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THE EVOLUTION OF CAVE GATING

How the philosophy and technology have changed

William R. Elliott

Expert Gaters

Engineer and renowned cave conservationist, Roy D. Powers, Jr., of Virginia has been caving nearly 48 years—since he was ten years old. Roy has built twenty cave gates this year—120 in his lifetime. Roy, who is ACCA's Vice President of Conservation, is sought after by private conservation organizations and state and federal agencies. He has engineered and consulted on more than 600 gates from Virginia to Arizona, New Hampshire to Alabama. For twenty years he has innovated the design and fabrication of cave gates in cooperation with cavers, biologists, archaeologists, and conservationists. As Roy puts it, "One reason I got into cave gating big time is that when I go into caves that I visited years ago, they're not the same. They're messed up. They're destroyed. The biology is trashed. A normal caver who just joins a grotto and caves for two or three years doesn't see this. If you take anybody who has been caving, say twenty years (sometimes it takes that long), they begin to notice, and they begin to appreciate the protection efforts a little bit more."

Roy's first cave gate in 1966 was at Salamander Cave, Virginia, then a virgin cave. He almost fell into the pit entrance while searching for it at night. The explorers rigged up a gate from an old trailer frame, gleaned from a junkyard, and anchored it with cables. At that time his motivation was from the explorer's viewpoint, to protect a pristine cave that he wanted to explore.

Now Roy's motivation is to protect resources, not just exploration. By the end of this year he will have helped protect 95–98% of the roosts for the Virginia big-eared bat (*Corynorhinus townsendii virginianus*), an endangered subspecies that is known from only 15 caves.

Tony McGee has built or collaborated on about 200 cave gates in the Tennessee area. Tony is an engineer, and he talks about the "bending moments" of different lengths of angle iron. Of his gates, 90% are on private land; the rest are 7% state, 2% federal, and 1% city land. About 40 or 45 caves were gated for bat protection, and the rest were for safety and "retaining access." In at least one case, the owner was planning to dynamite a cave until the cavers offered to gate it. Tony also has gated five abandoned coal mines, some of which had big-eared or gray bats. Tony also is an instructor in the National Cave Rescue Commission, so many of his gates are designed to allow a fully loaded stretcher through the door.

Mike Warton has built 135 cave gates, all in Texas. His first was at 0-9 Well in 1975. About 97 of his gates are on private land, 2 on university land, 1 on state land, and 35 on Army reservations. Of these, 75 or 80% are for endangered or rare cave invertebrates and 12% are for bats. Mike may be remembered for his illustrations and gate plans in the *Cave Gating* manual of 1975.

Marion Vittetoe of Arizona started gating caves in 1984, primarily to protect delicate caves. About 25% of his 25 cave gates have been to protect the caves *per se,* but 75% have been for bats. He's worked extensively with Dr. Virginia Dalton for the last seven years on bat cave gates. One gate was built to protect paleontological resources (animal fossils). Marion has also built gates on five different mine sites, some using up to three gates each. Abandoned mines are turning out to be very important bat roosts in the United States. Most of Marion's work has been on federal land in Arizona. but some gates were on state land. He'll soon be gating a water tunnel that was scheduled to be sealed until it was found to be a bat roost.

Jim Nieland, an ACCA director, started gating caves about 1991, both as a volunteer caver and on the job as a U. S. Forest Service cave specialist. Jim has built 13 gates; ten of his gates are on federal lands in the Washington-Oregon area, while two are on state land and one is on private land. Eight of the gates

were for bats, one for invertebrates, two for geologic features, and one for archaeology. Only 1% of Northwest caves and mines are used as bat maternity sites, usually by the declining *Corynorhinus townsendii* (Townsends big-eared bat.) About 5% of the caves are important hibernacula (winter hibernation roosts). Jim estimates that if every worthy cave in the Northwest were to be gated, only 6 or 7% of all their caves would be affected, leaving at least 93% available for unrestricted recreational use.

Jim Hathorn started gating caves in 1982 and has built six, all in Idaho. The gates were basically for resource protection, but one was for safety after an accident occurred. He and the Gem State Grotto work as volunteers; they have built one gate for the National Park Service, five for the Bureau of Land Management, and will soon be working on two new gates for Papoose Cave (Forest Service) after much discussion with cavers and experts about the cave's climate.

Early Cave Gates

In the early days of cave gating, steel plate doors or salvaged jail cells were slapped on caves. This either excluded the bats or changed the cave's temperature profile to where they could no longer use it. Biologists discovered that a raised concrete sill across the bottom of the gate could block the flow of cold air into the cave, affecting a bat hibernaculum. Cold, dense, winter air often flows along the cave floor like a fluid, and a raised sill can act like a dam. Different species prefer different temperatures, so it is best to protect natural air flow and water flow patterns. Some cave gates actually caused the decline of hibernating populations of Indiana bats and gray bats, two species now on the endangered species list.

Many early cave gates were flimsy things made of pipe, and were not anchored well enough to prevent vandals from tunneling under them or bending them to go around. In 1975 the National Speleological Society published its *Cave Gating* manual, which was the first of several influential documents on the subject. The manual had useful information about building stronger gates, but leaned toward the "weak link" philosophy of cave gate design, which is to create a weak area in the gate so that it can be broken without wrecking the entire gate. That way, the theory goes, most intruders will be kept out and the gate can be repaired easily. Most cave gaters have abandoned the weak link philosophy, or make the weak link stronger than before. Roy says, "I never believed in that. If you're going to protect the resource, you protect the resource. You're not putting something there to protect itself! If the vandals attack your gate, the philosophy is you fix it as quick as possible and outlive them."

Frustrated Vandals

Roy delights in frustrating vandals. Many of his cave gates have a large steel skirt in front of the gate. The skirt is buried under heavy rocks. By the time vandals dig down to the skirt they're usually tired and would still have to tunnel six or seven feet to get under the gate. None have succeeded. Concrete is rarely used to finish the edges of a large gate because it eventually deteriorates, but if he does use concrete, Roy uses massive amounts.

Most cave gaters still use mild steel because it's easy to work with and strong enough. Mike uses "modified" steel, which is slightly stronger. Mike brushes his gates with Rustoleum. Roy, instead of coating the gate right away, lets the gate rust a bit, then coats it with automotive "Extend," a water-based product that reacts with the iron oxide to form a stable coating. He favors stainless steel locks with brass tumblers, such as those made by Best Co. and Master Lock. Mike likes Olympus brass locks, and Marion Vittetoe likes Medico brass locks. All of these are corrosion resistant and have a ½-inch diameter shackle. Roy usually leaves a small can of WD-40 hidden behind the gate for cavers to lubricate the lock. He hasn't had any lock failures, except for those that were mutilated. A good cave gate will have the lock inside a hard-to-reach box inside the gate, accessible only by feel through an armhole in the gate. This prevents the direct application of levers and cutting tools on the lock. Mike sometimes puts two large locks and hasps on his gates for extra strength and security.

Roy docs not anchor his gates with plain re-bar, but uses heavy hangers made of plate or angle-iron. He drills a one-inch hole in the hanger and welds a one-inch-thick pin through it. The six or eight-inch square hanger gives him more room for attaching pieces of the gate. Most gaters use a hammer-drill to

imbed the pin 8 or 10 inches deep in the bedrock.

Roy originated the stiffener, or angle-within-angle-iron design, and the turning of the angle-iron bars to cut the drag on air flow. Various angles were tried with the advice of friends, until the current configuration, with the apex pointed up, became standard. With stiffer bars vandals cannot use jacks to bend the gate open, and the design has more widely spaced vertical columns, which is better for the bats because they need all the room they can get to fly out. The best way to stiffen horizontal bars, Tony thinks, is to use heavier, tougher steel, such as $^{5}/_{16}$ or ½-inch-thick angle iron. He spaces his vertical columns at four to five feet when using ⅜-inch-thick angle. Tony likes to harden gate parts by welding old tool bits inside the horizontal bars or filling pipes with concrete and tool bits. This will stop hacksaws very quickly. The same effect can by obtained by welding beads from harder welding rods on the surface of the gate.

Jim Hathorn likes to use the "psycho lock," an invention of Roy's that can fool vandals. The gate actually has two locks, one hidden in a vertical column and one more visible to the vandal. In one instance a vandal shot up three boxes of .22 shells to destroy a lock, but the hidden lock prevented entry.

Back in 1985, a massive bat gate like the one on Hubbards Cave, Tennessee, took 10,500 man-hours to build. That gate protects two endangered bat species. The gate used vertical members spaced four feet apart. Recently Roy and Marion built a bat gate on Gustafson Cave, Arkansas. The gate was almost as big as Hubbards, but took only 504 man-hours. The verticals were placed 10 feet apart, which is now possible because they stiffen the horizontal angle-iron bars. Roy thinks he could even go to 15 or 20-foot spacing of the verticals if he used ½-inch steel and 2-inch angle for stiffeners.

The Hubbards Cave gate, still the worlds largest at 39 feet long, 31 feet high, and 70,000 pounds, was a learning experience for Tony McGee and Roy, who worked on it with many others. Extruded steel columns, which are square tubes, were used for the verticals, but when welded on one side the other side stayed cold, causing deformation and cracking. The Hubbards gate needs repair as a result. Extruded columns also are difficult to adjust if they get out of alignment during fabrication. So, it is best to use large angle-iron instead of columns.

Marion builds small gates out of 2-inch square tubing, resulting in a gate that has less obstruction to air flow and animals while still being strong. On larger gates he uses the "T-bar" stiffeners inside the angle iron, like Roy, and he likes to use straight, heavy wall plates made of 6-inch-wide, ⅜-inch-thick angle. These are placed in front of and behind the large pins in the wall to protect them. He attaches the horizontal bars to these plates, and with this design he can avoid setting up verticals altogether on medium-sized gates. The design saves time because he avoids making elaborate cuts, but it requires finding straight walls or else modifying the wall a bit to accept a straight plate. This method saves time and results in a cleaner design too.

How Critters and People Respond to Gates

Bob Currie, a bat expert with the U. S. Fish & Wildlife Service and an ACCA director, says that some bats, like the Mexican free-tailed bat, do not tolerate cave gates at all, while others, like *Myotis grisescens,* the gray bat, tolerate a gate only if it is not a maternity colony. Merlin Tuttle of Bat Conservation International and his associates have found that some bats like gates better if they are back in the cave where predators are less likely to attack them at the gate. John MacGregor found that some early bat gates actually caused most of the decline in Indiana bat numbers since the 1950s and 1960s. These gates blocked air flow and bats actually had to land on some of them to get through. Since then, better gates have allowed some of those populations to increase again.

In Texas, many caves have been gated for the protection of endangered or rare cave invertebrates. Mike uses 2½-inch spacing on such gates if there are no bats. Such tight spacing will prevent a standard hacksaw from cutting through the bars but still allows air flow. However, bat gate designs are still used when the entrance is large enough, because the design, with 5¾-inch spacing between the bars, allows good air, water, and cave cricket "exchange." Roy reports that six-inch spacing was used on earlier bat gates, but experimentation showed that 5¾-inch spacing excludes all but a small percentage of adult humans.

The cave ecosystem is dependent on cave crickets, raccoons, mice, and other critters to provide guano (droppings), which provides nutrients to certain species who feed directly on the droppings or on bacteria and fungi growing on the guano. These "grazers," such as tiny springtail insects, are fed upon by other species such as spiders and pseudoscorpions. The cave crickets also support cave-adapted beetles, such as *Rhadine* in Texas and New Mexico, or *Neaphaenops* in Kentucky and Indiana. These beetles sniff out, dig up, and eat cave cricket eggs laid in the cave soil. Gate designs should not obstruct animals such as raccoons, who naturally use caves. In Texas, most cave gates have an eight-inch-diameter animal hole at one side or through an adjacent ledge, to accommodate raccoons and ringtails, but holes up to ten inches may be needed. Gates should not be covered with expanded metal or mesh, as that can hinder leaves and twigs from falling through a horizontal gate. Leaf litter can build up, blocking natural processes. Even in a dry cave, leaves and twigs are occasionally washed farther into the cave by runoff, providing nutrients and soil for invertebrates.

It is important to avoid polluting the cave environment when we build gates. Air flow patterns in the cave should be watched before welding starts, so that welding fumes can be directed out of the cave. In Gorman Cave, Texas, the writer had to set up a ventilation system to exhaust welding fumes out of the cave during construction of a bat gate. Box fans can be used in an entrance to blow fumes away from the cave and the workers. Metal slag should not be left on the cave floor—prefabrication of gate parts can cut down on such slag deposits. Spray paints should not be used in a cave environment—brushing the gate is better. And don't smoke in the cave!

Occasionally some people will actively oppose the idea of a cave gate. About ten years ago Roy and Marion were asked by the Coconino National Forest, Arizona, to gate Crucifixion Cave. ACCA paid the $1100 costs for the gate. This is an unusual limestone cave overlain by a lava flow and lava tube, some of which broke through into the limestone cave. Only three other caves of this type are known in the U. S. The cave had bats and delicate features and needed management. Certain individuals voiced opposition to gating the cave. About two weeks after the gate was finished, someone cut the three-ton gate out with a torch, and it disappeared without a trace. Then ensued a tense period in which U. S. Marshals investigated and the vociferous few had a good scare, although no one was arrested. In the end, Arizona cavers offered to help put the cave gate back and the incident became an object lesson. Cave gates are now accepted by most cavers in that area, although Crucifixion Cave remains ungated. According to Marion, a second cave gate disappeared in Arizona, and it has not been replaced.

The frequency of cave gate violations remains annoyingly common, according to Roy and Marion, but Roy thinks this is because there are more cave gates now. He thinks that the percentage of cave gates that are attacked has actually declined. Marion feels that attitudes are improving in Arizona, but some people still object to cave gates and threaten to destroy them. Probably five or six of his 25 gates have been vandalized—usually the door is taken off, but he repairs them. Roy is proud of the organized cavers in his area, many of whom have helped build cave gates. In Texas, most cave gate violations were done by uninformed noncavers.

Logistics

Marion Vittetoe recommends planning ahead and organizing people and equipment. He usually has four to eight people involved on each gate. He may make one trip to measure the entrance and another trip or two to build the gate. He has an inventory list that he checks off so he'll know what equipment or materials are missing. This list also allows assistants to pack up his tool boxes afterwards without him having to supervise them.

Roy doesn't prefabricate much except hangers with 1-inch pins in them. He prefers to build the whole gate in the field. In Texas, Mike Warton often makes careful measurements of a small entrance, prefabs the gate at his shop, then installs it on the entrance. Gates on small sinkholes with loose walls may have the edges finished with concrete. Gaters prefer to fill the entire hole with gate if the walls are solid; they occasionally pour massive concrete to anchor the bottom of an upright gate. If the gate is not built on bedrock, Marion often pours concrete over re-bar in a 7-inch deep trench, and anchors the sill plate to this footing at the bottom of the gate. Larger gates may warrant a deeper trench. Jim Nieland likes to

measure the entrance at two-foot intervals and design the gate on a computer, which then gives him a materials list to buy. He prefers pre-fabbing brackets and doors in the shop, where he has a large band saw that can cut these pieces much quicker and more precisely than with a cutting torch in the field. He has found a supplier who will deliver steel over 120 miles away at no charge!

Carrying the steel to the cave is a big job. Nieland has used a Honda "Toter," a machine with rubber tracks that handles like a wheel barrow, and which can carry up to 800 pounds. Then there's the "Libby Nieland Webbing Loop Technique," originated by Jim's wife. Fold a nylon webbing loop double, and wrap it around the steel bar forming a handle on each side. Two people, standing opposite, each grasp a loop handle with one hand and pick up the load. By adjusting the length of the loop on each side, one can compensate for height differences between people. Six people can easily pick up and move a 20-foot length of four-inch angle iron. With the straps, the angle needs only to be lifted six inches off the ground to be moved! The webbing loops grip the steel when going up or down hill, so control can be maintained.

In one instance a helicopter was used to move stuff over a mile from the road to the cave. They used a 150-foot line to lower sling loads between tall trees to the forest floor. The Forest Service used a similar method to gate El Capitan Cave, on the steep side of a glacial valley in Alaska.

Good lighting in the field is important. Nieland uses three or four halogen work lights. Small gates can be built with one welding machine, but two or more welders are needed for large gates. The welding is the most time-consuming operation. Space does not permit a discussion of all the methods used in welding the gate. Let us hope that a new cave gating handbook will be published in the future.

Philosophy

Jim Nieland says it takes technical expertise, coordination, many partners, and a willingness to work together toward a common goal. Partnerships are the single most important element in successful gating. It spreads the cost among the partners, while developing consensus and commitment. The "Washington Cave Working Group" has developed to carry out cave gating projects. Nine organizations were involved in the recent gating of Christmas Tree Cave, Washington. The ACCA has been a catalyst in cave gating in the Northwest, but Jim recommends that anyone seeking to protect caves should try to develop a cave working group and invite all interested parties, because they all have something to offer.

To have a successful cave gate, Roy says, "The philosophy is basically simple. You certainly should educate the cavers as to what's happening and why. Usually, if they understand why, and you can involve them in the situation, you've got a much greater chance of success." Of course, vigilance is still required in the case of non-cavers who never thought of the concept of cave conservation.

Looking back over his long years of effort, Roy muses, "Twenty years ago I probably wouldn't have gated a pristine cave just because it was a pristine cave. I don't have time to do that now because I'm trying to protect resources, and it's like stompin' out brush fires. But, if somebody's got free time and they have a pristine cave, and if they want it pristine ten or fifteen years from now, they'd better manage it. That doesn't necessarily mean a cave gate. They'd better manage it or it's not going to be there."

The author thanks a/l the cave gaters who helped him write this article.

Further Reading

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[Note: 12 illustrations included in the original magazine article were not scanned for this version.]