitor (his resting heart rate was between 170 and 190 beats per minute) and started an IV. They were eventually able to bring his heart rate down to normal, and he was able to walk out of the cave. He was transported by ambulance to the Ruidoso Hospital Emergency Room, and then to the Las Cruces Memorial General Hospital, where he was examined by a cardiologist. The diagnosis was a supraventricular tachycardia (SVT) event. Peerman was discharged from the hospital on 26 October.

1. E-mail to Southwest Cavers, 27 October 2015.
2. Steve Peerman, "The Events of October 24, 2015," undated.

Comments: Peerman reports he is now in good health.

15 November 2015
Lechuguilla Cave, New Mexico
other (muscle injury), injury, no aid

Tim Williams (50) was making his way up a climb that was slippery with corrosion residue when he slipped. He was able to push forcefully with his left leg to stop his fall. Unfortunately, the large amount of force necessary to stop the fall injured the quadriceps muscle in his thigh. When a cramping feeling caused him to investigate more closely, Williams noticed that a knot of muscle was bulging outward from the inside of his thigh. The accident occurred on the second day of an eight-day, nine-person survey expedition based at Deep Seas Camp in the Western Branch. Williams rested his leg for an hour, compressed the injury with athletic tape, and was able to make the 2.5-hour trip back to camp accompanied by his teammates.

In camp, another expedition member who is a medical doctor examined the leg and suggested that Williams may have torn the fascia around the quadriceps, causing muscle tissue to herniate outward through the tear (this was later confirmed to be the correct diagnosis). By taking a rest day in camp, medicating with ibuprofen, wrapping the injury with athletic tape, and being careful not to take big steps with his left leg, Williams was able to participate in shorter survey trips away from camp throughout the week.

To exit the cave, expedition members divided up and carried items from Williams' pack, leaving him with a half-weight camp pack to carry out. On the way out of the cave, his team left early, with the rest of the expedition an hour behind in case there were any problems. There were none, and the second team did not catch up with Williams' team until they reached the vehicles at the trailhead. Williams' team of three made the 1,000-foot ascent from Deep Seas Camp to the surface in three hours. After that and the 1.5-mile surface hike, Williams' good leg was sore and cramping from ascending more than 500 feet of rope and managing all the stepping up and down along the route while protecting the injured leg.

1. Tim Williams, Incident Report, 2 December 2015.

Comments: Under the right circumstances, allowing time for a patient to rehabilitate and recover underground can be the right decision. In warmer caves or caves with camp or bivouac supplies, it can be prudent strategy. This was a well-equipped expedition with medically-trained participants, personal first aid supplies, and access to an in-cave cache of additional first aid supplies. Also, the planned week-long camp in the cave provided good conditions for Williams to rest and care for his leg. From the accident site, it was much easier for Williams to reach camp than it would have been to try to head for the entrance. All of these conditions led to the treatment/evacuation decisions that were made. Williams was able to recover somewhat in the cave, to the point where he was able to cave with caution and exit the cave under his own power.

21 November 2015
Cherylsbad Cave, Oklahoma
medical issue, no injury, no aid

Three cavers from the Central Oklahoma Grotto entered Cherylsbad Cave for a day of surveying. The three cavers were all experienced and had been in the cave before. After six hours of surveying, the group put away their instruments and began making their way toward the surface. Along the way, one of the cavers, a woman (69), informed the other two that she was having difficulty breathing and was feeling very weak. The group rested for about 45 minutes and the woman took some Excedrin. The other two cavers considered going for help on the surface, but after evaluating the distances involved in getting a rescue to the cave location and then into the cave itself, they decided to just work at helping get their friend out of the cave. The cave passage in this area is horizontal but very rocky, with numerous boulders to climb up, around, or under. The sick caver was able to navigate the remainder of the cave, with assistance over the "tricky spots." Once out of the cave, they still faced a hike of about 0.25 miles over uneven ground back to their vehicle. They were in an area with no cell-phone service, so they drove directly to the closest hospital, where upon a medical diagnosis it was determined that she had suffered a mild heart attack.

1. Dale Amlee, Incident Report, 18 January 2016.
2. Dale Amlee, e-mail communication, 19 January 2016.

Comments: This is the second report in this issue of *ACA* of someone with a heart condition self-rescuing from a cave. Fortunately, both patients were able to continue to the surface with assistance. In some cases, patients with heart conditions may be so weak as to require litter transport, even after medical intervention.

25 November 2015
Pozo de Montemayor, Nuevo León, Mexico
exhaustion, no injury, no aid

"Luckily, the rescue did not involve anything other than providing warmth, food, and liquids..."

Over the 2015 Thanksgiving holiday, a group of cavers went to Nuevo León to finish resurveying caves on a ranch known as Minas Viejas. This group was larger than the previous year's group and included some cavers who would be touring the caves but not necessarily be a part of a survey team. The survey teams were working in Pozo de Montemayor, a deep cave that requires extensive vertical work. Those who were not surveying were very interested in seeing the cave. The survey teams explained that the cave was likely beyond the skill level of some of them, and they suggested that the group visit another less challenging vertical cave instead. Everyone agreed that a different trip would suffice. When this trip went well, the survey teams decided that everyone could rappel into the first section of Pozo de Montemayor but strongly suggested that they not rappel down The Big Pit (also known as Former 400 Pit), a pit just shy of 400 feet deep. The only other stipulation was that one woman (23) in the group, who had been having some difficulty with heights, stay with a more experienced companion while in the cave. Again, everyone agreed.

After the survey teams had rappelled The Big Pit, they began making their way deeper into the cave. At the next pit, Matt Zappitello, who was at the back of the group, heard someone calling his name somewhere behind him. He went back a short distance to find the 23-year-old female rappelling down The Big Pit. She had decided to continue on alone even though her companion had advised against it. Zappitello then had to make a choice, abandon his survey team and climb out with her, or let her join the survey team. After some discussion, she convinced him that she felt strong enough to join his team.

When the team finished surveying, they began heading for the entrance. Thirty feet up The Big Pit, the young woman began having difficulty. She would not perform a changeover and she did not want to continue climbing. Eventually, with encouragement from below, she began climbing a few feet at a time followed by rest breaks. Another survey team arrived at the bottom of the pit and the two teams waited. By the time she reached the top, the cavers at the bottom were huddled together under emergency blankets. The others then ascended out of the pit and Zappitello and one other caver stayed with the woman. Here they discovered that she had not brought enough food or water for the trip but had not told anyone. Sharing their food and water with her gave her more strength to continue. The trip out of the cave, which the teams normally do in three hours, took just over 10 hours. They arrived in camp as others were forming a rescue party.

1. Matthew Zappitello, Incident Report, 15 February 2016.
2. Matthew Zappitello, e-mail communication, 16 February 2016.

Comments: In his analysis of whether he should have delayed the survey and immediately escorted her out or not, Zappitello concludes, "It was an incredibly tough decision and I have concluded that we all need to trust each other's self assessments until someone is proven to be incapable of safely assessing their own strengths and weaknesses. Without that trust, we cannot ever cave with strangers. But, it can open us to some bad experiences like this. I just hope that everyone is smart enough and comfortable enough to admit when they can't do something so we can avoid these situations. We all need to be conscious to create an atmosphere that encourages people to admit when they don't feel comfortable with something."

27 November 2015
Pozo de Montemayor, Nuevo León, Mexico
equipment problem, no injury, no aid

During their Thanksgiving holiday expedition in Nuevo León, five cavers entered Pozo de Montemayor for a survey trip. Four cavers rappelled Argos Well (360 feet) without incident. As the fifth caver passed the last of the pit's four rebelays, a section of the rope "felt a little funny" as it passed through his brake hand and then "hitched" as it passed through his rack. This concerned him enough that he stopped to inspect the rope and found that the sheath was completely separated, revealing three inches of the rope's core. The caver immediately clipped his ascenders above the damage and removed his rack from the rope. Tying a butterfly knot in the rope, he was able to isolate the bad spot. Performing a changeover back to descent, he continued to the bottom. When he reached his companions, he asked if any of them had noticed a problem with the rope. They had not. Since the other four cavers were less experienced in vertical caving, they may not have had the experience to notice the beginning of a problem, or the rope somehow became damaged between the fourth and fifth cavers' use.

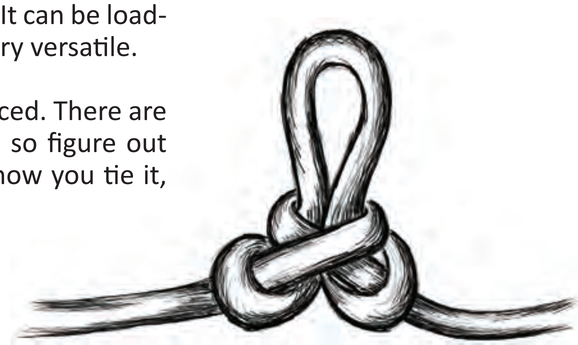
At the end of the trip, the first caver to ascend past the butterfly noticed that weighting the rope had pulled the rope's bad spot back into the knot. Luckily the rope held, and a butterfly knot, this time with a bigger bight, was retied. The rope came from a spool

Safety Break #3

(ALPINE) BUTTERFLY KNOT

Knots and ties can go by many names. Whether you call it an Alpine Butterfly, Butterfly, or Lineman's Loop, this tie has many uses and should be part of your rigging repertoire. It is a midline knot that, when tied properly, holds its shape and stays in place. Since you don't need the ends of the rope to tie this knot, it can be used any place along the line. Some of its many uses include making an improvised clip-in point or isolating a damaged spot in the rope. It can be loaded end-to-end or pulled from the bight, making it very versatile.

Remember: Knot-tying is a skill that should be practiced. There are different ways to tie rope and get the same result, so figure out what works for you. No matter what you call it or how you tie it, always dress it and inspect it before using it.



of 11-mm Highline Rope that was purchased specifically for the trip and first rigged the day before the incident. A reason for the damage could not be determined.

1. Matthew Zappitello, Incident Report, 15 February 2016.
2. Matthew Zappitello, e-mail communication, 28 December 2016.

Comments: A rope's condition should be inspected by every user, on every use, so as to find and correct issues before they become serious. In a discussion of this incident, Zappitello said, ". . . another takeaway for me was that when isolating a problem area in the rope, you should be generous with the bight containing the bad spot. That is especially true with wet ropes, which this one was."

28 November 2015
Bisaro Anima, British Columbia, Canada
other (overdue), no injury, aid

At 1110, Alberta/British Columbia Cave Rescue received an e-mail from a designated call-out person for some overdue cavers. Three cavers were due to come out of Bisaro Anima, a remote and deep cave undergoing exploration, and rendezvous with a helicopter at 1000. The cavers had a satellite phone, and the call-out person had not yet heard from them.

Minutes later, further contact was received, stating that the helicopter landed on the mountain and that there was no sign of the cavers. The pilot stated he would wait awhile and then fly out. Cave rescue started to make preparations. At 1322, cave rescue was contacted and told that the cavers were out of the cave and on the helicopter.

Further investigation with the involved group confirms a communication error with regard to call-out and pick-up time. The cavers were in an underground camp and departed camp at 0600. They exited the cave at 1300 hours which was as they had planned. There were no issues causing a delay.

1. Christian Stenner, Incident Report, 29 November 2015.

Comments: Clear communication is important when establishing a rescue call-out time, especially when costly helicopter transportation is involved!

5 December 2015
Cascade Cave, British Columbia, Canada
stranded, aid, no injury

Cascade Cave in British Columbia is a technical cave with waterfalls, vertical pitches, and tight crawlways; it is considered a sporty cave even for experienced cavers. Access to the cave is controlled with a locked gate, and on 5 December, six cavers were given access for a day trip.

In the cave, the cavers found the water to be higher and swifter than usual, but their experience level gave them the confidence to keep going. One caver exited the cave early, leaving five in the cave. The remaining cavers descended the Bastard's Crawl, an awkward, sloping, hands-and-knees crawl to the top of the Double Trouble waterfalls. After rappelling the 75-foot waterfall, the cavers took a break and cooked a hot meal. They continued a short distance after that until one of the cavers suggested they start heading out, since everyone was getting quite cold. Back at the top of the waterfall, it became apparent that the water was up quite a bit. Unbeknownst to those in the cave, a rainstorm had unexpectedly developed.

At the top of the waterfall, the cavers had to enter the Bastard's Crawl, this time traveling up, against the flow of water. The force of the water was tremendous, and the airspace above the water was slowly diminishing. Two cavers made it through, but Jason Storie (44) found that the force of the water coming through the crawlway pushed him down into a narrow wedge. His body acted like a cork in the passage and the rushing water rose to his ears and began washing over him. Andrew Munoz (32), the trip leader, tried to help Storie. Munoz's GoPro® captured footage of several terrifying minutes while he helped coax Storie back out. Eventually, Storie freed himself with Munoz's help. Storie was by now hypothermic, so Munoz and another caver got him out of the water and wrapped him in a space blanket. They used a small camp stove to heat water and pour it into Storie's cave suit. (Later they found it more effective to make hot water bottles and place them on Storie.) The level and strength of the water continued increasing and threatened to wash the three cavers over the waterfall.

Munoz encouraged the other caver to try to make it through the crawl while he stayed with Storie. That caver met the other two on the far side of the crawl, and the three exited the cave to call for help. When Storie was rewarmed, he and Munoz made another attempt to exit, but by now the water was even higher and they were turned back. The only place to get out of the water was a small, steeply sloping ledge, barely large enough for the two of them. They spent the next 14 hours on the ledge, not knowing if their teammates had made it out safely.

The other cavers had made it out and initiated a rescue response. Rescuers made it to within 25 feet of the stranded cavers but could not make contact. They decided to wait for the water to go down.

Munoz and Storie kept a close eye on the water levels, and when they saw the water level finally begin to drop, they made another push for the entrance. This time they were successful; they arrived at the bottom of the entrance pit just as rescuers were making their way into the cave.

1. Gina Noelle Daggett, "Duncan men recall harrowing cave expedition near Port Alberni," http://vancouversun.com, 29 May 2016.
2. Doug Munroe, Incident Report, December 2016.
3. Christian Stenner, "Submissions for American Caving Accidents," 1 January 2017.
4. Andrew Munoz, Incident Report, 3 February 2017.

Comments: In his report, the trip leader provides an excellent analysis of what the group did wrong and what they did right. In retrospect, he believes their biggest error was in misjudging the force of the water. Munoz writes, "The level of water was passable but the force should have alerted me to the fact that ascending was going to be an issue. If there was any increase in flow it would be VERY hazardous. However, I was suffering from risk hardening. With five years of commercial cave guiding in Watiomo, New Zealand, I had developed great skills in the water and was projecting that onto the group." While the water may have caught them by surprise, they were well-equipped for emergencies. Having rations, a stove, and a rugged emergency blanket likely saved the pair's life as they sheltered in place, cold and wet, for 14 hours. They also mentally prepared for a wait of unknown duration. While struggling to stay perched on their ledge, Munoz advised Storie, "We have no way to tell how long this is going to last, and things are probably going to get dark from time to time. The most important thing is that we stay together as a team and don't turn on each other."

For dramatic video coverage of this incident, see http://vancouversun.com/news/local-news/caving-in-cascadia-a-story-of-survival. The incident is also featured in the Mountain Rescue Association's webinar series, March 2017.

20 December 2015
unspecified talus cave, New Jersey
other (bear attack), injury, no aid

Boy Scout leader Christopher Petronino (50) wanted to show three Boy Scouts a talus cave he had been visiting since the 1980s. He had been in the cave two weeks prior. When they climbed up the hillside to enter it, he stuck his foot into the 2-foot-wide entrance. A black bear grabbed his foot and pulled him into the cave, then proceeded to bite him on the leg, arm, neck, and head. Petronino hit the bear in the head with his rock hammer, pulled his sweatshirt over his head, curled into a fetal position, and yelled to the Scouts to go and get help. The Scouts called 911, but couldn't tell the dispatcher exactly where they were. They built a signal fire to help searchers find them. Petronino instructed the Scouts to leave some food at the entrance of the cave. They did and then observed the bear exit the cave. A dog that was with them then barked and chased the bear up the hill. Petronino exited the cave and called 911 again, an hour and 20 minutes after the first call. A helicopter took Petronino to the Morristown Medical Center for treatment of his severe lacerations.

1. "Boy Scout leader, 'wanted to show scouts small talus cave,' never encountered bear before," http://abc7ny.com, 21 December 2015.
2. Jason Koestenblatt, "Bear attacks, traps scoutmaster in cave," http://patch.com, 21 December 2015.
3. Richard Cowen and Scott Fallon, "N.J. scouts who aided in rescue from bear mauling hailed as heroes," www.northjersey.com, 21 December 2015.
4. Avianne Tan, "911 call reveals bravery of 3 Boy Scouts during bear attack in NJ," www.abcnews.go.com, 29 December 2015.
5. Rebecca Ibarra, "Hear it: 911 call detailing New Jersey scoutmaster bear attack released," www.nydailynews.com, 29 December 2015.

Comments: New Jersey's black bear population is on the rise, with an estimated 3,500 bears. Black bears den for the winter, but do not enter a deep hibernation. One questions why Petronino was entering the cave with rock hammer in hand, but a whack to the head with it and some food was apparently enough to persuade the bear to lose interest in him.

27 December 2015
Cemetery Pit, Georgia
exhaustion/difficulty on rope, no injury, no aid

Five cavers entered Cemetery Pit to continue working on a dome climb. On 27 December, they found the dome was unusually wet so they decided not to climb that day. After three hours in the cave, they started their exit. One at a time, three of the cavers made their way up the 153-foot entrance pit. Tim White climbed fourth and waited at the top for the final caver. After a while, White realized he had been waiting a long time. Ron Miller came back into the cave to see if everything was alright. Just then, the 50-year-old caver on rope yelled up, "Tim, I can't climb anymore!" Checking the rope, White and Miller could feel the rope was tensioned. He was only about 50 feet up the rope. They yelled back that they would set up a haul system, but that he should keep trying to climb on his own.

The drop had been rigged from bolts as a Y-hang using a double figure-8 knot. The remaining few feet of tail was rigged as an approach line. The cavers on top used 30 feet of 8-mm cord to build a 3:1 haul system to pull the mainline up enough to create slack in the mainline. With the climber's weight now on the 8-mm cord, the mainline was rerigged as a 3:1 using webbing around a boulder as an anchor. Once his weight was transferred back to the mainline, the cavers began to haul him up. Even with only 4 feet of throw, and significant friction at the bolts where the rope went through a carabiner, the haul system worked well enough that the fifth caver was hauled the remaining 100 feet out of the pit. His difficulty on rope was due to his wearing a large pack full of bolting and climbing gear on his back. The extra weight pulling him backwards was too much for him to overcome and he quickly became too exhausted to continue climbing.

1. Tim White, personal communication, 8 May 2016.
2. Michael Hopkins, e-mail communication, 28 December 2016.

Comments: Using a tether to hang a heavy pack below a caver is usually more efficient than wearing it. Fortunately, the cavers on top were trained and highly skilled in cave-rescue techniques; White is an NCRC instructor.

2015 CAVE-DIVING ACCIDENTS AND INCIDENTS

17 January 2015
Devils Eye Spring, Florida
fatality, illness

Jack Gregory (63) of Marietta, Georgia, and Graham Murray were planning to use diver propulsion vehicles (DPVs) to get to the Sweet Surprise area in Devils Eye Spring. They were then going to push the DPVs through to the Mainland area, get back on the main guideline, and use the DPVs to exit. According to Murray, Gregory turned (aborted) the dive suddenly in Sweet Surprise. At one point, Murray turned around to check on Gregory and found him slumped over his scooter. Gregory's regulator was still in his mouth, but he was unresponsive. Murray tried to purge air from his own regulator into Gregory's mouth, but Gregory was still unresponsive. Murray returned to the surface for help. Gregory was recovered by International Underwater Cave Rescue and Recovery (IUCRR) divers.

Gregory was using sidemount tanks and had used all of the air in his right tank. His left tank still had 1800 psi. Friends report that Gregory had been doing long, extensive dives all week. He was overloaded with gear, video equipment, and a heavy DPV with added extra weight to make it negatively buoyant.

1. Forrest Wilson, Incident Report, 27 January 2015.

Comments: Jack Gregory was a certified cave diver with more than 100 logged cave dives. This may have been too ambitious a dive for the physical condition he was in at the time.

25 February 2015
Sistema Camilo, Quintana Roo, Mexico
fatality, lost, medical issue

On a Wednesday afternoon, three divers began their first dive during a trip to Quintana Roo. At approximately 1400, Keith Price (72), Tom Corwin, and Bill Lavine entered Cenote Muchachos, one of the cenote entrances to Sistema Camilo. The divers all had many years of experience and were familiar with this cave. Information later gathered from Price's dive computer was used by Bil Phillips to reconstruct this scenario: At approximately 35 minutes and some 1,800 feet penetration distance into the dive (underwater depth of approximately 60 feet), the divers reached their gas-turn-around pressures. The divers signaled to each other and started their exit toward the cave entrance. At this time, or very shortly thereafter, visual contact with Price was lost. One of the divers claims that he saw Price's light to the right side of the guideline and at a deeper depth than the other two divers. The divers began a short search for the missing diver, backtracking and looking with their lights for signs of their buddy until they were forced to leave the cave due to their gas reserves.

At approximately 1500, the two divers exited Cenote Muchachos and asked one diver's wife if the missing diver had surfaced. The answer was "No." The two divers informed the caretakers at the cenote site that there was a missing diver in the cave. By this time, the surviving divers assumed that the victim had either perished in the cave by exhausting his gas supply, or he had exited the cave system by another entrance. An underwater search team did a preliminary search of the main line and 150 feet down each side passage. The only clue observed was a bubble trail that led deeper into the cave. When that trail was lost, the team ended their search for the day. Land searches did not find Price at any of the cenotes they checked.

The underwater search resumed the next day. Divers again found and followed a bubble trail. It eventually led to Cenote Camillo, where Price's two dive cylinders were found at the water's edge; the tanks had 450 and 500 psi respectively. A diveline led into the jungle. The divers called out but heard no response, so they returned to Cenote Muchachos to inform the surface team.

Once the surface team located the cenote, they followed the guideline into the jungle and found where Price had discarded his fins and helmet. The guideline ended after 200 feet, but Price's trail was discernible from branches he had broken, pointing in his direction of travel. More than 1,600 feet from the cenote, Price was found face down on the ground. He was still wearing his mask with prescription lenses, wetsuit, hood, cave diving harness, buoyancy compensator, lights, and dive computer. An autopsy determined that a heart attack was the cause of death.

1. Bil A. Phillips, "Sistema Camilo Cave Diving Incident, February 25–26, 2015, Tulum, Quintana Roo, Mexico," undated.

Comments: It is not clear why Price separated from his group and began following an adjacent line. That line had permanent arrows, which he followed, but they led away from his point of entry. Phillips concludes his report, "At some point, the victim had to realize that the guideline he was following would not lead to his original entry point. He encountered a few jump lines coming from other directions. He followed one (without the use of a jump reel to maintain a continuous guideline). This second line contained line markers pointing further into the cave. This line in turn came to an abrupt end, and the victim chose to make another 'visual gap' without the use of a guideline. Including his original departure from the main line that the team used to enter the cave, the victim made a total of three 'intentional visual gaps' neglecting to maintain a continuous guideline to his original exit. By pure chance his wanderings led him to Cenote Camillo. He was able to surface here before exhausting his gas supply. By him attempting to reach his vehicle and starting point overland, we can guess that he was overcome by the combination of physical exertion, dehydration, and overheating. As stated in the autopsy, a heart attack was the cause of death. Although this accident did not occur in the cave environment, the cause of death was a direct result of poor decisions made by the cave diver during the dive."

26 April 2015
Devils Eye Spring, Florida
fatality, silt, lost guideline, out of air

Robert Jurich (68) and Evelyn Dudas, from Pennsylvania, entered Devils Eye Spring planning to use diver propulsion vehicles (DPVs) to get to the area known as Mainland, which is approximately 3,000 feet from the entrance. They had planned to push their DPVs through a low, silty area in Mainland, continue through an area called Sweet Surprise, rejoin the main passage, and exit the cave. In the beginning of Mainland, they stirred up the silt and became separated. Dudas managed to find her way back to the larger passage and waited for Jurich. When he didn't return, she exited the cave to get help. A recovery team entered the cave several hours later, and found Jurich, deceased, about 400 feet from the entrance.

According to Lamar Hires, who led the recovery effort, Jurich's DPV was found partially embedded in silt, which would have made it impossible to operate without removing it from the silt. Once it was removed, it was in working order.

1. Lt. Jeff Manning, "Gilchrist County Sheriff's Office Press Release," 27 April 2015.
2. Lamar Hires, e-mail communication, 19 May 2015.

Comments: Jurich and Dudas were using only side-mounted 85 cubic feet tanks, with no additional breathing gas. That would have been enough if nothing had gone wrong, and they had been able to use their DPVs to exit. It isn't a good idea to push a DPV into a low silty area. We can only assume that Jurich left the DPV behind because it was making it hard to follow the guideline in low visibility. He likely would have survived if they hadn't stirred up the silt, he had kept the DPV with him, he had made it to the larger tunnel before Dudas left, and/or he had carried a stage tank of extra breathing gas.

28 April 2015
Sistema Dos Ojos, Quintana Roo, Mexico
fatality, unknown, diving solo

A young male living in Playa del Carmen, Quintana Roo, rented a single SCUBA tank from his uncle at a dive facility in Tulum. The SCUBA tank, full of normoxic gas, was rented with the understanding that the diver would be visiting open water locations along the coastal region of Sian Ka'an Biosphere Reserve. The diver was Open Water certified. He did not hold Cave Diver or Cavern Diver certifications.

The diver paid his entry fee at the Ejido San Jacinto Pat security gate to enter the Dos Ojos Cenote Park at 0800 Thursday morning. The Ejido personnel did not ask for his diving certifications or check his diving equipment. After a short drive inland, he parked his vehicle at the main Dos Ojos Cenote Park parking area and carried his open-water equipment past a park employee. She was the last person to see this diver alive.

The diver entered the West Ojo of the Dos Ojos region of Sistema Sac Actun. Diving in open-water SCUBA configuration and with his GoPro® camera, he found the "Cavern" traverse guideline leading to the East Ojo. The East Ojo entrance is plainly visible once a diver has submerged from the West Ojo cavern zone. It is believed the diver did a visual jump from this West Ojo to the East Ojo permanent traverse guideline to a parallel guideline that deviates to the Bat Cave entrance in the same cave system. This secondary guideline continues toward the Green Room that contains a small cenote entrance opening. From the Green Room, it is possible to continue the traverse to the East Ojo cenote exit. There is little doubt that the victim had done prior guided tours in this area of the Dos Ojos cave.

A cave-certified dive instructor from the Akumal Dive Center entered the East Ojo with his cavern tour group around 0845 on the same date. His dive plan included leading his tour group to the Green Room. During this tour, he noticed a blinking LED common to GoPro® cameras in record mode, and he found a body in open-water SCUBA equipment pinned to the cave ceiling. The body was located off the permanent guideline by some distance. This instructor moved the body to the Green Room cenote exit. Local authorities were called but could not revive the diver.

1. Jim Coke, "Sistema Dos Ojos Cave Diving Accident Report, Municipio de Tulum, Quintana Roo, Mexico," 9 November 2015.

Comments: It is not known what became of the GoPro® video, but it may provide some answers to what went wrong. Cave diving requires a significant amount of specialized training. This diver did not have that training.

8 June 2015
Volusia Blue Spring, Florida
fatality, ran out of air

Rhys Dervan (56) and his 16-year-old son were diving at Blue Spring State Park on a Monday afternoon. When the son decided he was finished diving for the day, the father said he was going to do one more dive and meet his son later. When his father did not show up an hour later, the younger Dervan notified authorities. Rescue divers responded and found Dervan's body a short way into the cave. He had run out of air and drowned.

1. Patricio G. Balona, "Man dies while cave diving at Blue Spring State Park," www.news-journalonline.com, 8 June 2015.
2. David Sutta, "Cave Diving Death under Investigation in Volusia County," http://miami.cbslocal.com, 10 June 2015.

Comments: No other information was available.

Devils Eye Spring, Florida. Photo by Gene Page.

2015 CAVING-RELATED ACCIDENTS AND INCIDENTS

3 January 2015
unnamed cave, Kentucky
dog rescued from cave

A dog named Trudy entered an unnamed cave, probably chasing a raccoon. The tight entrance has a stream flowing from it that prevented the owners or anyone else from reaching the dog. Trudy's owners obtained permission from the landowner to dig a hole to try and reach her. A backhoe excavated an opening to another tight passage closer to Trudy, but she refused to come out and still no one could quite reach her.

On Trudy's fifth day underground, the animal rescue organization, Almost Home, contacted cavers. Thor H. Bahrman III organized other cavers and went to Trudy's aid. The cavers made more progress at enlarging the entrance. Eventually, Alex Roberts, donning a wetsuit, was able to reach her and bring her out of the cave.

1. Thor H. Bahrman III, Incident Report, 10 January 2015.

Comments: It's not uncommon for dogs to chase raccoons into caves and small crevices. This same group of cavers rescued another dog from a different cave only one week before. While rescuing Trudy, two dog collars and one dog corpse were found in the cave.

5 March 2015
unspecified cave, Missouri
dog rescued from cave

In March, a shepherd-mix named Lucious wandered 20 miles from home and entered a cave located on a cliff. For three days, the dog whined and yelped but wouldn't come out. Two Independence, Missouri, animal control officers were able to sedate Lucious with a sedative-laced donut and then grab him with a snare pole. The sleepy, 50-pound dog was then lowered off the cliff by rope.

1. Kasey Babbitt and Robert Townsend, "Dynamic duo rescues dog stuck in cave," http://fox4kc.com, 11 March 2015.

Comments: Lucious is a bad boy.

8 March 2015
unspecified cave, Texas
caver fall hiking from cave

After the March 2015 NSS Board of Governors meeting in San Antonio, cavers participated in a recreational cave trip in Real County, Texas. After a three-hour trip, several cavers were heading toward their vehicles parked 150 yards downhill. A light rain had made the ground and rocks slippery, contributing to Tom Florer (46) slipping and twisting his ankle. Florer made it to his vehicle where he took some naproxen sodium for the swelling and wrapped his ankle in an ACE bandage. An x-ray later revealed he had fractured his fibula.

1. Tom Florer, Incident Report, 28 March 2015.

Comments: Slips and falls can happen to anyone at almost any time. Florer said that one important lesson he learned was "You cannot buy a pair of crutches in San Antonio, Texas, at 8:00 p.m. on a Sunday evening."

6 June 2015
ridgewalking, Oregon
illness, aid, no injury

Thirteen members of the Oregon High Desert Grotto made a long drive from central Oregon to a remote location in the southeast corner of the state. The next morning, the group left camp to ridgewalk, looking for lava tubes. The area is sage-covered desert and basalt floes. The day saw the first hot temperatures of the year, and there were no trees for shade.

In the early afternoon, two cavers decided to make the 2.4-mile hike back to camp while the others continued ridgewalking and checking out lava tubes. Halfway back to the vehicles, a 26-year-old female in the group of two began to have difficulties due to the heat and a pre-existing medical condition. Her partner had a radio, but the batteries had died. The woman was told to sit and rest in the shade of a boulder while her partner went to see if a vehicle could be driven in to pick her up.

The terrain was too difficult for a vehicle, so the caver got supplies and fresh batteries for the radio and hiked back to the woman. When he returned to the boulder, she was gone. Feeling slightly better, she had attempted to continue hiking but went the wrong way. When her symptoms returned, she again rested in the shade of a boulder and attempted to call for help on her cell phone. One call to her mother was successful and her mom contacted EMS who sent an ambulance and a deputy.

By 1900, the other cavers had been notified of the emergency and began searching for the missing caver. She was located around 2030 and escorted back to the vehicles. The request for EMS services was canceled when she appeared to be doing better.

1. Neil Marchington, "Eastern Oregon Caving/ All home and fine," e-mail to Oregon High Desert Grotto, 7 June 2015.
2. Neil Marchington, e-mail communication, 4 December 2015.

Comments: In his report, Marchington explains that, while many in the group had two-way radios, there was some confusion in their operation that made communication during the incident ineffective. He also suggests: "More people should have had GPS receivers with the truck and route marked. A GPS point of [the patient's] location would have really helped, and a GPS would have kept [her] on the right track. Many of the people along did not have their GPS on them. There were about 5 for 13 people." If the patient had stayed in place, the other cavers would have found her sooner, even without GPS receivers.. A patient who wanders puts themselves and others at greater risk.

2016 CAVING ACCIDENTS AND INCIDENTS

1 January 2016
Byers Cave, Georgia
caver fall, injury and aid

A group of cavers from Atlanta received permission from the Southeastern Cave Conservancy to explore Byers Cave. During their trip, an experienced caver (63) stumbled and fell about 20 feet. He received multiple injuries to his head, shoulders, and back. Two cavers on the trip left the cave to call for help, and more than 40 rescuers from various agencies and volunteer rescue groups responded. The rescue operation lasted through the night and required multiple vertical-haul systems to bring the patient to the surface. He was then airlifted to a nearby hospital in critical condition.

1. Kate Smith, "Man had proper training and experience to navigate cave; in critical condition after cave rescue," www.wrcbtv.com, 2 January 2016.
2. Emmett Gienapp, "Spelunker rescued from Dade County cave after falling 25 feet," www.timesfreepress.com, 2 January 2016.
3. Greg Mathis, Incident Report, undated.

Comments: This man was on a horizontal cave trip, yet required multiple haul systems to be brought out of the cave. This incident in Byers Cave is a good example of how a horizontal cave can become a vertical cave during a rescue.

16 January 2016
Jewel Cave, South Dakota
caver fall, injury, no aid

Six cavers entered Jewel Cave to spend four days underground at the newly established camp in the western portion of the cave. On the second day of the trip, the cavers traveled nearly four hours from camp. They stopped briefly at Hourglass Lake to collect water samples and split into survey teams. Dan Austin, Rene Ohms, and Ian McMillan (26) formed a team to survey leads south of the lake, while the others planned to survey near the Limestone Lunchroom. The teams set a rendezvous time of 2300, planning to be back at camp by 0300.

As survey began, McMillan took the lead, setting stations in virgin passage heading south off the map. Just a few shots into the survey, he came to a shallow pit in the floor. The passage continued on the other side of the pit, so McMillan traversed along the pit, using a slight protrusion on the right wall. Not finding a suitable location for the survey station on the far side, he returned to the near side of the pit, using the same protrusion, and set the survey station. After taking the shot, McMillan once again crossed the pit, this time to check a lead at the bottom. He again used the wall protrusion for stability. Unexpectedly, the protrusion broke, and he fell 9 feet into the pit, landing among jagged breakdown.

Austin and Ohms heard him fall and rushed to his aid. Blood was already soaking through McMillan's tights. McMillan and Ohms both had personal first-aid kits. Ohms and Austin assisted in cleaning and bandaging a large wound on McMillan's calf and a less serious laceration to his arm. The seriousness of the injuries convinced the team they should start making their way out of the cave. On their way to camp, Ohms found the other team who joined them.

Ian McMillan received this wound from a fall when he was six hours from the Jewel Cave entrance. Fortunately, he and a teammate had well-stocked personal first-aid kits. Photo courtesy of Ian McMillan.

When the cavers reached camp shortly after midnight, they decided it would be better to spend the night and make the long trek out the following day. By this time McMillan was experiencing nausea and finding it difficult to eat. The group broke camp at noon the next day and traveled slowly, reaching

Rescuers carry an injured patient out of Tumbling Rock Cave. Photo by Amy Hinkle, courtesy of the Huntsville Cave Rescue Unit.

the entrance at 1830. Teammates drove McMillan to the hospital where physicians, concerned over the possibility of infection, decided not to stitch up the wound. McMillan flew home to Hawai'i where a physician concurred it was best to let the wound heal naturally.

1. Daniel Austin, Incident Report, 3 March 2016.

Comments: Jewel Cave National Monument held an After-Action Review so that trip participants could discuss the incident. Although McMillan and Ohms carried their own first-aid kits, the cavers had never discussed who was carrying what first-aid supplies and some assumed the in-cave rescue packs were sufficient. Jewel Cave cavers will now start carrying two park-supplied first-aid kits, splitting up supplies among team members.

16 January 2016
Tumbling Rock Cave, Alabama
rockfall, injury and aid

During a group outing to Tumbling Rock Cave, a large boulder unexpectedly dislodged and rolled onto the foot of a girl (15), crushing her foot and ankle. Some members of the group stayed with the girl while others went to get help. A call to 911 resulted in several rescue groups arriving at the cave between 1800 and 2000.

The patient was about a mile into the cave, beyond a tight section known as the Suicide Passage. Local cave rescue groups had participated in rescue trainings in this area previously, and they knew that a patient could not be transported in a Ferno® litter through the Suicide Passage due to its small spaces and twisting nature. The patient would either need to be assisted through without a litter or the passage would need to be widened. A caver experienced with passage modification was sent in to widen the passage enough to move the patient through in a SKED® (a more flexible type of litter). Due to safety concerns, the passage modification was completed with hand tools instead of explosives. Once the patient was moved through the Suicide Passage, she was repackaged into a Ferno®.

Evacuation teams worked together to carry the patient over breakdown and up and down slopes while maintaining a belay for safety. The patient was brought to the surface at 0145 and flown to Erlanger Health System for treatment of her injuries.

1. Chase Erwin and Franklin White, "Rescuers bring injured girl to surface after hours trapped in cave," 17 January 2016.
2. Huntsville Cave Rescue Unit, Incident Report, undated.

Comments: A spokesperson for the Huntsville Cave Rescue Unit said that the actual rescue took about one hour less than practice rescues and credits the rescue's success to the dedicated individual rescuers and teams and the cooperation between the Jackson County Rescue Squad, the Huntsville Cave Rescue Unit, and Chattanooga-Hamilton County Rescue Squad Cave and Cliff Team.

31 January 2016
unspecified cave, Tennessee
stranded, injury and aid

Two men returned to a cave they had found previously in Cumberland Gap National Historic Park. They brought along a rope purchased at Walmart, and only one of the men entered the cave. Inside the small entrance, the cave slopes downward at a 45-degree angle for about 60 feet before coming to a 15-foot free hang. The man slid hand over hand down the rope to the bottom, but was unable to climb back up. His friend eventually called National Park Service (NPS) Rangers.

Claiborne County Rescue Squad, Bell County (Kentucky) Rescue Squad, and the NPS responded. The stranded man was located and placed in a harness. Rescuers used a 3:1 haul system with a belay to raise him to the surface. The man was mildly hypothermic after spending five hours stranded in the cave. He also had rope burns on his hands. His only gear was a headlamp. He was ticketed by the NPS.

1. Earl Pelfrey, Incident Report, 31 January 2016.
2. Earl Pelfrey, phone communication, 1 February 2016.

Comments: NPS at Cumberland Gap prohibits unauthorized cave entry. One reason is to make sure that those exploring caves in the park are doing so with proper experience and caving equipment.

16 February 2016
Neffs Cave, Utah
other (dislocated shoulder), injury, aid

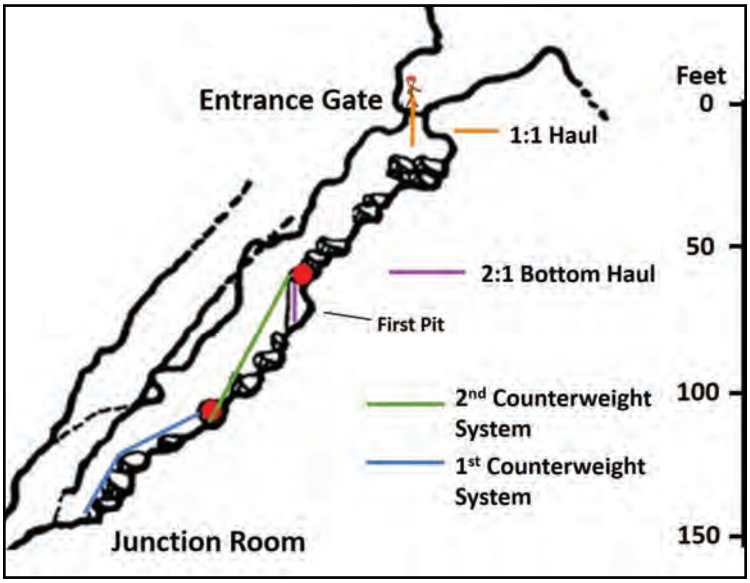
At approximately 1000, Rodney Mulder, Swede Larson, Adam Jones, and Peter Hartley entered Neffs Cave. At noon, a second group made up of Brian Dickey (40), Kristin Adams, Ben Ling, Bryce Ling, and Joseph Vasko, entered the cave. As noted previously in this publication, Neffs Cave is vertically rigorous, with nine drops requiring 690 feet of rope.

About an hour into the cave, having descended about 150 feet, Dickey dislocated his shoulder while downclimbing in the Junction Room. After three unsuccessful attempts to reduce the shoulder, Dickey was given 800 mg of ibuprofen and treated for hypothermia. Adams went deeper into the cave to get help from the other group, Ling and Ling went to the surface to notify the surface watch of the problem and get extra warming supplies, and Vasko stayed with the patient.

Mulder was the first person from the first cave group to arrive at Dickey. Mulder took charge and assigned Adams as the medic. She immobilized Dickey's arm and shoulder using webbing. In order to extricate the patient up multiple vertical pitches, Mulder used techniques he had learned from two National Cave Rescue Commission (NCRC) Small Party Assisted Rescue (SPAR) courses he had recently attended. He initially set up two counterweight systems to help Dickey up a 120-foot vertical section that was at a 45-degree angle. The group had a 100-foot rope, webbing, a Petzl Micro Traxion®, a mini pulley, and extra carabiners to do the rigging. Jones served as the counterweight, and other team members took turns assisting Dickey up the steep passages. Later, a traveling haul was used to get Dickey up a 12-foot pit, again using techniques from the SPAR course and the gear that team members had with them. More ibuprofen was administered to relieve Dickey's pain, and the cavers observed that Dickey was showing signs of shock. At the entrance, a 1:1 haul system was used. Mulder straddled the hole to serve as the anchor, and he ended up reinjuring a torn meniscus in his left knee in the process. Dickey exited the cave approximately four and a half hours after his fall, hiked an hour to the trailhead, and was driven to the hospital.

1. Swede Larson, Incident Report, 7 February 2016.
2. Brian Dickey, Incident Report, 9 February 2016.
3. Rodney Mulder, Incident Report, 10 February 2016.
4. Debbie Spoons, e-mail communication, 29 December 2016.

Comments: This was an ideal rescue for small party skills, with eight other cavers to help, a mostly vertical cave, and a patient who was ambulatory. The patient noted that the ibuprofen allowed him to go from a pain level of 8 out of 10, when he wasn't capable of doing anything, to a pain level of 5 or 6, which allowed him to move and help get himself out of the cave.



A diagram of the rescue systems used to extricate a caver with a dislocated shoulder from Neffs Cave. Courtesy of Rodney Mulder and Bonny Armstrong.

18 March 2016
Neversink, Alabama
stranded, aid, no injury

A group of rock climbers went to Neversink to rappel into the 162-foot-deep pit and then climb out. One man began to rappel using an ATC belay device. Twenty feet down, he realized that neither he, nor anyone in his group, would be able to climb out, so he continued rappelling to the bottom. His friends at the top called 911. A local caver was contacted and was able to reach the stranded climber and supply him with mechanical ascenders. After a little bit of instruction, the man was able to ascend out.

1. Aaron Polsky, Facebook post, 18 March 2016.

Comments: After repeated requests, the *ACA* editor was not able to obtain any more information on this incident. It would be interesting to know what mechanism was in place that allowed a local caver to be contacted and to respond to this incident.

26 March 2016
Ellisons Cave, Georgia
difficulty on rope, injury and aid

A 22-year-old man was rescued from Ellisons Cave after he was unable to climb out of Fantastic Pit (586 feet deep). The man apparently ascended about 100 feet up the rope but was unable to continue further. According to reports, this was due to some combination of him becoming ill or exhausted and dehydrated due to an inefficient climbing system. His partner climbed up to him and was able to perform a pickoff and lower him back to the ground. The man's friend then climbed out of Fantastic Pit and the Warm Up Pit (125 feet deep) and called for help.

Several rescue groups responded. At Fantastic Pit, they found the rope used by the two adventurers. It was rigged in an unconventional location, placing the rope in a waterfall, and it was severely abraded where it bent over the lip of the pit. (Some rescuers have speculated that even if the patient had been able to climb out, the rope probably would have severed completely from the additional use of the second person).

The patient was found, severely hypothermic, at the bottom of Fantastic Pit. His hypothermia had progressed to the point where he had begun removing his clothes, a behavior known as paradoxical undressing.

Rescuers dressed the patient, provided him with food and water, and encouraged him to get up, walk, and move until he warmed up. He was then placed in a harness and raised up both drops with rescuers encouraging him to keep moving his limbs and to stay awake. The rescue operation took about six hours.

1. Callie Starnes, "UPDATE: Man rescued in Ellison's Cave on Pigeon Mountain," www.wrcbtv.com, 26 March 2016.
2. Based on interviews with rescuers, conducted by Bonny Armstrong.
3. B. Wedin, L. Vanggaard, J. Hirvonen, "'Paradoxical undressing' in fatal hypothermia," Journal of Forensic Sciences, volume 24, number 3, pages 543–53, July 1979.

Comments: Paradoxical undressing has been reported in cases of both moderate and severe hypothermia. As the body loses heat, blood vessels contract in order to keep heat near the body's core and vital organs. Eventually, the muscles necessary for vasoconstriction tire and relax. Warm blood then flows back to the extremities, and patients may suddenly feel hot. With mental alertness already compromised, patients do not realize the folly of removing their clothes. One study suggests that up to 50% of hypothermia fatalities displayed some degree of paradoxical undressing. This patient is extremely fortunate that he was young and physically fit and that help arrived when it did.

According to reports, the two men were experienced rock climbers but had no caving experience.

17 April 2016
Woman Cave, Arizona
difficulty on rope, no injury, no aid

Ray Keeler led a small group of cavers on a weekend trip to place registers in several Tonto National Forest caves. On Saturday, they placed registers in four horizontal caves. On Sunday, the group went to a cave that can be entered either with a 15-foot rappel or with a free-climbable bypass. With the exception of Keeler, the group was new to vertical work, and they chose to rappel in and ascend back out for practice. Under Keeler's tutelage, the group did well and had no problems.

The next cave they visited, Woman Cave, has a 40-foot entrance rappel into a large room. Here, the group rigged an extra rope as a "safety rope." Brooke Kubby (20) was the fourth person to rappel. About 10 feet down the drop, she realized that her hair had been pulled into her rappel rack. She was able to stop her rappel and call for help. Keeler pulled the second rope up, tied a figure-8 knot on a bight, attached a carabiner to the bight, and lowered it to Kubby. He thought that if she could attach the carabiner to her harness's D-ring, he could pull up and take tension off of the main line. Kubby, however, was not able to attach the carabiner to her harness.

Keeler then rappelled down and attached his quick attachment safety (QAS) tether to Kubby's harness and the QAS to the mainline above her. This unweighted the rack slightly. Keeler was able to pull some of her hair out of the rack but had to resort to cutting the rest out, with Kubby's permission.

Once her hair was free, Kubby and Keeler finished the rappel. The group placed the register and ascended out without further incident.

1. Ray Keeler, Incident Report, 26 April 2016.

Comments: Photos of Kubby taken on the morning of the incident show her hair pulled back into a barrette. Upon entering Woman Cave, cavers must pass through a 3- by 2-foot gate which has some bars sticking out into the opening. Although it is not tight, care must be taken to work around the bars. It is possible that her hair became caught while she was looking down to negotiate the gate and that she did not realize it until rappelling a few feet further. Having a second rope allowed Keeler to offer assistance. When possible, cavers should consider using releasable contingency rigging that allows a stuck caver to be lowered especially when training beginners.

A still-smiling Brooke Kubby displays her hair that was cut in order to remove it from her rappel rack. Photo courtesy of Brooke Kubby.

25 April 2016
Rats Nest Cave, Alberta, Canada
stranded, aid, no injury

A man on a guided, commercial cave tour had to be rescued when he was unable to negotiate a tight section in Rats Nest Cave. Canmore Cave Tours led a group into the cave at 1300. Around 1600, the group came to one of the highlights of the cave tour, a passage known as the Laundry Chute. A narrow, downward sloping passage accessed by a tight, 90-degree bend, the Laundry Chute requires squeezing and wriggling through constrictions either on your back or stomach. One of the tour group members successfully negotiated the bend and proceeded down the Laundry Chute, but he could not exit through the end of the tight passage. The guide tried for an hour to help the man go back up the passage or move forward, but eventually he had to leave the cave to call for additional help. The owner of the tour company sent in more people to help but ultimately additional resources were called. Officials responded from Kananaskis Country Public Safety, Canmore Fire-Rescue, Alberta/B. C. Cave Rescue Service, and Alberta Health Services.

Rescuers used various power tools to remove rock and make the passage wider, but because of the small space, only one person was able to work at a time. After many hours of drilling and chiseling, the man was able to walk out of the cave under his own power. Paramedics checked him for injuries and then allowed him to drive home. He had been trapped for 14 hours.

1. Rachel Maclean, "Rat's Nest Cave rescue takes place overnight to free man stuck on tour," www.cbc.ca/news/canada , 26 April 2016.
2. Colette Derworiz, "Tourist rescued from deep inside Alberta cave after being wedged between rocks

for 13 hours," http://news.nationalpost.com/news/canada, 27 April 2016.
3. Christian Stenner, “Submissions for American Caving Accidents,” 1 January 2017.

Comments: A stuck or stranded caver can be in a life-threatening situation. In this case of a stuck caver, there were several advantages leading to successful rescue. For example, the passage in the cave was not far from the entrance, the patient still had enough room for movement to keep warm, and he was accessible by rescuers from both sides.

7 May 2016
Transect 80 Cave, British Columbia, Canada
rockfall, injury, no aid

Five cavers were surveying the newly discovered Transect 80 Cave. As Larry Henson (80) and another caver worked ahead of the group, choosing survey stations, the rest of the group heard "a tremendous crash." Henson was reaching out to test a handhold when the half-ton rock he grabbed came sliding down the muddy slope, knocking him into the opposite wall. The group found Henson standing, but visibly shaken. He left the cave under his own power, assuring the others he would be all right since they were not far from the entrance. The rest carried on with the survey, but eventually went to see how Henson was doing. He was bruised and sore, but didn’t think anything was broken.

1. Peter Curtis, "Transect 80 cave," The BC Caver, volume 30, number 2, pages 4–7, Spring 2016.

Comments: Cavers traveling through virgin or newly discovered cave must be extra cautious about handholds, footholds, loose rocks, and false floors. Over time, as dozens to hundreds of cavers travel a popular route, loose rocks get moved, weak holds break off, and things on the walls and floors that can collapse generally do. When one is exploring “new” cave, the caver is in many cases the only thing that has come along in thousands of years to upset the balance of things. In some cases, large rocks may be only precariously perched, just waiting for a caver to come along and disturb the equilibrium.

8 May 2016
unspecified cave, Kentucky
fatality, other (unknown)

A few hours after he was reported missing, Anthony Wayne "Doc" Erisman (57) was found dead in a cave. Friends of Erisman knew he enjoyed spend-

Cave rescuers work with a pneumatic chisel to free a trapped caver at the exit of the “Laundry Chute” in Rat’s Nest Cave. Photo by Matt Mueller.

Safety Break #4

HYPOTHERMIA

Be careful of getting cold—even when it's hot outside. Caves take on the average yearly temperature of the area in which they are located. Even caves located in warm tropical regions are usually cooler than your body's temperature, which means that hypothermia can happen in almost any cave. Hypothermia occurs when your body loses heat faster than it can produce heat. Fatigue, injury, and getting lost or stuck can increase the risk of hypothermia. In a cave, everything around you will rob you of body heat—including rock, water, and even the ambient air temperature.

Here are a few tips that can help ward off hypothermia:

- Find a place out of water and away from windy passages. Sit on your pack to insulate yourself from the ground.
- Add warm, dry, clothing. If you're wet, try to change out of the wet clothing and put on something dry.
- Wool and synthetic fabrics dry faster than cotton, and wool maintains its thermal properties even when wet.
- Put on a hat. You lose heat everywhere, but your head is usually more exposed, even when wearing a helmet. Wear a beanie under your helmet.
- Keep a large trash bag in the space in your helmet or in a first aid kit. It might not feel very warm, but putting a trash bag over yourself creates a vapor barrier to block wind and creates a smaller air space you have to warm. (Be sure to tear a small hole to keep your head exposed.) Even better, add a candle to create a heat tent, also known as a "Palmer Furnace."
- Eat some food. Calories are potential energy, which are needed to generate body heat.
- Hydrate. Drinking water isn't appealing when you're cold—but it is essential. Trying to stay warm takes energy, and if you don't drink water, then dehydration will soon be an additional problem.

ing time in a particular Wayne County cave and soon discovered some of the man's belongings near the cave entrance. As they looked further into the cave, they found bits of his clothing and eventually his helmet and lights. Further into the cave, they found Erisman's naked body. The body was removed from the cave and the coroner initially reported seeing no signs of trauma. The results of an autopsy have not been made public at this time.

1. Phil Pendleton, "Questions remain after experienced spelunker found dead in Wayne County cave," www.wkyt.com , 10 May 2016.

10 May 2016
Pettijohns Cave, Georgia
caver fall (3), injury, no aid

During in-cave exercises conducted in Pettijohns Cave as part of the NCRC's 2016 National Weeklong Seminar, two Level 3 students, both of which are experienced cavers (35 and 33), fell approximately 15 feet while on rappel. The two students were practicing passing a rebelay with the rescuer suspended just below the patient and operating descenders on the patient's harness. The fall occurred when a medium-sized rock that was being used as an anchor, was pulled out of place after the two-person load was applied. The failure of this anchor caused both students and the rock to fall down the near vertical slope. An instructor (38) stationed near the anchor saw the anchor rock fly by, and in an effort to slow or deflect the rock, he instinctively grabbed the rope as it was being pulled down the slope by the falling students. Initially after being pulled head first toward the drop, he let go at the last second, hitting his back against a rock ledge about halfway down the slope. All three sustained minor injuries consisting of cuts and bruises, but based on a medical assessment by a physician in the group, none of the injuries were life threatening or required immobilization. Two of the three people involved were able to exit the cave without assistance while the third person (who was essentially uninjured) remained with the other students to finish their training scenarios.

1. John Maddox, Incident Report, 2 June 2016.

Comments: The anchor had been inspected by several people and had previously supported a single person load about ten times prior to the accident. The anchor failed shortly after being placed under a two-person load. When the two cavers pushed out from the wall with their legs, they changed not only the force but the direction of loading on the anchor. The fall zone was cleared moments before the incident occurred. This is a good reminder that anchors of questionable integrity should always be backed up or back-tied. Anchors must be re-evaluated when the size or direction of load changes. Critical-point anchors must be bombproof, and people should stay out of the fall zone whenever possible.

13 May 2016
Tumbling Rock Cave, Alabama
caver fall, injury, no aid

Steve Davis (57) was observing the mock rescue during the 2016 NCRC National Weeklong Training Seminar held in Mentone, Alabama. Davis said, "I was in Tumbling Rock photographing one of the stretchers being used in their mock rescue. Trying to stay out of their way and move back in front of the group, I slipped and fell about four feet, landing on a sandy surface on top of the one football-sized rock anywhere around. Normally I would have just cussed at myself and got back up." But due to some pain he was experiencing, Davis allowed the group to unpackage the mock patient and package him into the Ferno. He was carried from the cave by a large group of instructors and students.

1. John Maddox, Incident Report, 2 June 2016.

Comments: In a large mock rescue, there can be a lot of commotion, causing one to become distracted and have an accident. Rescuers and others involved must always look out for their own safety first. While it's never good to get hurt in a cave, doing so in the middle of a large-scale mock rescue can lead to a rapid evacuation.

20 May 2016
Gourdneck Cave, Tennessee
caver fall, injury, no aid

A group of eight experienced women cavers entered Gourdneck Cave for a recreational trip. At the waterfall, Susan Williamson (60) volunteered to rig a rope for the rest of the group to access upper passages. While climbing and simultaneously looking for a rig point, Williamson slipped and fell about 25 feet. As she fell, she banged against the rock several times but managed to land on her feet at the bottom. A quick assessment found that her ear was badly cut, but she was otherwise unhurt. The group left the cave without further incident. Williamson was driven to the hospital where she received seven stitches to her left ear and was diagnosed with a vertebral avulsion fracture.

1. Susan Williamson, Incident Report, 27 May 2016.

Comments: In her report, Williamson notes that having the proper gear—helmet, sturdy boots, knee pads, elbow pads, and a shorty-style wetsuit—probably helped reduce the extent of injury she sustained.

26 May 2016
Hidden River Cave, Kentucky
flooding, aid, no injury

A group of geology students from Clemson University were taking part in guided tours of Hidden River Cave. In the early afternoon, a thunderstorm developed and dropped a large amount of rain in the area. The cave began flooding while the students and their guides were far underground. Two police officers entered the cave to alert the groups about the flooding and escort them out. The groups had already noticed the rising water, and they began making their way toward the surface. Although the students and guides were required to enter neck-deep water, they continued moving, and everyone made it out safely by 1645.

1. Lisa Autrey, "Hart County Tour Guide Recalls Cave Rescue," http://wkms.org, 27 May 2016.
2. WHAS11 Staff, "Cave operator eyeing new safety features after students trapped," www.whas11.com, 28 May 2016.

Comments: In interviews with Hidden River Cave tour guides, one guide said that Hidden River Cave had adopted new safety procedures after a tour group was trapped by floodwaters in March 2012. Those procedures include waiting in an area that is elevated above expected flood levels. Waiting for floodwaters to recede is often the best option in a flood situation. In this incident, the guides decided to continue out rather than wait.

5 June 2016
Red Baron Cave, Utah
caver fall, injury, no aid

Adam Haydock (38) and two others were enjoying their first visit to Red Baron Cave when Haydock found a side passage that looked interesting to photograph. The passage slopes steeply downward for about 30 feet, and he began making his way down. Near the top, a handhold broke and Haydock began sliding out of control. He managed to slow his descent just before reaching the bottom, but along the way he cut his hand, knee, and leg. The hand laceration was bleeding profusely.

Haydock took a few quick photos then began climbing back up the slope. The climb was difficult and his hand injury made it even more challenging. He cleaned his wounds with water and alcohol and bandaged them. The others helped him as needed as he exited the cave. After de-rigging, the three cavers made their way down the mountain to their vehicles. The hand laceration continued bleeding until he received ten stitches at the hospital.

1. Adam Haydock, Incident Report, 6 June 2016.
2. Adam Haydock, "Red Baron Cave, Utah," www.adamhaydock.blogspot.com, 6 June 2016.

Comments: In his report, Haydock notes that rigging a handline at the slope would have prevented this accident.

11 June 2016
Buckner Cave, Indiana
caver fall, injury and aid

At approximately 1530, a woman (31) slipped and fell a short distance, dislocating her right shoulder. The woman and her group were approximately 1,500 feet into the cave at the junction of the Waterfall Passage and the South BS Passage, and the accident occurred as she was climbing down into the Waterfall Passage. Two of her fellow cavers attempted to find their way out while a third stayed with her. The two people attempting to exit the cave became lost and eventually returned to the patient after several hours. The person who had stayed with her left with one of the others to make a second attempt to exit. They finally reached the cave entrance at 2100.

Van Buren Township Fire Department (VBTFD) was called to respond and they in turn called for local cave-rescue specialists. Rescuers were on scene by 2200, and the VBTFD asked local caver Anmar Mirza to run the operation. As a team began running communication lines into the cave, Mirza, two other cavers, and one of the reporting party made their way to the patient. They found her with the other caver sitting and holding the patient's arm straight out to her side.

Mirza determined it would not be possible to evacuate her with her arm in an extended position. For 20 minutes, he had the patient attempt to reduce the dislocation using the Stimson method. This was unsuccessful, but she could now put her arm down by her side. Mirza called for a litter and an evacuation team.

While waiting for the evacuation team, the patient was coaxed to slowly start moving toward the entrance with assistance. After about 45 minutes of travel, they met the evacuation team, and the patient was placed in the litter and carried out. She reached the surface at 0115 and was transported to a local hospital.

1. Anmar Mirza, Incident Report, 12 June 2016.

Comments: Encouraging the patient to begin moving toward the entrance reduced the distance rescuers had to carry her, the amount of time she spent strapped in a litter, and the chance of her becoming hypothermic. Area resources are highly trained and familiar with incidents in Buckner Cave and thus were able to facilitate this carry-out rescue with only 12 rescuers.

11 June 2016
Little Bitterroot Canyon Ice Cave, Montana
lost control on rappel, no injury, no aid

Cliff Thorsen led two other cavers on a trip to Little Bitterroot Canyon Ice Cave. One of the trip participants, a 21-year-old volunteer firefighter, had some experience rappelling with a figure-8 device on cliffs, but this would be his first time rappelling in a cave. Thorsen rigged the entrance drop and rappelled first. The novice caver rappelled next. As he was partially down-climbing the pit, he let go of the rope with his brake hand. Passing over a ledge, he began to free fall when his weight transferred back to his rappel device. Thorsen shouted for him to grab the rope, which he did after a few seconds. He regained control of his rappel before hitting the bottom of the 40-foot pit.

At the next drop, also about 40 feet deep, Thorsen again went first. This time, he ran the bottom of the rope through his Croll and stood just out of the fall zone, ready to provide a bottom belay if his buddy had trouble again. An almost identical situation occurred again as the man passed a ledge and momentarily lost control. As Thorsen was starting to provide a bottom belay, however, the novice caver again regained control and rappelled safely to the bottom.

1. Cliff Thorsen, personal communication, 15 October 2016.
2. Cliff Thorsen, Incident Report, 14 February 2017.

Comments: After the first incident, Thorsen instructed his friend in better use of the figure-8 device, including keeping his non-braking hand below the device and holding the rope against the attaching carabiner (during the first rappel, his non-braking hand was on the rope above the rappel device). Thorsen also rigged a secondary rope at the second drop as a precaution. It is generally preferable to practice single-rope technique (SRT) skills for the first time in a controlled environment outside of a cave. Also, figure-8 devices have largely fallen out of favor among cavers. A figure-8 on a cave trip may imply that the user is less experienced. Less experienced cavers require more supervision and coaching. Contingency rigging and bottom belays can add extra layers of safety when applicable.

2 July 2016
Raccoon Mountain Caverns, Tennessee
caver fall, injury and aid

A woman on a wild cave tour fell and dislocated her elbow. Chattanooga-Hamilton County Rescue Services responded and carried her out of the cave. No other information was provided.

1. WTVC staff, "Cave rescue at Raccoon Mountain this past weekend," http://newschannel9.com, 5 July 2016.

6 July 2016
Laurel Caverns, Pennsylvania
caver fall, injury and aid

Three cavers entered Laurel Caverns with a special permit for a photography trip. While in a section of the cave known as the Ball Room, one of the cavers (42) slipped and fell. She landed in a way that caused a rock to hit her on the head, just below her helmet, and she lost consciousness for about 20 seconds. Her companions completed a medical assessment and contacted cave staff for assistance. The woman reported feeling nauseated but was able to make it out of the cave with minimal assistance. She was driven to a hospital where she was diagnosed with a minor concussion.

1. Ryan Maurer, Incident Report, 6 July 2016.

Comments: The woman was relatively new to caving. The reporting party said it was a simple accident that could have happened to anyone, despite their experience level.

Safety Break #5

PERSONAL FIRST-AID KITS

What's in *your* cave pack? Lights? Food and water? Clothing? What about a personal first-aid kit? Experienced cavers tend to streamline their pack and lighten what they carry, and this sometimes means taking out items that aren't frequently used but that can be worth their weight in gold when they are needed. Many pre-packaged first aid kits have items that don't work well underground. Instead, consider building a custom first-aid kit that can fit in a Nalgene® bottle or small Pelican™ case. Sprains and breaks are among the mostly likely injuries underground, so cater to that type of injury.

Also, consider adding multipurpose items to your first-aid kit.

- Duct tape can be used to cover small wounds or hold a splint in place, and a long, twisted strip of tape can serve as a sling.
- Extra plastic sandwich bags are also versatile. Fill a plastic bag with clean water and poke a small hole to help irrigate a wound, or use it to cover bandages so they stay dry and mud-free.
- Bandanas have many uses.

Include some protective gloves, sample packs of Neosporin®, and a few dosages of over-the-counter drugs like ibuprofen or Imodium®, and you're on your way to having a well-supplied first-aid kit.

8 July 2016
Upana Cave, British Columbia, Canada
caver fall, injury, no aid

On 8 July, Alberta-British Columbia Cave Rescue volunteers were engaged in a mock rescue in Upana Cave as part of an 80-hour training seminar. During the exercise, a cave rescue volunteer slipped from standing height on a slope; she sustained a muscle injury in her back, but she continued to work as part of the exercise. Two to three hours later, she slipped again while on an evacuation team and aggravated her injury. A short time later, she began to experience intense pain.

A warming shelter was constructed at the command post, and the injured volunteer was carried there on a stretcher. She was initially attended by a medic and another volunteer, but eventually she was driven to a medical facility and examined by a physician. The volunteer rested throughout the next day of training and rejoined the group for the final seminar debriefing on the morning of 10 July. She reported that her condition was steadily improving and she continued medical treatment upon her return home.

1. Doug Munroe, Incident Report, 9 August 2016.

Comments: Fatigue and poor footing due to heavy rain were likely contributing factors.

9 July 2016
Portage Valley Ice Cave, Alaska
trapped, injury and aid

An Anchorage man (21) was injured when a slab of ice fell on him as he explored a popular ice cave near Girdwood, Alaska. Other hikers at the cave used rocks to chip away at the ice trapping him. Girdwood Fire Department responded and assisted the man in hiking out of the canyon. He was then transported to a local medical facility.

1. Alaska Native News, "Anchorage Man Rescued After becoming Trapped in Portage Valley Ice Cave," http://alaska-native-news.com, 10 July 2016.
2. Chris Klint, "Falling ice traps man inside Portage Valley ice cave," www.adn.com, 14 July 2016.

Comments: Entering a cave with ice overhead is always a risky undertaking. Doing so during warm temperatures may increase the risk.

12 July 2016
Serendipity Pit, Tennessee
equipment problem, no injury, no aid

Warren Wyatt and Kathie Ferrari visited Serendipity Pit to rappel the cave's 40-foot entrance pit and the 110-foot pit inside the cave. They rigged the entrance pit by tying an 11-mm rope around a tree using a bowline knot. They rappelled the entrance pit, rigged the next drop, and rappelled it. They then climbed out, derigging as they went. They made the short walk back to Wyatt's Jeep, loaded their gear, and began to drive away. When they pulled out onto the road, Wyatt was surprised to see his low fuel indicator light come on. He suspected his gas had been siphoned.

When he returned home and unloaded his gear, Wyatt noticed a problem with his rope. According to Wyatt, the rope "had been cleanly and purposely sliced, twice, about three inches apart, both slices to the core of the rope. The cuts were made about four feet from the end and would have been the part of the rope that was actually on the tree. I have zero doubt that the rope was vandalized while we were both in the pit." In his report, Wyatt mentions that he and others have previously seen evidence of illegal activities in the area and warns others to be careful when caving in the Dorton Knob area of Cumberland County.

1. Warren Wyatt, Incident Report, 6 December 2016.

Comments: This is the second incident in this issue with entrance ropes being cut while cavers were underground. Be careful out there!

13 July 2016
Conner Cave, Missouri
flooding, aid, no injury

Three people visited Conner Cave in Rock Bridge State Park following a rain storm. Two men entered the cave while a companion waited at the entrance. During their visit, water in the cave continued to rise, eventually trapping the men inside. At 2020, their companion called 911 and several agencies responded. One man was rescued at approximately 2230 and the other three hours later. No other information was provided.

1. M.P. White, "Spelunkers rescued from cave at Rock Bridge State Park," www.columbiamissourian.com, 14 July 2016.
2. Scott Christenson, e-mail communication, 19 December 2016.

Comments: Predicting when a cave will flood can be difficult. Caves may flood during a storm or hours to days after. All cavers can benefit from a basic understanding of cave and karst hydrology.

21 July 2016
unspecified cave, Minnesota
stranded, injury and aid

Two people became stranded in a cave for several hours when their only light source went out. The couple had visited the cave with another friend, who had remained outside of the cave entrance. The couple entered the cave with one cell phone flashlight. When the phone's battery died, the two sat in one place until help arrived. Their friend eventually became worried and called 911. Rescuers found the couple and escorted them out of the cave. The man was unhurt; the woman had a laceration to her hand.

1. Dave Aeikens, Matt Belanger, "Crews Rescue 2 People from St. Paul Cave," http://kstp.com, 21 July 2016.
2. KARE 11 Staff, "2 rescued from St. Paul cave," www.kare11.com, 21 July 2016.

Comments: Several people have been rescued from the small caves in this area over the years. The city of St. Paul is considering sealing the caves and ticketing trespassers.

29 July 2016
unspecified cave, Jamaica
3 fatalities, bad air

Four Jamaican men, ages between 36 and 48, went into a cave in St. Catherine to collect water for their crops. The men did not realize that the pump system they were using was emitting noxious fumes. Three of the men died while working in the cave; the fourth man made it out and needed hospitalization. The men's bodies were recovered the next day.

1. "Cops search for 3 men trapped in St Catherine cave," www.jamaicaobserver.com, 1 August 2016.
2. Tanesha Mundle, "Death in a cave: Search for water leaves three farmers dead," www.jamaicaobserver.com, 3 August 2016.

Comments: Combustion engines commonly produce carbon monoxide and should not be run inside or near the entrances to caves unless absolutely necessary—and then only with proper ventilation.

30 July 2016
Simmons-Mingo Cave System, West Virginia
stranded, no injury, no aid

A planned through trip from the Historic Entrance to the Zarathustra Entrance in the Simmons-Mingo Cave System took about 11 hours longer than expected for four cavers. Before entering, the group hiked to the Zarathustra Entrance. Everything at the entrance looked normal, and the cavers could feel the usual breeze issuing from the cave. They then entered the Historic Entrance shortly before noon.

Eight hours later, the group reached the inside of the Zarathustra Entrance and noticed more water than usual dripping into the cave. Exiting from this side is aided by a permanently rigged rope that can be used as a handline to climb up a slope into the bottom of the entrance opening. On this trip however, the cavers found that the small hole that the rope hangs through was blocked with a rock choke.

The cavers did not want to disturb the rock pile over their heads, and they could not continue up. Their only option was to turn around and go out the way they had come in. This backtracking added more than 10 hours to their trip for which they had not prepared. One member had water purification tablets that enabled the cavers to drink from the cave stream (which rose continuously during their trip), preventing dehydration. They emerged from the cave at 0700 the next morning.

1. Carl Pierce, "Simmons-Mingo Cave blocked inside Zarathustra entrance," e-mail communication, 1 August 2016.

Comments: In his e-mail to local cavers, Carl Pierce strongly suggests that cavers make sure the Zarathustra Entrance is open before attempting a through trip from the Historic Entrance. He concludes, "The Simmons Mingo through trip between the Historic and Zarathustra entrances is a lengthy, complicated, demanding trip for many cavers, and lack of physical, mental, and resource preparedness for essentially having to do it twice could very easily have a less fortunate result than our trip did."

7 August 2016
unspecified cave, New York
other (overdue), aid, no injury

As he was leaving home to go explore a cave with friends on a Saturday evening, a Bethlehem man told his wife she should call the police if he wasn't home by two o'clock in the morning. When

Safety Break #6

SURFACE WATCH or CALL-OUT PERSON

Surface watch or call-out person refers to a person outside of your caving party who knows where you are and when to expect you out of the cave. This person can be a significant other, family member, or fellow caver. Having a dependable surface watch can significantly reduce delays in a rescue response if it's needed. The surface watch should know whom to call to initiate a rescue in your area.

Things to consider telling your designated surface watch:

- Use the real or most common name of the cave! Do not use a nickname that no one else would recognize. You might call it "Cake Lady Pit," but does anyone else?
- The location of the cave.
- The names and contact information for other individuals on the trip.
- Experience level of the group.
- What the trip's objectives are such as surveying, bolt climbing, or pushing leads.
- A designated time to expect you out of the cave and a time to initiate a rescue.

Have a surface watch for every cave trip, no matter the trip length or difficulty. And don't forget to call them when you're out!

he wasn't home by the designated time, she called 911. Police arrived at the cave just as one person was coming out. That person informed the police that the others were on their way out also. Media reports did not say why the group was overdue.

1. Joe Gullo, "No one injured in Carlisle cave rescue," http://news10.com, 8 August 2016.

Comments: While we do not know what caused the group to be late, this is an example of a surface watch working exactly as planned.

10 August 2016
Blowing Cave, Arkansas
lost, aid, no injury

Three students from Arkansas State University had to sit and wait for rescue when they became lost in Blowing Cave. A senior student led two first-year students to Blowing Cave wearing only jeans, tennis shoes, T-shirts, and a single headlamp each. They entered the cave late that morning, and by early evening they realized they were lost. The leader of the group made the decision that they would simply sit and wait for rescue. They sat back to back to try and share body heat.

When the students were not out of the cave by midnight, the group leader's wife called 911. The call was routed through various Emergency Services, with no one quite certain what to do. Eventually, somebody from Independence County Emergency Services thought to call a friend, who is a caver. Cavers began joining county officials at the cave by 0200.

The first search team did not find the missing men before their turn-around time. The second search team advanced 15 minutes farther and found the students near Noisy Dome. They were cold, but their lights still worked and they were able to follow the cavers back to the surface after spending 30 hours in the cave. The senior student had somehow managed to lose one shoe and one sock.

1. Brandon Labat, "Missing Students found SAFE," http://abc7chicago.com, 11 August 2016.
2. "Arkansas College Students Survive 30 Hours Trapped In Cave," http://abc7chicago.com, 12 August 2016.
3. Dewayne Agin, e-mail communication, 12 August 2016.

Comments: Pre-planning for cave rescue among cavers and agencies can help to speed response times in the event of an emergency. The local volunteer fire department attended an NCRC training in early 2017, bringing cavers and responders together in a training environment to prepare together for the future.

17 August 2016
unspecified cave, Tennessee
fatality, other (unknown)

A man (23) was found dead, submerged in water in a cave that is popular with the local community. The man's family reported him missing four days earlier and had been looking for him. His father found him in the cave.

An autopsy was not made public, but this likely was not an accident resulting from regular caving activities.

1. Najahe Sherman, "Man found dead, submerged in water at Cheatham County cave," http://wkrn.com, 17 August 2016.
2. Tim Adkins, "Body found inside cave in Pleasant View," www.tennessean.com, 18 August 2016.

3 September 2016
Carpenter-Swago Cave System, West Virginia
lost, aid, no injury

During the 2016 Old-Timers Reunion (OTR) in Dailey, West Virginia, five cavers decided to do a through trip in the Carpenter-Swago Cave System. The trip leader knew the cave had been closed by the landowner, but decided to proceed anyway. He had led through trips in the system previously when the cave was open.

In his report, the trip leader describes the cave system, “Swago is a wet cave with four waterfalls. The first is an open-air pit with a small waterfall which is traditionally rigged off of a tree. The other three waterfalls are situated along a stream passage inside the cave. The bottom of the fourth waterfall is the junction between Carpenter and Swago. Carpenter has a series of three drops. The first is also located in an open-air pit; it is rigged utilizing fixed bolts. The next two drops are inside the cave. All three drops are close enough so that they can be rigged with a single 300-foot rope. Beyond the third drop, the cave is horizontal.”

The group planned to travel from the Swago Entrance to the Carpenter Entrance, so the Carpenter side had to be rigged first. The trip leader continues, “The plan was to rig the rope on the first and second drops, but not the third. On all the previous through trips I had done, we used a bypass crawl that brought us to the bottom of the second drop, without having to first climb up the third drop. Our plan was to make use of that bypass crawl on this trip, as well.” At the Swago Entrance, they rigged to a tree for the first drop and carried a second rope that would be

Members of the Cushman Volunteer Fire Department and Arkansas Nomads participate in a cave rescue training alongside local cavers. Photo by Michael Patton.

pulled down behind them on the next three pitches. The cavers, intending to travel quickly, carried packs with minimal food, water, and emergency supplies. Everyone rappelled the first drop without incident. They traveled a short distance to the second drop. Once everyone was down, they pulled the rope down, committing themselves to continuing through the cave to the Carpenter Entrance. When the rope came down, they realized that they had left two packs at the top of the pit. One of the packs belonged to the trip leader and contained webbing that was to be used for handlines and his ascenders, which he had chosen not to wear while rappelling. The cavers had no choice but to continue on.

When they reached the area of the bypass crawl that would lead them to the Carpenter entrance, the trip leader scouted ahead. The crawl looked smaller than he remembered so he sent one of the other cavers in to check. That caver, which had never been in this cave before, returned to say that the crawl did not look safe and probably wasn't the way (it was, in fact, the correct route). The group spent the next 12 hours looking for the way on. By now they were cold and almost out of food and water. They traveled back to the bottom of the last drop in Swago and waited for rescue.

The group discussed how long it might take for anyone from OTR to notice they were missing. They realized they had not established a surface watch and probably wouldn't be missed until the next morning. They were correct; help did not arrive until 1300 the next day. Chris Beauchamp and Peter Welles were the first to make contact with the group and supplied them with hot coffee, food, water, and extra clothing layers. Welles exited the cave to notify rescuers on the surface that everyone had been found. Beauchamp led the group toward the Carpenter side. Since the rescuers did not know about the bypass crawl, they had rigged the third drop. Other than having to pass ascenders down to the trip leader everyone climbed out without incident.

1. Jacob Kirk, "Carpenter-Swago Trip Report," 4 September 2016.

Comments: In his report, the trip leader thanked the rescuers and apologized to the caving community and the landowner, who did not press charges. He concludes, “We learned a lot of lessons on this trip, and have since had plenty of time to think about what went wrong—both in the cave and out of the cave. Here are a few of the key points. First and foremost, you never go into a cave (even if it’s easy and you know it well) without a solid call-out plan. People knew where we were, but no one had been given an official time for our return. If we had a better call-out plan, we would have been rescued in half the time. We learned that you just don’t go into closed caves, whether you think one quick trip would be OK or not. The harm done to the caving community simply isn’t worth it (whether you, ultimately, need to be rescued or not). Always bring extra food, warming layers, etc., and never leave your pack behind. Always carry a map of the cave, if one is available. If we had a good copy of the map, we would have known if we were in the right area and would have pushed that crawl.”

This is the second reported incident in just over a month where a team planned for a quick through trip and was not able to complete the through trip. Plan to have enough food, water, and warmth for Plan B if Plan A becomes impossible for any reason.

21 September 2016
Eagle Cave, New York
other (unknown), injury and aid

Eagle Cave is a fissure cave popular with hikers and novice cavers. Around noon on 21 September, authorities received a call that a caver (24) had been injured and needed help. Rangers from the New York Department of Environmental Conservation responded and removed the injured man using haul systems. He was then carried in a litter to a helicopter and flown to a hospital in Burlington, Vermont, to be treated for head injuries.

1. David Figura, "Injured cave explorer, lost hunter: Adirondack Ranger rescues," www.newyorkupstate.com, 28 September 2016.
2. Thom Engle, e-mail communication, 28 September 2016.
3. Chuck Porter, e-mail communication, 13 November 2016.

Comments: Cavers were not called to assist with the rescue operation, and no other information is available. We may assume the head injury was due to a fall, but this cannot be confirmed.

16 October 2016
Lillyguard Cave, Montana
exhaustion, aid, no injury

The first annual Cave Camp, hosted by the Northern Rocky Mountain Grotto, took place over three days in October 2016. The first two days were devoted to a series of workshops to train new cavers, and enhance the skills of experienced cavers, in vertical caving, surveying, cartography, cave photography, rescue techniques, and more. On the final day, everyone pitched in to clean up the camp before breaking into various groups to go caving. Chris Rost and Steven Rehbien led 12 other cavers to Lillyguard Cave, a horizontal cave appropriate for beginners.

During the half-mile hike to the cave, one female (44) was noticeably slower than the rest, and the trip leaders made note of this. At the cave, the trip leaders reminded her that the trip into the cave would be all downhill, which meant exiting the cave uphill would be more strenuous, and she would need to pace herself.

Halfway to the bottom of the cave, three other cavers decided to turn around. Rost led those cavers to the surface, while the female continued with Rehbien and the others to the back of the cave. The cavers on the surface waited for the others, who began to exit the cave within an hour. The female said she felt tired, and the leaders attributed this to her physical condition and the fact that this was only her second cave trip. Hiking back to their vehicles, she fell to the back of the group, so Lee Brooks walked with her while the others went ahead. When Brooks and the female failed to join the group, Rost went back to check on them. He didn't go far before he found the two; the female was exhausted and needed a break. Rost, a physician assistant, did a medical assessment. She reported being light headed, her hands felt tingly, she was cold, she hadn't eaten for eight hours,

Montana cavers in a remote location loading an ill caver into the back of a pickup. They drove out of the mountains and met the ambulance en route. Photo courtesy of Chris Rost.

was on several prescription medications, and had drunk very little water. Over the next few minutes, the patient became less responsive and eventually lost consciousness. Rost sent Brooks to drive to where he could get a cell phone signal and call 911.

The cavers who had been waiting at the vehicles came to assist. They dressed the patient in dry clothing, laid her on a Therm-a-rest® pad, and covered her in sleeping bags. They placed her in the back of a pickup truck, and Rost and James Everett (an advanced EMT) attended to her while they drove out of the mountains. The cavers eventually met the approaching ambulance and transferred the patient to EMS care. The ambulance drove her to a waiting helicopter and she was flown to Great Falls. She was released six hours later.

1. Chris Rost, "Medical Emergency Incident Report: Lillyguard Cave, Stanford MT 10/16/2016," 21 October 2016.
2. Chris Rost, e-mail communication, 21 October 2016.

Comments: The woman was incapable of assessing her own ability to go on this cave trip, despite knowing she was tired, dehydrated, hadn't eaten, and was on medication. Cavers should be especially vigilant for unprepared cavers at a weekend caving event, as these events often cater to beginning cavers with led trips and workshops. We should help set up beginning cavers for success by making sure they are eating, staying hydrated, and otherwise prepared for the particular trip.

28 October 2016
Waterfall Cave, Georgia
caver fall, injury and aid

A geologist visiting Waterfall Cave tried to get a better look at the 100-foot-wide sinkhole by climbing over the railing of a boardwalk that surrounds the pit. In doing so, he landed on a steep, leaf-covered slope. He lost his footing and, finding nothing to grab, slid 15 feet down the slope, slipped over the edge and fell 40 feet to the bottom.

The landowner's nephew witnessed the fall and called 911. The first rescuer attempting to make his way to the patient twisted his ankle and had to be rescued from the pit before operations could continue. When rescuers reached the man, they first had to 'dispatch' a water moccasin (*Agkistrodon piscivorus*) that was reportedly "as thick as a man's arm" and approaching the patient. They then immobilized and packaged the patient and raised him out of the pit. The geologist suffered numerous broken bones and, despite a shattered jaw, repeatedly told his rescuers, "Thank you, thank you, thank you."

1. Jordan Barela, "Grady County personnel rescue man after cave fall," www.moultrieobserver.com, 17 November 2016.
2. Tevis Kouts, e-mail communication, 11 December 2016.

Comments: A rescuer's number-one priority should be his own safety, because, as seen here, having to rescue a rescuer can slow down the overall operation and put even more people at risk.

29 October 2016
Twin Sinks, Utah
difficulty on rope, no injury, no aid

Four adults and one youth (14) spent an afternoon exploring Twin Sinks in Cache County, Utah. The entrance drop was rigged in a location that placed the rope between a rock ceiling and a cone of snow in one place. As the cavers ascended, they had to pull the rope to the side to get around the snow. The youth was ascending out of the cave on prusik knots and had difficulty when he reached the snow cone. The rope had cut its way into the snow and he was not able to pull it out. Cold water was also dripping on him and soaking his clothes. Brian Dickey, the youth's father, had already climbed out. He instructed his son to climb back down and get off rope. After an attempt to redirect the rope failed, Dickey joined his son at the bottom and found him to be "showing signs of cold stress and perhaps mild hypothermia, with strong shivering and emotional distress." He warmed his son using a large garbage bag and a candle to create a heat tent, or "Palmer Furnace." While others attended to the young man, Dickey climbed out, rerigged the rope on the other side of the entrance drop, and then returned to his son. When the youth was warm enough, he climbed out using his father's mechanical ascenders. An older brother rappelled back into the cave to return his dad's vertical gear and the trip was completed without further incident.

1. Brian Dickey, Incident Report, 30 October 2016.

Comments: In his own analysis, Dickey states that he and one of the other adult cavers "had recently attended NCRC Level 1 training. This training helped [Dickey] recognize and quickly treat [his son] to prevent his condition from escalating further. It

Safety Break #7

AUTHORITY HAVING JURISDICTION (AHJ)

The AHJ is the public safety official that has responsibility for a specific area. Conveniently, in most cases, they all have the same phone number, and that number is 911.

The actual entity may vary from state to state and locale to locale. These agencies may or may not actually take part in a cave rescue, but they will retain the responsibility.

Some examples of AHJ include:
- State police
- County sheriff
- NPS park ranger
- BLM manager
- State game warden
- State park ranger
- Within city limits, possibly local services

The AHJ may then contact local cave rescue groups or individuals. A good relationship between the AHJ and cavers can be established by training and practicing cave rescue techniques together.

also helped in keeping calm as the group formulated a plan and put it into action."

24 November 2016
Bloomington Cave, Utah
exhaustion, aid, no injury

A family's Thanksgiving outing to Bloomington Cave proved to be too much for a man in his 50s. After making his way deep into the cave, the man became exhausted and asked his nephew to bring back help. While other family members stayed with the man, the nephew found his way out and called 911. When rescuers reached the man, they found he was unhurt but very tired and nauseous. They encouraged him along, letting him take as many breaks as he needed. As they neared the entrance, they used a haul system to help him up a steep incline, but he otherwise made it out under his own power. The rescue operation took 10 hours to complete.

1. Cody Blowers, "Man exploring Bloomington Cave falls ill, nephew runs for help," www.stgeorgeutah.com, 25 November 2016.

Comments: Caving can be very strenuous, overworking muscles that do not often see use in everyday life. This combined with poor physical conditioning, dehydration, and poor nutrition make exhaustion an ever-present possibility, even among experienced cavers. With newer cavers, we should be even more vigilant for signs of exhaustion. Several incidents in this issue serve to illustrate that point.

2 December 2016
Bisaro Anima , British Columbia, Canada
rockfall, injury, no aid

A group of experienced cavers traveled by helicopter to the remote Bisaro karst to conduct a survey trip in Bisaro Anima. An underground camp was established at -1,150 feet for a multi-day stay. On 2 December, two cavers were exploring and rigging pitches ahead of the others. Claire Gougeon (37) was shuttling gear to assist her partner, who was rigging a pitch and needing supplies. Along the way, she came to an exposed climb that was the route she previously used. Not wanting to do this climb again, she elected to climb up and over large, but apparently stable, boulders. When she pushed off of one round boulder, it shifted and pinched her left middle fingertip between the boulder and the rock wall before falling the rest of the way down the slope. She experienced pain but continued caving to meet up with her partner.

When she removed her glove, she found the fingertip cut open three-fourths of the way around starting from the base of the finger nail and bleeding profusely. It was cleaned in some fast-moving water nearby, but she and her partner otherwise had no first-aid supplies with them. They met up with another team and the finger was bandaged with gauze and she kept it elevated. Gougeon, who is a nurse, and another caver with emergency-medicine experience judged it to be a bad cut. They determined that even to exit the cave and call in the helicopter would not get her to the hospital in time to allow for stitches.

The next day Gougeon decided to take an easy day and exit the following day with the rest of the group as originally scheduled. The group exited the cave, flew out by helicopter, and Gougeon was driven to a hospital for x-rays. The x-rays showed that the middle finger tip bone was broken and in fact had been crushed. She was given a tetanus shot and antibiotics and the injury was bandaged and left to heal. On-going issues required a return visit and a second opinion. On December 10, just over a week after the initial injury, she went for emergency surgery and received two pins and eight stitches to treat the injury.

1. Katie Graham, personal communication, 16 December 2016.
2. Claire Gougeon, phone communication, 23 December 2016.

Comments: It was likely a good call to stay in place rather than try to evacuate after a full day of activity. A first-aid kit that contains butterfly strips or steri-strips can assist with deep cut injuries when evacuation to medical aid is delayed. Short lengths of VetRap™, ACE™ Bandages, or Gorilla® Tape are easy to carry and can be invaluable when needing to close, compress, and protect a wound in wilderness (cave) environments.

18 December 2016
Binkley Cave System, Indiana
flooding, aid, no injury

Seven cavers entered the Binkley Cave System on a rainy December afternoon. The forecast at the time predicted less than an inch of rain for the day. Their survey destination was a several-hour trip into the cave, to a section few cavers are familiar with. They had left word with a surface watch that their out time would be 0300.

When the cavers reached a section known as the D&B Crawl, they encountered standing water in the crawlway with low air space. One of the cavers did not want to go through the crawl, so the cavers had a discussion about splitting into two groups. As they were deciding who would go with which group, one of the cavers mentioned that the water seemed different. Within minutes the water level was noticeably higher, and the cavers quickly retreated back the way they had come.

At 2030, long before their out time, the landowner contacted Anmar Mirza, a local caver and the National Coordinator for NCRC. He was concerned about the amount of rain (by then more than two inches had fallen and it was still raining) and the level of the river in the cave. Mirza was familiar with every member of the caving team and knew them to all be strong and experienced cavers. He also knew that the cavers had entered the cave not knowing the storm had increased in strength. Mirza arranged for a gauge to be placed in the cave stream to monitor water levels. As a precaution, he began to notify local cavers and asked them to be on standby. Mirza explains, "I limited the number of people I put on standby to allow people to get a good night's sleep and to limit the number of people who felt compelled to go to the scene in spite of the fact that there was nothing that could be done. Temperatures that night were going to fall to below freezing, and we did not need the additional logistical load." At 0400, the rain stopped, but the cavers had not appeared. A gauge at Indiana Caverns, the commercial portion of the Binkley Cave System, showed that the area had received more than four inches of rain. By 0630 the next morning, the level of the cave's river was 4 to 5 feet above the usual low-water levels.

Underground, the cavers had realized that water levels were rising. They began making their way toward the entrance but were stopped by the river near Fantastic Avenue. The river that had been a mere trickle on the way in was now more than five feet deep with a current too strong to enter safely. The cavers found a safe place to camp and wait out the flood. At 0600, they thought the water was low enough to start making their way out, but despite their best efforts, they were forced to return to their camp.

When the cavers still had not exited by 0930, Mirza decided it was time to start a rescue. He first contacted the Indiana Department of Natural Resources (IDNR), as they were the authority having jurisdiction. The IDNR Conservation Officers have also been proactive in getting cave-rescue training and have a good working relationship with Indiana

Anmar Mirza stands outside the entrance of the Binkley Cave System, waiting for the return of seven overdue cavers. Photo by Jerry Lewis.

cavers. The IDNR then contacted other local authorities. The biggest logistical problems now facing the rescue operation were the freezing temperatures outside and the lack of cavers familiar with the route to the missing cavers' destination.

The first initial response teams (IRT) entered the cave at 1310 carrying extra food and hypothermia supplies. From Mirza's report, "IRT 1 was three people, one of which was familiar with the in-cave crew's objective. Their objective was to head to the point furthest in the cave that would hamper the in-cave crew's exiting due to high water, the D&B Crawl, and report back on the conditions by 2300. IRT 2 was two people, both strong cavers but less familiar with the cave, and their objective was to accompany IRT 1 to the Mountain Room, which we considered a high probability for a location for the in-cave crew to be holed up, then split off and report back by 1700 which would give us guidance planning for the next operational period."

At 1730, IRT 1 made contact with the cavers; they had been waiting out the flood in Fantastic Avenue. The team leader of IRT 1 and two of the missing cavers exited the cave at 2250, reporting that everyone was alive and well. The other members of IRT 1 were following with the remaining cavers at a slower pace. An evacuation team was sent in to assist and three more cavers exited at 0240. The remaining two cavers exited 15 minutes later.

1. Elizabeth Depompei, "RESCUE AT BINKLEY'S CAVE: Community, multiple agencies work together to free Corydon cavers," www.newsandtribune.com, 19 December 2016.
2. Roger Moon, "To the rescue: Former Bedford man plays key role in saving seven trapped cavers," The Herald Times, 22 December 2016.
3. Anmar Mirza, "Binkleys Cave rescue report," 22 December 2016.
4. Laura Demarest, "Binkley Cave Trip Report December 17–19th, 2016 – The 39-Hour Fugue State," 24 December 2016.

Comments: The cavers were aware of rain in the area, but decided to continue with the trip based on an overall prediction of less than one inch in the forecast. With the hindsight of knowing the final total was actually quadruple that, it is easy to question the cavers' decision to continue. In fact, one planned member of the team decided to sit out the trip based on the uncertainty of the weather. However, the cavers were making an informed decision based on the best information they had at the time. Long cave systems can be especially unforgiving in the face of uncertain weather. Besides typically having large catchment areas for floodwaters, long caves can take many hours to traverse. This trip was originally planned to be nearly 20 hours long. Weather decisions have to be made based on conditions and forecasts up to the moment of entering, but conditions can change rapidly after the cavers are underground.

The rescue response worked smoothly and efficiently. This is a result of years of training and preparation in the area that have resulted in cavers, rescuers, and landowners working together to achieve positive rescue outcomes.

2016 CAVE-DIVING ACCIDENTS AND INCIDENTS

26 March 2016
Blue Hole, New Mexico
fatality, stuck

Robert (Shane) Thompson (43) died while exploring the cave at the base of the Blue Hole in Santa Rosa as a member of the ADM Exploration Foundation team led by Curt Bowen. The team was working that week to explore and open the cave on behalf of the city.

The cave had been closed for 40 years after the death of divers there. In closing the cave, the city had dumped tons of rocks into the opening, which made navigation difficult and required that the team open new passages in addition to exploring them. It had taken two previous visits over several years to open the top portion, and the team was now working to expand their progress.

The previous work had opened a narrow passageway from the opening at a depth of 85 feet to a tight restriction at a depth of 160 feet. As work progressed, the team divided into three groups: those expanding and clearing the upper portion, those working to enlarge the restriction at 160 feet, and those exploring the passages past the 160-foot restriction.

The team that was able to get past the 160-foot restriction and continue the exploration was composed of Mike Young and Shane Thompson. Young was using a sidemount rebreather system, and Thompson was using a backmounted system. Young led, and Thompson provided support. They were working in tight passages with loose rock and fine gray silt that stirred easily, creating zero visibility. They encountered several passages that were dead ends, but they were able to find the main passage. As usual, they laid line to follow for their exits. During the exploration, they encountered two more severe restrictions, and Young was better able to squeeze through them with his sidemount system. The second was at a depth of about 194 feet, and they progressed a few feet past that.

Because of the danger of working simultaneously in different sections of a nearly vertical shaft filled with loose rocks, the team decided to have only one group work at a time. On 26 March, the team plan was for Young and Thompson to enter first and then exit so that the 160-foot team could work, after which the team doing the upper section would enter. Because of the difficulty Thompson had with the second restriction the previous day, the plan was for him to stay on the exit side of the restriction while Young continued the exploration beyond that alone. While exploring about 45 feet past that restriction, Young came to the conclusion that the cave had "walled out," meaning that it would not be possible to go any farther and there was no longer any possibility of continuing the exploration. When he started his return, he was surprised to find that Thompson had gone past the second restriction, and the two met head on in the confining passage.

After considerable effort, Thompson was able to turn around. Young went through the second restriction first and then helped Thompson get through by pulling on him. This resulted in the two of them being tightly wedged in opposite directions, necessitating a second challenging effort to get turned in the right direction. This effort caused some of the tie offs of their guideline to come loose, resulting in a loose guideline. This meant that, although the line would still ultimately be able to lead them out, it would not always be in the desired location. This caused what are called "line traps," when the line goes in places too small for the diver to navigate. This happened in several places during their exit. They also lost the line several times and had to relocate it.

Eventually Young believed they were at a safe point. He had the line and could feel vibration from Shane being on the line. He assumed Thompson was ahead of him. He crossed a secure tie off to get into an intact section of line, after which he no longer felt the vibration and knew that Thompson was instead behind him. He turned to head back, and as he was doing so, the vibrations stopped. When he found Thompson, he was stuck in a restriction, and he was already deceased.

Young tried to get him out, but after a while he realized he could not, especially given the length of time he had already been at that depth. The body recovery was completed the next day. Because of the restriction, it was necessary to remove the rebreather, which was left in the cave. The cave has since been sealed.

1. Debbi Baker, "San Diego scuba diver dies in New Mexico underwater cave accident: Shane Thompson became trapped in a cramped cavern and could not escape," www.sandiegouniontribune.com, 31 March 2016.

2. Laura Bult, "Expert diver died after getting trapped overnight navigating the dangerous Blue Hole caverns in New Mexico: 'Everything went terribly wrong'," www.nydailynews.com, 2 April 2016.

3. John Adsit, Incident Report, 19 October 2016.

3 April 2016
Ginnie Springs, Florida
fatality, medical

Mike Schultz (61) of Ohio died of a heart attack while diving in the Devil's System at Ginnie Springs near High Springs, Florida, on 3 April. Schultz was a highly experienced and trained diver using an Optima Rebreather, for which he was certified.

Shultz and a dive buddy entered the system using Dive Propulsion Vehicles (scooters), which they took into the cave for a distance of about 2,150 feet. They then left their scooters, and swam to an area called Sweet Surprise at a distance of about 3,100 feet. (When using a scooter, it is common to use it to reach an area of the cave and then leave it to complete the dive plan while swimming.) After their visit to the planned area, they turned the dive, with Shultz following his buddy back to their scooters so they could exit.

During the exit, Shultz began to shows signs of distress by having difficulty performing routine skills. Shultz indicated he was having trouble managing his scooter and wanted to swim instead, but he had trouble swimming as well. His buddy began to tow him out, but eventually there was a complete loss of buoyancy leading to a silt out. At that time a cave-diving instructor, Ted McCoy, encountered them while teaching a class, and he attempted to assist. Shortly after that it became evident that Shultz was deceased, and a recovery team was formed to recover the body.

An autopsy identified the cause of death as drowning, and the event that precipitated the drowning was a heart attack with a blocked coronary artery.

1. "Diver death at Ginnie 3-APR-2016", www.cavediver.net, 3 April 2016.
2. Brent Booth, personal communication, 25 October 2016.

10 September 2016
Orange Grove Sink, Florida
fatality, cause unknown

A man died while diving in the Orange Grove Sink at Peacock Springs State Park. A formal report was not available, but the accident was likely caused by the diver attempting a trip beyond his training level. He followed another team's dive line, which was removed while he was still in the cave.

1. "Accident at Orange Grove 9-10-16," www.cavediver.net, 10 September 2016.

Comments: Members of the Cave Diver's Forum have expressed a great deal of frustration over the lack of reporting in cave-diving accidents. It is impossible to learn any lessons if no one writes a report.

16 October 2016
Eagles Nest, Florida
2 fatalities, cause unknown

"The rescue divers were private volunteers because the expertise necessary to retrieve the men exceeded the authorities' abilities."

Three men visited Eagles Nest as part of a three-day dive trip. The underwater cave is notorious for its difficulty and at least eight people have died while diving its depths. A sign at the entrance to the cave proclaims, "STOP. PREVENT YOUR DEATH. THERE'S NOTHING IN THIS CAVE WORTH DYING FOR!" Patrick Peacock (53) and Chris Rittenmeyer (38) were experienced cave divers and felt confident about their ability to explore the cave. Their friend, Justin Blakely, decided to stay closer to the surface. They planned to meet up again in the afternoon at 1500.

Peacock and Rittenmeyer did not show up at the scheduled rendezvous time, so Blakely waited another 30 minutes, and then another 30 minutes. At 1800 there was still no sign of the missing divers, and Blakely called 911. A search team did not initially find the two men. The search was resumed the next day, and the bodies of Peacock and Rittenmeyer were found and removed from the cave.

1. Katie Mettler, "Stop. Prevent Your Death' Said Sign at Florida Underwater Cave. These Experienced Divers Ignored It," www.ndtv.com, 18 October 2016.
2. Mike Clary, "Fort Lauderdale friends die cave-diving in underwater spring where others have perished," www.sun-sentinel.com, 18 October 2016.

Comments: Again, no report was published so there is very little that we can learn from this unfortunate accident.

27 November 2016
Sistema Sac Actun, Quintana Roo, Mexico
fatality, lost

Amy Maria Arriaga and her former cave diving instructor, Alessandro Morano, planned a day of diving together in Sistema Sac Actun. They discussed at

This sign, placed at the entrance of Eagles Nest, is intended to deter divers from entering this notoriously difficult underwater cave. Despite the morbid message, many divers ignore the warning, and both experienced and inexperienced divers have died within its depths. Photo by Andreas Hagberg.

length their dive plan of traveling through the cave to the Cuzan Nah loop. Their starting and ending point would be Grand Cenote. Their other objective was for Morano to take video footage of Arriaga and the cave. During most of the dive, the two stayed close together with Arriaga leading, making note of permanently placed markers and leaving their own when their route deviated from the mainline. As they approached No Name Cenote, Morano took pictures of the light shining into the water. When he was done, Arriaga was nowhere in sight.

He searched briefly, checking nearby cenotes where she might have exited, but decided that she must have gone on ahead of him. As he made his way back to Grand Cenote, Morano picked up the markers and dive lines they had placed. At Grand Cenote, he did not find Arriaga.

Morano went back into the cave and came across another dive team. They communicated that they had seen a solo diver fitting Arriaga's description near Cenote Ho-Tul (that team later noted that Arriaga at the time did not show any signs of being in distress). Morano did not find her there. By now, he was running low on air, so he left the cave to get fresh tanks. There, he ran into the team he met underwater and informed them of what had happened. He then entered the cave again for another search, replacing his markers as he went. Back in the Cuzan Nah loop, he found Arriaga's body. Both of her tanks were empty. He pulled her to the surface of a nearby cenote where other divers tried to resuscitate her. Morano swam her body back to Grand Cenote and turned it over to waiting authorities.

1. Alessandro Morano, Incident Report, undated.
2. Ron Engle, Letter to IANTD, undated.

Comments: Morano lost track of Arriaga in the Cuzan Nah loop. It is not known if she swam ahead and accidentally started around the loop again, got behind Morano and swam back the way they had come, or had made her way ahead and gone beyond the loop only to be confused by the second team's dive line and so turned back. Whatever happened, as soon as Morano removed their jump lines and markers (because he assumed she was ahead of him), it would have been almost impossible for her to find her way out. Losing track of a dive buddy, and then removing necessary markers before they are located, is a breach of cave-diving protocol, and here it had deadly consequences.

2016 CAVING-RELATED ACCIDENTS AND INCIDENTS

10 March 2016
Meramec Caverns, Missouri
bad air, no injury, no aid

Meramec Caverns, a popular show cave near U.S. Route 66, was closed for three months when the U.S. Environmental Protection Agency (EPA) found levels of trichloroethylene (TCE) vapors in the cave to be above acceptable limits. TCE has been a problem in the cave since 2003, and the vapors are likely from a nearby automotive parts plant or a landfill, both of which are associated with a Superfund site. Increased ventilation in the cave helped to reduce the vapors to levels acceptable for employees. The EPA states, "TCE is carcinogenic to humans by all routes of exposure."

1. Ron Warnick, "Meramec Caverns may be closed until mid-summer," www.route66news.com, 3 April 2016.
2. Ron Warnick, "Meramec Caverns reopens today," www.route66news.com, 10 June 2016.

Comments: Three months after closing, Meramec Caverns reopened to the public on June 10. The Superfund site in question is about four miles away. This incident highlights the ability of karst to transport unfiltered pollutants over long distances.

8 July 2016
unspecified sea cave, California
stranded, injury and aid

A man fell from cliffs into the ocean near the Sutro Baths in San Francisco. He swam into a sea cave but was not able to get out. The San Francisco Fire Department was able to raise the man back to the top of the cliffs.

1. Jack Morse, "Man Rescued From Sutro Cave After Falling From Cliffs," http://sfist.com, 8 July 2016.

26 July 2016
unspecified cave, North Carolina
rock fall, injury and aid

During a rock-climbing trip with an outdoor adventure group, two youths (13 and 16) took shelter in a cave when the weather turned bad. One of the youths accidentally pulled a rock down on himself, trapping both boys. Eleven different agencies responded and rescued the boys in about three hours.

1. Jerrika Insco, "Two teens rescued after being trapped by fallen rock in cave," http://wlos.com, 26 July 2016.

29 July 2016
unspecified cave, Idaho
dog rescued from cave

Brothers Dan and Bret Friend know of a cave in Idaho that has been a "family secret" for more than 40 years. In July 2016, during a family reunion, Dan and Bret took some family members to show them the cave. They arrived at the cave's pit entrance and were surprised to hear a dog, whining in the pit, 25 feet below them.

The two brothers rappelled into the pit and found a very skinny hound dog. They placed the dog in a pack, and she was hauled up by people on the surface. The hound, whose name is Tinker, was learning to hunt bear in Idaho's Payette National Forest when her trainer lost the signal from her tracking collar. Having no idea the dog had fallen in a pit, the trainer eventually gave up looking for her. Tinker survived in the cave for two weeks before she was found. She was eventually returned to her owner in Montana.

1. Kristin Rodine, "Dog has its day: Hound rescued from bottom of a remote Idaho cave," www.idahostatesman.com, 1 August 2016.
2. Karen Lehr, "Treasure Valley family rescues dog trapped in secluded cave for extensive period of time," www.kivitv.com, 1 August 2016.

Comments: This was only the second time in 30 years that Dan and Bret had visited the cave; how very fortunate for Tinker.

The Steve Hudson Award for Service to Cave Rescue

Steve Hudson (NSS 11444 RL, FE, OS) was a founder of the National Cave Rescue Commission (NCRC) in the late 1970s and supported it through the next four decades. He served as one of its first instructors, as the Southeastern Region coordinator, as the national coordinator, and as the training coordinator. Steve owned and ran Pigeon Mountain Industries (PMI) and was an internationally acknowledged expert on rope and rope rescue. He used his experience to raise standards and practice in industrial rope access as well. He was a founder of the Society of Professional Rope Access Technicians (SPRAT) and an author of *High Angle Rescue Techniques.* Steve served as Deputy Director of Emergency Services for Walker County, Georgia, and was a recipient of its Distinguished Service Award. He was also the recipient of the International Technical Rescue's Lifetime Achievement Award. Steve donated countless hours to teaching rescue techniques to make cavers safer. Steve was taken from us prematurely in 2013 in Puerto Rico, a place he grew to love after traveling to teach cave rescue there. In recognition of his lifetime of service, the National Speleological Society created the Steve Hudson Award for Service to Cave Rescue.

In 2016, the NSS bestowed the inaugural Steve Hudson award on Diane Cousineau (NSS 9284 RL, FE, SH). Diane completed her first NCRC training in 1986 and is now the lead instructor for the NCRC instructor qualification course. She is the captain of Walker County Emergency Services Station 21, which is responsible for cave, cliff, and ground search for the county. Her team also provides mutual aid for cave rescues in other Georgia counties, as well as in Alabama and Tennessee, and has accomplished many successful rescues in technically difficult caves, including Ellisons Cave. Diane was the 2015 recipient of her department's Distinguished Service Award.

To learn more about Steve and Diane, see the February 2003 issue of the *NSS News*, where they were featured in the Spelean Spotlight.

Diane Cousineau and Steve Hudson in 2003. Photo courtesy of Diane Cousineau.

Contributors

Andy Armstrong, NSS 45993 RL, FE Heber City, UT
Andy has been caving for 24 years and has specialized in survey expeditions involving backpacking and underground camping, primarily in Lechuguilla Cave, Jewel Cave, and Grand Canyon National Park. He is the Rocky Mountain Regional Coordinator for the NCRC and has served as an NCRC instructor since 2011. Andy works as a Cave Resource Specialist for the National Park Service. Since 2008, he has been stationed at Timpanogos Cave National Monument, where he also serves as park EMS and SAR coordinator.

Bonny Armstrong, NSS 43003 RL, FE Heber City, UT
Bonny graduated from Western Michigan University with a Master's Degree in Geology. She has been the editor of *American Caving Accidents* since 2011, and she served on the *ACA* review committee for several years before that. An instructor for both the NCRC and the NSS Vertical Section, Bonny is committed to helping others learn safe rope skills and basic cave rescue techniques, especially rope-rescue skills using minimal gear. She has been employed by the U.S. National Park Service since 2005, and currently works in the Resource Management Division at Timpanogos Cave National Monument.

Gretchen Baker, NSS 50323 RL, FE Baker, NV
Gretchen has been caving for about 20 years and is an NCRC instructor. She helps to manage caves at Great Basin National Park in Nevada. She's also a volunteer firefighter and EMT for White Pine County. She has written non-fiction books about the Great Basin and writes caving mysteries under the pen name C.A. Cox.

Roger Brucker, NSS 1999 RL, HM, CM, CM, PH, AL, FE Beavercreek, OH
Roger has been a caver since 1952, and as indicated by all those initials next to his name, has won many honors from the NSS, including Honorary Member. He is the author or coauthor of five books and numerous articles, and he has presented hundreds of talks. He is coauthor with Robert K. Murray of *Trapped! The Story of Floyd Collins*. Roger is a past president of the Cave Research Foundation and has taught Speleology for Western Kentucky University for 25 years. He is retired and lives with his caver wife of 32 years, Lynn. He and the late Joan Brucker have four adult children, including Tom Brucker.

Peter Buzzacott, PhD, NSS 64284 RL Durham, NC
Peter is a life member of the NSS and the Cave Diving Section (CDS) and a former member of a number of international caving and cave diving associations, including in France and Australia, where he formerly lived, caved, and dived before moving to the U.S. Peter has a Master of Public Health degree and a PhD in diving injuries, has 50 scientific papers published on the topic of diving injuries, and around 200 diving magazine feature articles on cave diving and diving safety. A former diving instructor with more than 500 certifications issued, Peter is an advanced cave diver and advanced trimix diver, certified in cave DPV (scooters), rebreather diving, and an International Underwater Cave Rescue and Recovery (IUCRR) diver.

Thomas Evans, NSS 57831 Mountain View, CA
Tom runs SAR^3, a nonprofit organization that performs rigging research, reviews rigging literature, and provides teaching and learning aids for rope users. An avid ultralight backpacker, packrafter, caver, and canyoneer, Tom enjoys being outdoors and helping others be safer when they venture out as well. He volunteers as an NCRC instructor and with local search and rescue whenever possible.

Curt Harler, NSS 22735 CL Strongsville, OH
Curt is the Executive Vice President of the NSS and a long-time member of the Cleveland Grotto where he has held most of the key offices. Before that, he was a founding member of Tampa Bay Area Grotto and was active in the York Grotto and Nittany Grotto. He is coeditor of the NSS's widely respected book *Caving Basics*. When not caving, he works as a freelance writer specializing in security, agriculture, and environmental issues. Curt is an avid mountaineer, caver, cross-country skier, and tennis player.

Scott McCrea, NSS 40839 RL Asheville, NC
Scott is owner of Swaygo Gear—manufacturer of innovative and ingenious caving gear. He is the Chairman of the Safety and Techniques Committee of the NSS, an NCRC instructor, the NCRC sub-regional coordinator of North Carolina, and level 1 SPRAT certified. He caves mostly in North Carolina, Tennessee, and Virginia.

Roger Mortimer, MD, NSS 26529 RL, FE Fresno, CA
Roger is a Clinical Professor with the University of California at San Francisco. He is an NCRC instructor and the Western Region coordinator of the NCRC. He has taken his interest in caving and search and rescue and turned it into research in wilderness medicine. He caves with the San Joaquin Valley Grotto and the Cave Research Foundation. Roger has presented nationally on suspension trauma.

Don Paquette, NSS 8545 RL, FE, CM Martinsville, IN
Don started caving in 1961 and participated in his first rescue in 1963. He is one of the founders of the NCRC, having served as the first Central Region Coordinator from 1978 through 1984 and from 1991 through 1994. He was National Coordinator from 1984 through 1991. He served as NSS Executive Vice President from 2001 through 2004. He is attempting to be a retired technical writer and industrial training contractor.

John Punches, NSS 39211 Roseburg, OR
John is an associate professor and administrator for Oregon State University. He has been an instructor for the NCRC since 1996, has served as its National Coordinator and Pacific Northwest Regional Coordinator, and is currently its Training Coordinator. John has contributed to National Park Service rescue plans for Lechuguilla, Wind, and Jewel caves. He is also the long-time training officer for the Douglas County Mountain Rescue Unit (Oregon), with expertise in cliff, cave, and alpine rescue. He has extensive experience in search management in Oregon and the eastern U.S.

Dean H. Snyder, NSS 17870 RL, PH, FE Schnecksville, PA
Dean started caving in 1973 and is a founding member of the Greater Allentown Grotto. He is currently the president of the American Spelean History Association. Much of his underground time today is spent in cave conservation.

Christian Stenner, NSS 61663 Calgary, AB
Christian has been caving since 2004 and has contributed to expedition projects in Canada, the USA, and Mexico, mostly with the Alberta Speleological Society. Since 2008, he has volunteered with Alberta/British Columbia Cave Rescue, where he was a Regional Coordinator and Training Director prior to becoming the Alberta Provincial Coordinator in 2014. Additionally, Christian is a Senior Advisor in the Environment, Health, and Safety Division of a large North American energy company, where he has managed corporate emergency incidents. He holds a certificate in management with specialization in risk management and is an instructor, facilitator, and sought-after presenter in various subjects. He also serves as a captain in the Canadian Armed Forces reserve, instructing cadets and staff in expedition programs, outdoor leadership, and risk management.

Tom Wood, NSS 65725 Conifer, CO
Tom is the Technical Department Manager for Pigeon Mountain Industries (PMI) Vertical Rescue Solutions and a 19-year veteran of the Alpine Rescue Team in Evergreen, Colorado. He is a Level 3 SPRAT Rope Access Supervisor and serves as the Terrestrial Rescue Delegate to the International Commission for Alpine Rescue (ICAR) on behalf of the Mountain Rescue Association. He is an NCRC-trained cave rescuer and writer who has contributed to *High Angle Rope Rescue Techniques, 4th Edition*, and *Professional Rope Access: A Guide to Working Safely at Height*. His memoir, *Trading Steel for Stone, Tales of a Rustbelt Refugee Turned Rocky Mountain Rescuer*, was published in 2016.

Photo by Rich Pumplin.

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