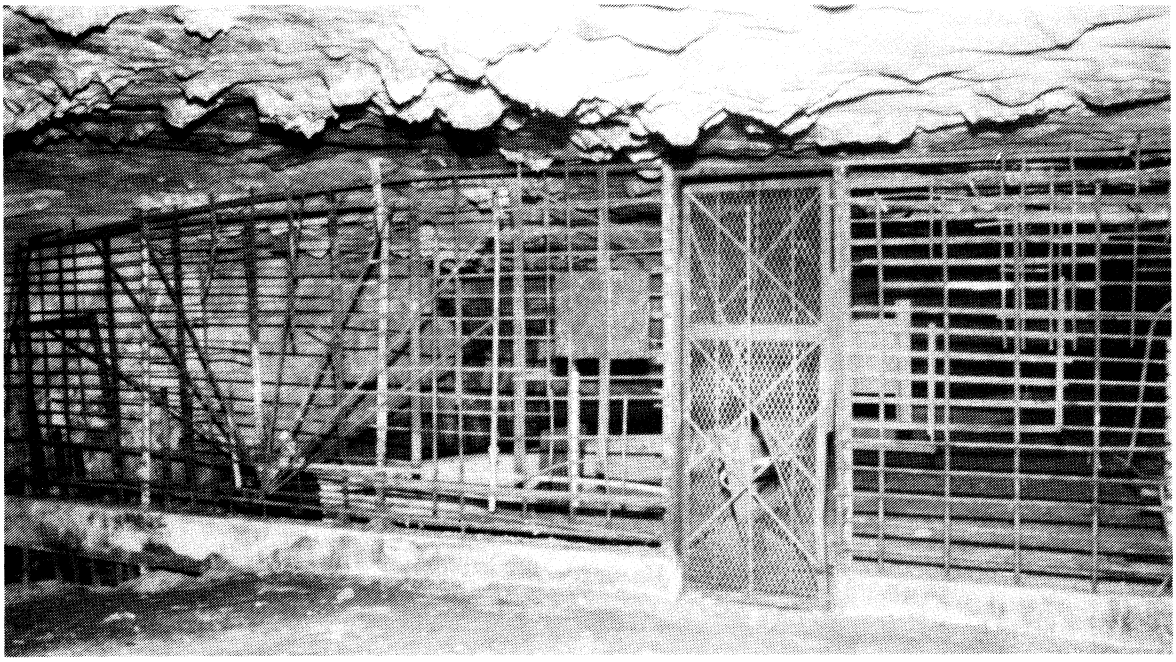


THE GATING OF CAVES

By Jonathan B. Beard • Digest Associate Editor

Introduction

Every cave in the crust of the Earth is doomed to total destruction! A cave is the product of some type of geologic process that includes the breakup of rocks by physical or chemical means, and erosion by stream-water, sea-water, lake-water, groundwater, wind, glacial ice or gravity. These processes are continually at work; they do not stop just because a cave has become large enough for human entry. The geologic processes continue, taking a cave from birth to youth to maturity to old age and eventually to destruction. Nature thus creates caves and destroys them. Like everything on the planet, caves exist for only a finite span of time. It is unfortunate that they must also face the prospect of vandalism and contamination.

Some people argue that no cave is safe from vandalism due to ever expanding population densities and to the spread of humans across the face of the land. Population growth brings development and continual change in the shape of the landscape. Most caves have traditionally had a "rural" environment, a setting that has given them some protection from recognition, use and contamination.

Given the destiny of caves, one might reasonably ask why we should even practice cave conservation at all — isn't it a waste of time, effort and money? Why should we even consider gating a cave?

The answer lies in the values of caves as a natural resource. Caves are living museums of natural and cultural history and are therefore as important as any man-made museum.

"The relationship between human societies and caves is long and complex," said George M. Crothers (*Digest*, July 1995). "It extends to the appearance of our earliest bipedal ancestors...who lived some 2.5 million years ago in South Africa...While archaeology in Missouri caves is not as internationally spectacular as these examples, it is still important to understanding the regional prehistory and early history of our state."

Above: The often-abused rebar cave gate at Doling City Park Cave in Greene County. It has been breached countless times and "spot repaired," resulting in this chaotic design. The cave is gated to prevent vandalism, but has thus far been too easy to breach.

All photos by Jonathan Beard unless otherwise noted.

Only a small number of the more than 5,500 recorded caves in Missouri have been carefully examined by professional archaeologists to determine the cultural secrets they may hold to Missouri's prehistoric past. Protecting the resource from cultural desecration and physical harm is necessary if we are to someday discover and unravel the information preserved within them. One Missouri cave, for instance, contains human footprints made thousands of years ago. They are as fresh-looking as yesterday. Who were these people? What were they doing in the cave? For thousands of years the footprints have been preserved by the constant humidity and temperature of the cave, and its lack of human visitors. The footprints are being preserved now by a gate and controlled access to the cave.

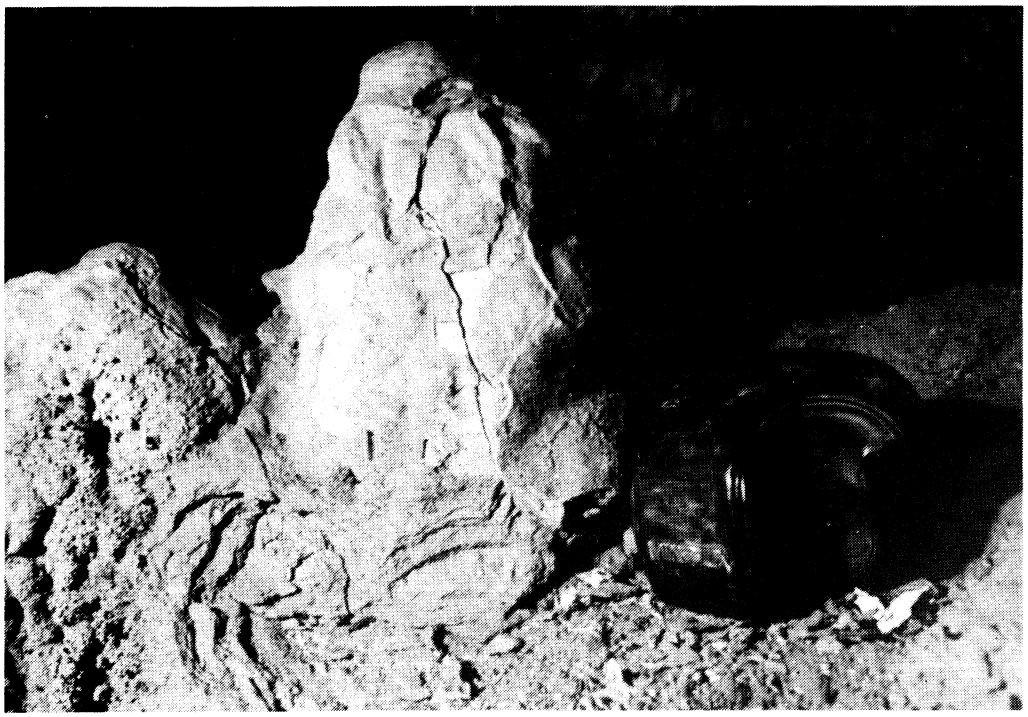
Some caves hold clues to past climates and to organisms long gone. The bones of numerous extinct species of animals have been discovered in caves and many more lie undiscovered, unstudied, locked within the sediments that caves contain.

Caves are home to a wide variety of living species, some of which are endangered organisms. Some cave organisms, such as blind fish, sightless crayfish and blind, albino salamanders, have adapted to their totally dark subterranean habitat over a period of thousands of generations. Their ecosystems are fragile and intimately associated with the surface ecosystem above their cave. Human activities threaten many populations of unique cave organisms, especially in karst areas. Just as the plants and animals of tropical rain forests can hold the keys to curing diseases that afflict humanity, who knows what organisms in caves might also be of benefit to human health and welfare.

Show-cave owners and operators are generally careful custodians of the values of the cave resources they manage because the caves have economic value to them, to their employees, and to the state. The caves also serve as classrooms, introducing millions of people each year to the beauty, history, and values of caves.

Caves are also windows to one of our most precious and widely needed natural resources — groundwater. According to the Missouri Department of Natural Resources, 42 percent of the population of Missouri (approximately 2,150,000 people) depend upon groundwater for all their water needs. For this reason, groundwater quality is an important issue for Missourians. Caves and spring systems give us a better understanding of our groundwater aquifers. Protecting caves from contamination ultimately protects the quality of our ground-water.

These are just a few of the reasons why it is important to protect and conserve caves resources. As it turns out, there are several ways to accomplish this task and they include secrecy, education, management, restoration and gating.



This 12-inch stalagmite is cracking and pealing due to the excessive air-draft caused by the man-made second entrance in Cave Spring Onyx Caverns. It will continue to deteriorate until the second entrance is filled or made airtight by using a set of airlock doors.

Secrecy

Keeping the location of a cave a secret, even the very knowledge that a certain cave exists, is one method of cave protection. It has been a moderately successful method in some parts of the country where the geographic location of the cave often works to its advantage. West of the 100th meridian (roughly the western half of the lower 48 states), the population density is much sparser than that of the eastern half of the United States. The caves of the western half of the country are much more isolated, more widely scattered, and are often located in extremely rugged territory. Here, secrecy has worked quite well in protecting some cave resources. It is definitely a first line of defense for a cave and its contents upon initial discovery. The fewer people who know about the cave, as the reasoning goes, the less likely it will suffer abuse.

Secrecy, even when completely successful in preventing vandalism, is often scorned by others when they learn about the existence of a particular cave but have no way of finding out how to get to it so they may see it too.

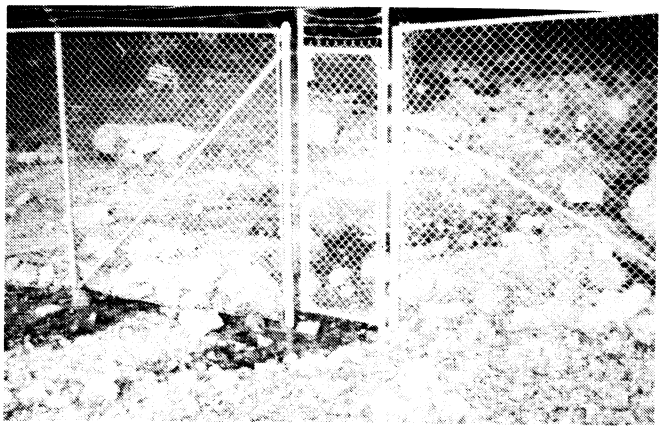
Practicing secrecy often involves being in the "inner circle" of caving friends who keep the location to themselves, allowing someone else to learn of its location only after that person is accepted into the trust of the inner circle. This approach may be seen as self-serving, arrogant and moralistic. Its practitioners, in effect, promote themselves as being the only people who are trustworthy and good enough to visit the cave without harming it, or the only ones qualified to protect it. Such an approach can produce much ill will, contempt, and may, in the long run, produce a backlash. Despite this, however, secrecy does carry an excellent track record for some caves, especially those in the western states, even when it causes a clash of caving and cave protection philosophies.

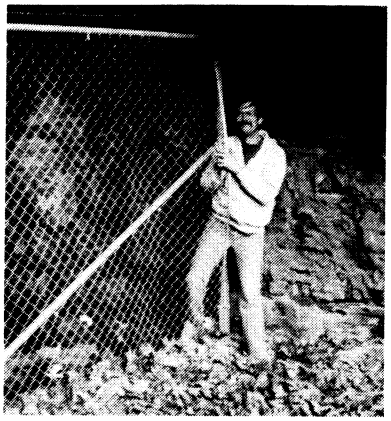
A secret can remain a secret only so long. It is inevitable that someone else will discover the cave eventually no matter how isolated the cave may be. Caving cliques, like most cliques, eventually break up. Cavers who belong to cliques have non-caving friends and family with whom they converse and share confidences, people who are not bound by the same rules that govern the clique. Word about the cave eventually gets out by one means or another.

It also stands to reason that if one caver has discovered a cave, another person can make the same discovery and it may be someone without a strong conservation ethic. So, a second line of defense must be implemented to protect the resource. In fact, a second line of defense — Plan B — should be developed at the outset, even by those who use secrecy as plan A, so that when rediscovery occurs, there will be an alternative cave protection plan immediately available to them.

Once a cave is known to many cavers or the general public, then there are basically three ways to prevent vandalism to the cave. One method is to post sentries at the cave 24 hours a day, seven days a week, year after year. This, of course, is impractical, which leaves public education and cave conservation and restoration as a second method, and gating as the third.

Alicia Beard at the rebar gate to Island Cave in Camden County. To be more bat-friendly, the vertical bars should be 25 inches apart, the spaces between horizontal bars no less than 6 inches wide. To be more vandal-resistant, the rebar should be replaced with angle iron and the locking mechanism should be protected against blows from a hammer, hacksaw or pry bar.





Left: **The entrance fence at Great Spirit Cave in Pulaski County. Entrance fencing is often easily breached as is this one. This cave is both home to hibernating Indiana bats in winter and nursing Gray bats in the summer. The lack of adequate footing enables vandals to frequently pass under the gate despite attempts by the cave managers to pile rocks around the base of the fence. The exposed lock and chain are a "weak link," but not the weakest link in this cave gate.** ***Right:*** **The end of the fence has been pulled away from the wall, enabling trespassers to squeeze in as demonstrated by Todd Heintz. Adequate footing plus sturdy anchoring to the wall will make this gate more difficult to breach. More frequent monitoring of the fence is also needed to deter trespassing.**

Education

Educating the public would be the cure-all remedy except that not every person entering caves would necessarily hear the message or pay heed to it. But educating the public in areas where spelunking is a popular sport is not a bad idea, as long as other conservation methods are also employed. Certainly many novice cavers would heed a conservation message, but vandalism would still be done by those who choose to do damage. Surely in many cave areas east of the 100th meridian, education of the great numbers of people who occasionally go caving for sport is needed. Education west of the meridian may do more harm than good by introducing the topic to those who might not have considered it at all. However, it is also inevitable that the problems occurring east of the line today will eventually occur west of the line, and if not in our lifetimes then certainly within the next millennium.

Cave Restoration

Cleaning, reattaching and renewing speleothem areas, removing graffiti, and revitalizing ecosystems in caves damaged by vandalism and overuse are certainly ways to counteract vandalism, but this is after-the-fact. Resource protection works best when it is "pro-active" not "re-active."

Restoration cannot undo all damage, damage that in some instances might have been prevented by implementing some other type of protection method. In caving areas plagued by vandalism, restoration efforts cannot begin to keep up with the damage being done by others unless a combination of other conservation methods are used to slow it down or eliminate it. Coupled with education and cave gating, restoration efforts can certainly be worthwhile provided some measure can be taken to see that vandals do not return and destroy all of your hard work.

Gating

Gating a cave is the last practical line of defense. It is used when all else has failed; when the resource is so fragile that any kind of uncontrolled, unmanaged access might be harmful; or when the issue is one of liability, trespass or privacy.

Gating a cave, like the other conservation methods listed, is controversial. When a cave is

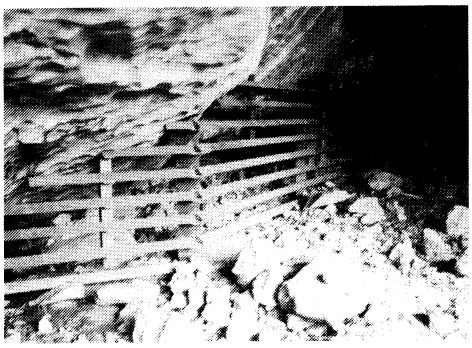
gated, it bars the way into the cave for not only the vandal, but also the conservationist caver as well. Some argue that gated caves will all eventually be destroyed by the ardent vandal, and thus, what good are they? Gates are as much a hindrance to good cavers as they are to bad cavers.

The fact is that *good cave gates work until the time they are breached.* With some gates, that is relatively soon after they are installed. With other cave gates, the gates remain intact for many years. Some gates are easy to destroy, others are impossible to breach without the use of dynamite. Some gate designs have not only kept out human visitors, but have also had disastrous effects on the cave ecosystem! When the bats that were supposed to be protected by the gate refuse to enter the gated cave, the gate has done exactly the opposite of what it was intended to do. Instead of protecting the colony, it may have destroyed it unless the colony subsequently found suitable refuge in another cave.

In the following discussion, we will assume that a correctly designed gate made of the best materials and located in the most optimum location in a cave will:

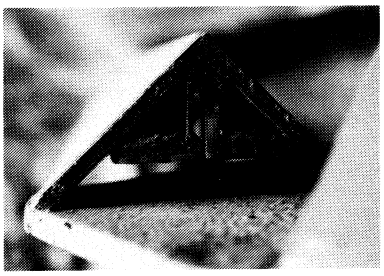
1. Keep out all but the most determined of vandals;
2. Allow relatively easy access to those people qualified to gain legal entry; and
3. Have little or no affect on air flow, water flow or biological flow, protecting the speleothems and ecosystem within the cave, and performing as a better alternative than no gate at all.

Schermerhorn Cave Gate in Cherokee County, Kansas



This open-grid angle iron gate is located about 35 feet inside the cave and replaces a solid rock-and-mortar wall that was not bat-friendly and was breached by vandals.

As good as this gate was built, it has its weakness: It lacks a footing, thus enabling vandals to dig under the gate as shown by the location of the camera case.



The cross-section view of the 4" by 4" angle iron material of the gate. To deter vandals, the inside angle of the material contains two 1.5" by 1.5" angle iron sections. The gate has been painted to ward off corrosion. There are a few variations of this design, including the welding of sandy concrete-filled 1-inch piping to the inside of the angles.

The door of the gate as seen from the outside. The hinges of the door are on the inside of the gate to prevent their being damaged by vandals. The lock is in a protective box not visible to the vandal. When the lock is removed, a sliding bar is moved to allow the door to swing open.

Criteria for Gating—Questions to Answer

In gating a cave, several questions ***must*** be answered before gating actually begins. Gaters (those who erect cave gates) have found, through trial and error, that *it is often better to not gate a cave than to do it incorrectly.* Be sure you know what you're doing! Guessing at gate placement and design is putting the cave and its contents at risk. The better prepared you are, the lesser the risk.

Many questions have to be answered before gating begins, such as, is there a bonafide reason to gate the cave? Is gating the best alternative to the cave's current status? Hopefully, the following discussion will teach you how to make the best possible decisions for a particular cave gating situation. A situation may develop that is not addressed here but the following exercise should help you gain enough knowledge to be able to implement the optimum management plan for a cave.

1. Why are you gating the cave? Are you gating the cave to: (a) protect the cave and its contents from people? (b) protect people or livestock from cave hazards? (c) protect the landowner's right to privacy? (d) accomplish all of the above?

Caves are usually gated to protect speleothems and cave life forms and their habitats, to safeguard people and livestock from cave hazards, to prevent overuse and control human traffic, to protect a landowner's rights to privacy, and to minimize a cave owner's liability and fear of lawsuits.

A gate that prevents entry to a cave will prevent many an injury to novice spelunkers who may later sue the landowner for said injuries. However, if the gate itself causes injury, or if vandals who breach the gate are subsequently injured in the cave, it could still mean a lawsuit. You must determine if there is a significant reason to gate the cave. The time, energy and cost of gating a cave and maintaining a gate should not outweigh the time, energy and cost of maintaining the cave without a gate. Unfortunately, gut feeling is sometimes the only way to make such a determination.

2. With what materials will you be gating the cave? What means will be used? Are there better means and materials available? What kind of gate design have you chosen and is it the best design for the cave's entrance?

You should choose a gate design that does not have a negative affect on the flow of air and water in and out of the cave, a design that does not impede the travel of cave life, a gate that does not endanger cave life by giving predators an unfair advantage over them, and a gate that is difficult for vandals to damage, destroy or breach.

Consider if the gate's design will make it more difficult for vandals to breach the gate, so difficult in fact that they will choose to go elsewhere. You may want to make access that difficult and you may not. But you also need to construct the gate out of materials that will be easy to maintain while also hindering or stopping people who might try to breach it.

3. Do you have the blessings of the landowner, tenants or manager? Who will fund the gating?

A cave belongs to either a government agency or a private landowner. In either case, you do not have to right the gate a cave unless you have obtained the permission of the owner.

If the cave is owned by a government agency, the authorities may have their own opinions on whether to gate the cave or not and may have their own means by which to carry out the task; however, your ideas may be welcome and useful.

If the cave is privately owned, the owner(s) should be approached by first finding out if you should be educating them on the need for a gate, as well as discussing gate placement, design, funding, maintenance and management (including who will or should have access to the cave after it is gated).

4. Will the gate impact the natural flow of air in and out of the cave?

Any gate will have some kind of an affect on the air flow through a cave passage. However, a cave gate **must** have the **least** impact on the natural flow of air and water possible in cases where you are striving to maintain the cave in a natural state. Solid walls of concrete, metal, wood or earthen material can have dramatic and negative impacts upon a cave. The only time that air and/or water restricting gate designs should be implemented is to return a cave environment to its natural conditions by blocking a previous "man-made" opening to a cave already possessing a natural, free-flowing entrance. A secondary man-made, free-flowing entrance could affect cave temperature and humidity. If you severely limit the air flow through the only entrance to the cave, you may be dooming the cave ecosystem by changing the climate within the cave. Some species of cave life require specific temperatures or humidities for survival.

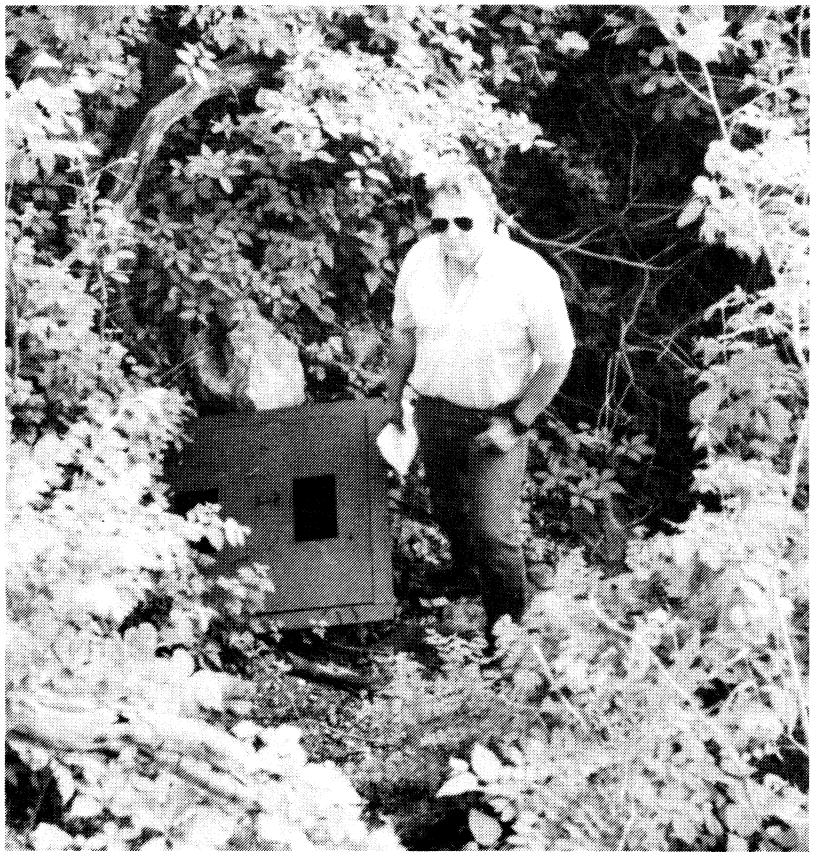
5. How easily can vandals damage the gate? How easily can the gate be repaired?

Gating can be a difficult, time-consuming, energy-sapping, wallet-emptying endeavor. Do not attempt to gate a cave by designing a cave gate that is too easy to breach yet very difficult to repair. If it is too easy to enter illegally, then its effectiveness and the efforts to build and maintain it are negated. Typically, gaters should strive to make a gate *very difficult* for most vandals to damage. It should be more difficult to illegally enter a gated cave than it is to simply try to visit another cave. The gate's placement, design, and materials will determine how difficult it is to enter illegally.

6. Will the gate be vulnerable to flooding and how easily will it be for flood water and debris to damage the gate?

Many cave entrances are located on or near the flood plain of a major river or stream. Some cave entrances function as swallow holes for perennial or intermittent surface streams. Both situations can make a cave entrance prone to flooding during major precipitation events. A gate can be wiped out by a flood that may transport heavy rocks or trees. A gate can act as a "screen" by trapping debris that would otherwise have travelled in or out of the cave, thus affecting the ecosystem. Organic debris carried into a cave by flood waters may be a source of nutrients for the cave life and cave life may have adapted to periodic flooding that brings them food. A gate could seriously interrupt the food supply for cave life.

If the cave entrance is flood-prone, you will have to design and place the gate accordingly. Even the best designed and placed gate may require periodic "flood maintenance" work, which should be considered a critical part of the management plan.

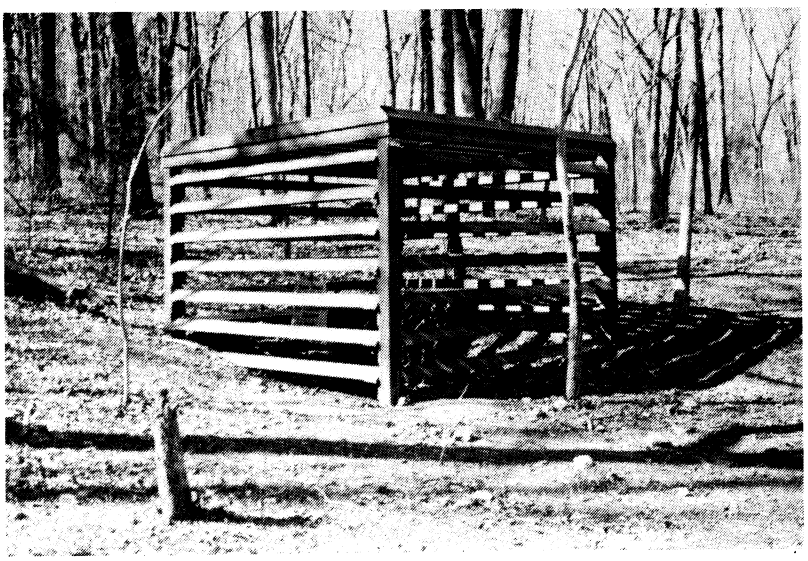


Bob Taylor stands beside the gate at Lon Odell Memorial Cave in Dade County. The gate is atop a 14-foot culvert with welded steps over a 40-foot drop to a talus cone floor. Note the 6" x 10" holes for use by pipistrelle bats. The gate protects prehistoric human footprints and torch remains found in the cave. The door to the gate was manufactured by Don Rimbach and Earl Hancock.

7. Will the gate prevent cave animals from entering or exiting the cave? Where are you locating the gate?

Gate design and placement are very important criteria concerning the positive and negative effects that a gate can have on the ecology of a cave. Gate design must allow unimpeded movement in and out of the cave by animals that use the cave for food, shelter and reproduction, including the movement of micro and macroscopic life forms. By blocking the entrance to a cave, you may doom the ecosystem within the cave. Even permanent cave-dwelling species that do not pass in and out of the cave depend upon biota that do leave and enter the cave for their nutritional needs.

The old entrance gate to the Dry Hole entrance to Turnback Cave in Lawrence County. Note the wire replacement of the missing rebar piece. Because rebar is so easily removed with a hacksaw, rebar gates suffer much damage from vandals.



The new gate to the Dry Hole entrance to Turnback Cave, an angle iron open-grid design. The lack of concrete footing may enable vandals to dig under it to gain illegal entry. This is a "no-door" gate. Only the main entrance of the cave has a gate to provide authorized people access to the cave. The gate was placed by the Missouri Department of Conservation to protect endangered species habitat.

In some cases, the placement of a gate determines the success or failure of a cave gate. For instance, many bats will not use a gated cave, regardless of the gate's design or materials, if the gate has been located at the dripline. Locating the gate inside the cave may make all the difference in the world to the bats.

Solitary bats such as the pipistrelle bat have an amazing tolerance for gates. I've witnessed a pipistrelle tucking its wings and zooming through the 4-inch diameter arm hole of one gate, and two dozen pipistrelles using two 6-inch by 10-inch holes in a gate located at the top of a narrow vertical pit.

Colony bats, on the other hand, especially those of pregnant females, are very intimidated by cave gates and will avoid them unless they are designed just right and placed in an optimum location. ***If you find that the gate you have built is overly intimidating to the bats, and that they refuse to use the gate, then you must remove the gate immediately before major harm is done to the bats using the cave and the ecosystem.***

This does not mean that gating the cave was a bad idea, just that the gate design and location are not suitable. It is possible that a particular cave cannot have an interior gate because there is no location inside that is acceptable to the particular bats using the cave. When this situation arises, outside fencing must be attempted. In any case, if you want the gate to be "bat friendly" to colony bats, it is best if the gate is not placed right at the dripline.

8. Will the gate enable predators to more easily kill cave wildlife?

In the case of a small cave entrance or passage, a constricted opening involving a cave gate may actually allow predators such as snakes, raccoons and cats, to easily prey on bats and other

cave life. This, in turn, can have a major impact upon a cave's ecosystem. Gates can slow or limit the flight of bats, thus making them easy targets for quick, sharp-eyed predators. A gate's design can also become a "ladder" for predators to climb, enabling them to better position themselves for the kill. Be sure that your cave gate does not dramatically change the predator/prey relationship. If it does, then the gate must be redesigned and relocated.

9. How easily can people legally open the cave gate?

If legal visitation is intended, do not make the unlocking process so difficult that legal access cannot be readily obtained. Avoid a system that gives the legal visitor as much difficulty as it does trespassers and vandals.

10. How easily can the gate be maintained? Is it rustproof? Can it be easily sanded and repainted?

Gate materials should be rustproof if possible, and if not, the material should be relatively easy to sand and paint at regular intervals to prevent excessive corrosion. Again, the size and shape of the passage and the gate placement are important subjects to consider when gating. The job is not done when the gate has been finished. Regular monitoring and maintenance will prolong the useful life of the gate, making it decades instead of a few years (providing, of course, that vandalism or natural catastrophic events do not occur).

11. Are you using the right type of lock? Is the lock protected against vandalism?

Many agencies that own visited cave gates use combination locks and most of them change the combination at regular intervals, some as often as weekly. Obviously, combination locks must be visible to the visitor (however, there *are* nonvisible combination locks located inside a gate that can be made visible by using a mirror). If a combination lock is not practical, then use a heavy-duty key lock. Regardless of the lock type, be sure it is corrosion-resistant or regularly oiled to prevent corrosion.

12. Is it worthwhile to gate the cave?

This may seem like a redundant question, but consider all the other questions posed here. Are there speleothems worth protecting? Is the cave ecology significant (rich populations of cave life, endangered species, highly diverse and dynamic ecosystems, etc.)? Does the cave pose a hazard to human visitors or the owner's or neighborhood children, pets or livestock? If the cave is not significant and does not pose a great threat, it may be more worthwhile to consider gating another, more significant cave with your time and resources. Also consider the difficulty in the gating process and the expense of the materials. Are the cave and its contents worth the trouble of gating and maintaining the gate?

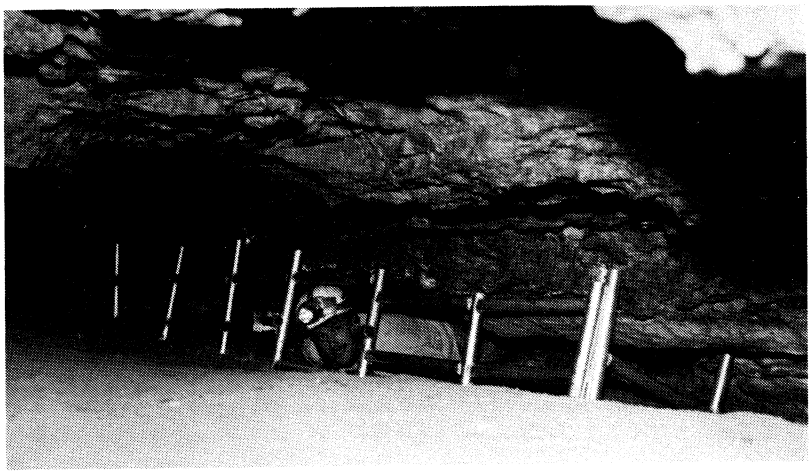
13. Who will manage the gate? Who will maintain the integrity of the gate? Who will monitor the possible positive/negative impacts of the gate on the cave and its ecosystem? Who will have access to the keys/combination of the lock? How will visitations to the cave by other cavers/strangers be handled? Will the landowner(s) have access to the cave?

Someone must regularly check on the integrity of the gate, to make sure it hasn't been damaged by vandals or natural events, and to make sure it is still structurally sound. Someone should monitor the cave to see if there are any positive or negative impacts by the gate on the cave and its contents. It must be determined who will have access to the key and/or combination of the lock. A cave visitation policy must be established that determines who will be able to visit the cave, how often, for what reasons, and limits to the size and number of visitor groups allowed to visit the cave. Some owners want to be in charge of this determination, wanting active participation in the management of the cave (such as show cave operators and government agencies). But some owners do not want this responsibility, leaving it up to the caving or speleological groups to make the determination, wishing instead to defer visitation requests to someone else. One landowner insisted on not having a key to the lock, saying "If they know I don't have a key, they won't bother me about it."

14. What are your local cave conservation and trespassing laws? Are you prepared to help enforce these laws when they are broken by trespassers and vandals?

If you are going to build a gate, you and the cave owner should know the local laws in order to be able to better enforce them. Are there cave protection laws in your state or county? Many such laws include damage to gates, some do not. Even in those areas that do not, are there suitable "breaking and entering" laws? If the vandals have taken speleothems or animals out of the cave, local burglary laws and state or federal endangered species laws may apply. Know the criteria in determining the arrest and prosecution of trespassers. In becoming effective cave gate managers, such knowledge is very helpful. When catching vandals and trespassers in the act of breaching a cave gate, be prepared to have them arrested and prosecuted under applicable laws.

The gating of Fourteen Forty Cave in Wright County in 1995 by Ozark Highlands Grotto nears completion. David Binns uses a portable welder fueled by a portable generator (both located outside of the cave to prevent hazardous fumes from doing harm to the welder and cave lifeforms). The cave entrance is approximately 25 feet in front of the welder. An intermittent pool of water exists in the belly crawlway between the gate and the entrance to the cave, offering more deterrence to vandals.



David Binns peers into the cave from the newly painted entrance gate to Fourteen Forty Cave. This is an example of an open-grid gate made of l-inch iron pipe. The vertical posts are anchored in concrete footing to prevent trespassers from digging under the gate. The gate was installed to protect fragile speleothems and healthy populations of several species of salamanders.

Gate Placement

Thorough consideration should be given to the placement of the cave gate. Traditionally, people have placed cave gates at or very close to the dripline of the cave because it is the easiest location in which to work — during daylight hours no artificial lighting is required, no caving equipment is needed, vehicles carrying equipment and materials can often be driven close to the entrance — and because even the entrance zone needs protection. Gaters generally want to protect the entire cave from vandals, or keep people from being injured in the entrance as well as the rest of the cave. It is also easier to monitor a gate at the entrance than somewhere in the interior.

There are, however, at least three good reasons not to place a gate at or near the dripline.

First and foremost is that many animals, including colonies of endangered bats, may refuse to fly through the openings in a cave gate even when it is properly designed and made of ideal materials simply because it ***is*** at the entrance. The gate is intimidating to them because when bats fly into the cave, they are flying ***away*** from potential predators or bad weather. They may not want any impedance at the entrance to the cave.

The very same gate, when placed many feet inside the cave, in the total darkness zone (or at the very least, the twilight zone) may not be as intimidating to the same bats because they may sense that they are already in the safe confines of the cave. The second reason is one of aesthetics — a gated entrance

does affect the natural scenery around a cave entrance, both when looking into the cave and when looking out. It is also possible that an entrance gate will draw more attention to the cave than an interior gate.

The third reason is that interior gates are less likely to be dynamited, bulldozed or pulled out by a winch.

The major point made here is to place the gate as far into the cave as feasible. Considerations include the ease or difficulty of gating further inside the cave and how soon inside the entrance that protection must begin. Archaeological and paleontological sites, for instance, may actually begin outside the dripline; bat and other life forms and significant ecosystems may be located relatively close to the entrance; and speleothem sites may be close to the entrance.

If the areas needing protection are located deep inside the cave, locating the gates deep inside the cave should be considered, especially if only a section of the cave requires the protection of a gate. However, if heavy equipment is needed for gate construction, such as welding equipment, locating a gate deep inside the cave may be too difficult. Fumes produced by welding can be dangerous to both gaters and cave life. But deep cave gates can be built if alternative methods are used, such as bolting the pieces together and then subsequently scarring the threads of the bolts or minor spot welding the bolt to the nut to make bolts impossible to unthread. In many cases, this method is as effective as welding bars together. It is also sometimes possible to prefabricate the gate in a welding shop and then transport the gate to the site where it can be anchored with a concrete footing.

Other considerations for locating cave gates should be based on the passage size and shape. For time, effort and expense reasons, a gate site might be determined by locating a small passage constriction. In a large passage this may be impossible, but where there is an ideal constriction, it should be a prime site. Do not select, however, a constriction that is so small that it makes the gate construction difficult, and intimidating to bats, or one that allows excessive predation to occur (a "lair" for predatory snakes and varmints). Remember also that the smaller the constriction, the greater the gate will alter air flow.

In the six cave gating projects that I have participated in, only one gate was placed at the entrance. It was a vertical pit that had just formed by collapse with little or no ecosystem in place. As noted before, two 6- by 10-inch holes were made in the door and culvert gate, and two dozen bats use it! Experience has since taught me that the gate should have been placed at the *bottom* of the vertical culvert, not the top (more attractive to wildlife and more difficult to vandalize).

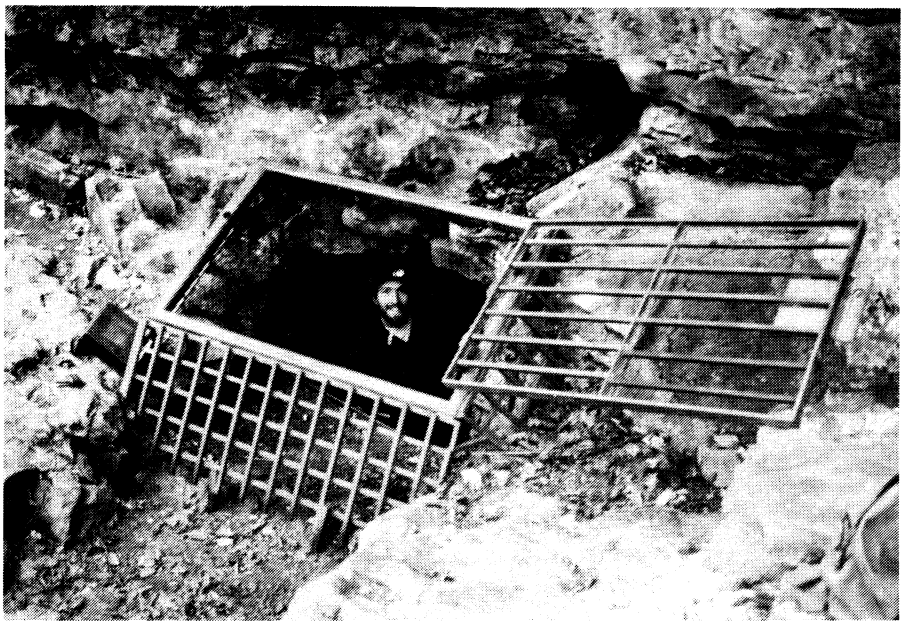
Gate Designs

If you were to travel around the world studying every gate now in use, you might be able to write a book the size of the Encyclopedia Britannica by just describing every gate design and variation. To do so here would not be practical so the following information covers only a few of the more common gate designs.

As indicated previously, you must know the cave you are gating, the potential impact a gate might have, and the shortcomings of your gating resources. If you intend to protect a bat colony, the gate design may differ from one built for a cave that does not house bats. However, a gate should be designed whenever possible to be "bat friendly." (A bat friendly gate will also be friendly to just about any other small critter that would use the cave.) A gate whose parts are adequately open and spaced to permit easy flight for bats as they pass through it is a gate that will be the least intimidating to the bats. If a bat friendly gate is not an option (if the cave has not housed bats recently or ever), or if the cave is a chronically severe vandalism site, then try to make the gate as impregnable as possible with the resources that you have.

Chain Gates

Chain gates are often used as deep cave gates when welding equipment and heavy materials are either too difficult or just plain impossible to transport to the site. The chain material is attached to the bedrock by a series of expansion bolts or equivalent and a lock is used as the common "link." Various designs can be used. One of the more common is the spider web where the segments of chain are gathered at the center where a lock is placed. The disadvantages to the chain gate include ease of damage by vandals (heavy duty bolt cutters can make illegal entry somewhat easy) and to be effective against human entry, it must be relatively bat-unfriendly.



The galvanized open-grid gate to the "Fitton" or "Dry" entrance to Fitton Cave, Arkansas. Its other entrance gate, constructed of the same material, is used by a wintering colony of endangered Indiana bats. That entrance is only available to cavers in the summer season. The cave was gated to limit traffic to this popular cave and to protect the bats.

Barrel Gates

Barrel gates can be used in passages that need to be more constricted than they are without added obstructions. By requiring a person to crawl inside the barrel to open the gate, the excessive leverage that would be needed to damage the gate is considerably reduced. This makes destruction more difficult and less likely.

On the end of the barrel facing inside the cave is the gate which can be a door, a sliding bar, or a chain gate. If the barrel is the only opening, serious consideration should be made that the gate wall around the barrel be designed to be bat-friendly. If the area surrounding the barrel is a section of bat-friendly gate, then the section of gate accessed from inside the barrel can be a solid door or some other "impregnable" design.

Some variations of the barrel gate include the "plug" gate, where a passage-plugging barrel is chained to an anchor. By crawling inside the barrel, reaching through a hole and unlocking the anchor chain, the barrel can be pulled out of the constriction, providing access to the passage. This type of gate, however, is only feasible in caves that do not house bat colonies. It may also inhibit natural air flow to a considerable degree.

Open-Grid Gates

Angle Iron Gates

Angle iron gates are becoming very popular as an effective bat-friendly design that also happens to be difficult for vandals to breach. Galvanized angle iron about 0.25 inches thick by 4-inches by 4-inches is a formidable obstacle to hacksaw, especially if 1-inch piping filled with sandy concrete has been welded to the inside of the angle of each piece used.

To be bat-friendly, the open spaces between the vertical angle iron posts should be no less than 24 inches (preferably more), and the open spaces between the horizontal angle iron pieces should be no less than 6 inches. The outside of the angle of each horizontal piece should face upward, making the design slightly less intimidating to bats entering the cave. Hinged doors should have hinges on the inside of the gate (thus making them more difficult to damage) with locks housed in boxes to make them less prone to vandalism.

Piping Gates

Piping gates are another popular gate design, basically the same as angle iron gates except that piping is used. This material is fairly easy and inexpensive to obtain, but is usually rust-prone, so it must be painted regularly to prevent rust.

The best piping material to obtain is galvanized, but then you run into expense. One- to two-inch diameter piping is most common, but by itself is not very difficult to breach with a hacksaw. When constructing the gate, there-

fore, each piece should be filled with sandy concrete before being welded in place. Traditional hacksaw blades are immediately ruined once they come in contact with the sand in the concrete! Many piping gate doors are very simple — one of the horizontal pieces is fitted into fixed collars welded to the inside of the gate, and when the lock (located in a protective box) is opened and removed, the pipe piece is pushed through its collars out of the way, providing a crawl space by which to enter the cave.

Rebar Gates

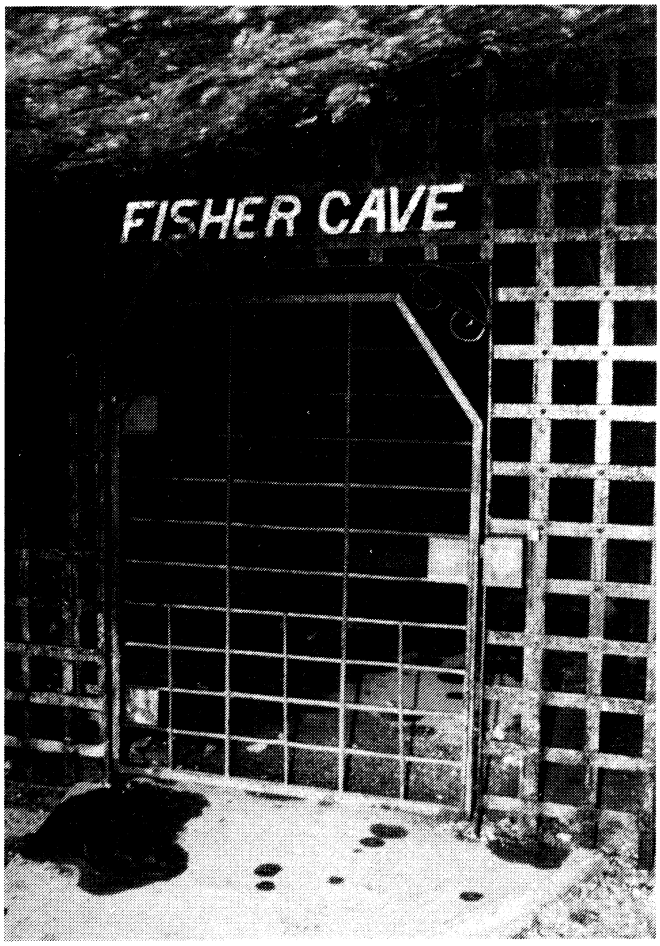
Rebar gates were once popular gates, but too often they are quickly breached by five minutes of hacksawing. Rebar gates are not recommended, even with heavy duty 0.75-inch diameter rebar. For not much more expense, piping material can be obtained that can be filled with sandy concrete and be much more difficult to vandalize.

Fill Gates

Cobble Gates

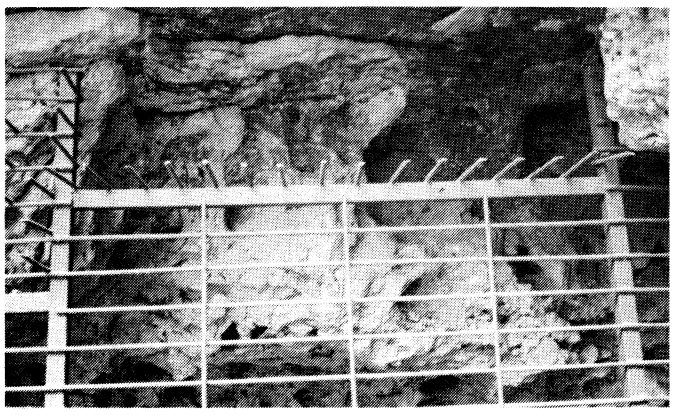
Cobble gates are a common design in popular caves, and although limited in scope, they can be very successful in protecting speleothem areas. If the rock cobble can be found, smaller entrances to passages can be "filled," thus "hiding" the passage opening from most potential vandals. This "gate" is unlocked by removing some of the cobble and then replacing the cobble after exiting. This works well when the passage is known to only a few individuals and the secret is well kept, but once the "word" leaks to one unscrupulous individual, the cobble gate becomes useless. In addition, the cobble gate is usually not rebuilt by the unscrupulous person upon discovery or subsequent visits.

Cobble gates are not bat-friendly or ecosystem-friendly constructions because they limit airflow and make it difficult or impossible for bats and larger organisms to travel through. Such gates should be used only when other entrances to that section of the cave are able to be used by biota and air, or in areas of the cave that have no detectable macro-biota. Some effort should be made to make this determination before a cobble gate is put into place.



Left: Historic Fisher Cave gate in Meramec State Park in Franklin County. Although used by male Gray bats, maternal females do not use it. To be more attractive to female Gray bats, the design of the gate should be more bat friendly and placed further back into the cave. Ironically, use by a maternity colony of bats could result in the closure of one of Missouri's oldest show-cave operations!

Below: The 2-foot by 8-foot "bat window" at the River Cave entrance gate in Camden County. Horizontal prongs of rebar deter trespassers from using this opening to gain illegal access to the cave. The gate protects a maternal Gray bat population.



Filling Cave Entrances

Entrance filling is the method of "gating" often used by the uninformed to keep people out. Simply stated, dozing or blasting shut a cave entrance may be an effective deterrent to cave trespass and vandalism, but it also seals the cave to air, water and biological movement. Such measures put the cave's ecosystem at risk unless there is a suitable second entrance. But even this may not provide a margin for survival of cave life forms that have a severely limited range of travel, a restricted habitat or insurmountable barriers to the second opening. Such alterations may impact the flow of groundwater and recharge of local aquifers if the opening is a substantial intake or outlet for water. Filling cave entrances also blocks all access to the cave by legitimate researchers and anyone who might, in the future, have an important need to examine the cave. This might be especially true if, at some future date, the cave presents problems for the use or development of surface areas above it, if the cave extends beneath the property of more than one land owner, or ownership of the cave property changes at a future date. It is a very poor way to manage a cave. This method of gating is ***not recommended.***

Plug Gates

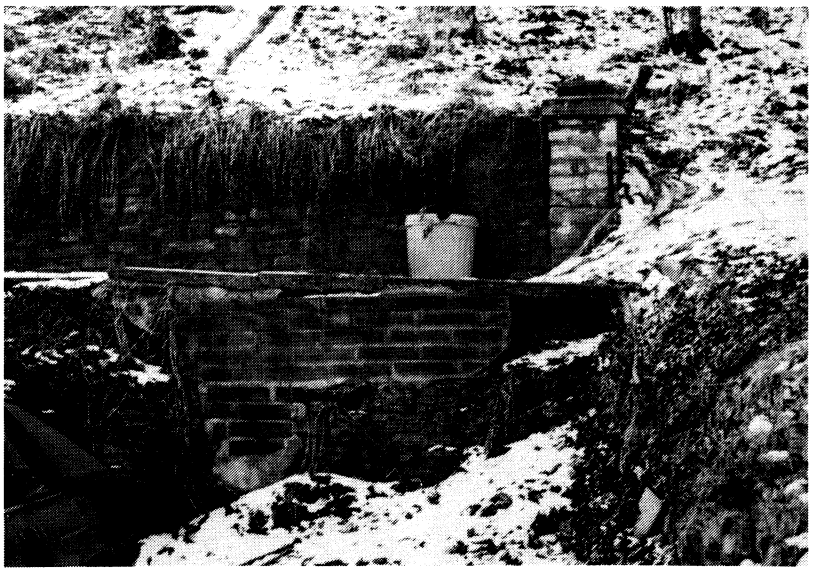
Plug gates are sometimes used to prevent air flow to a passage previously without an entrance, such as one whose entrance has been excavated. Here, mud or concrete can hide an entrance, and the re-excavation of the entrance can provide access, or some object such as a filled tire or other form-fitting object can be pulled out of the plug. The "Silent Splendor" section of Cave of the Winds in Colorado is such a design. A cave passage in eastern Europe is hidden in the floor of one passage. The mud plugging the opening is re-excavated upon each visit and then the opening is filled again upon exiting the cave.

Exterior Gating

Fencing is recommended only on the *outside* of cave entrances or in very large entrance passages. Its success depends on the popularity of the cave and how well the entrance is patrolled.

Galvanized chain link fencing with three angled rows of barbed wire above is the most commonly used fence design. To be bat friendly, the fence must be placed away from the dripline to allow plenty of free space for the bats to enter and exit the cave, or there must be adequate space between the ceiling of the cave and the top of the fence. Exterior fencing is used primarily to protect not only the cave but the area immediately outside of the cave, especially when archaeological or paleontological remains need protection. Outside fencing also works well in keeping livestock out of horizontal cave entrances and out of vertical entrance pits.

Fencing should be accomplished by digging a trench, when possible, and placing the vertical fence posts in a concrete footing. If soil is not present, drilling fence post holes in bedrock and placing the posts in them as they are filled with concrete also works. A concrete barrier footing should be



David Mahon

This brick wall and cement slab covers the main entrance to Murphy Cave in Marion County. In May of 1967, three boys were allegedly missing in the cave. During a search, not one shred of evidence of the boys was found, but the entrance was completely blocked to prevent anyone from getting lost or injured in the cave. This type of entrance, however, is potentially harmful to the cave ecosystem as it prevents the free flow of air, water or cave life.

placed under the entire length of the fence to prevent trespassers from digging under the fence. The ends of the fence should be anchored to the walls of the entrance or bluff face to prevent pulling the fence out from the wall.

A fence is the easiest type of gate to breach but it is also the easiest gate to repair and monitor. Fences do, however, draw attention to a cave that might otherwise go unnoticed. Fences require frequent monitoring.

Lock Systems

Once a gate has been designed, a locking system must be chosen. At Breakdown Cave in Christian County, Missouri, two removable locks and pins are used on opposing sides of the door. At Lon Odell Memorial Cave in Dade County, a lock with a fixed pin is used. At Fox Creek Cave (Douglas County), 1440 Cave, and Watterson Cave, both in Wright County, a sliding bar (through collars) with aligned lock holes to a welded plate is used. In all the examples, extra pieces of material have been welded to form protective boxes around the locks, all of which are located on the inside of the gates. These lock boxes protect the locks from damage from hammering, hacksawing and bolt cutting.

A lock may be chosen to be the "weak link" of the gate, that is, it is meant to be the easiest object to damage in order to gain illegal access to the cave. This requires the gate manager only to purchase another lock to again make the cave gate effective. Many gaters, however, do not want any weakness in their gate system or mechanism and do everything possible to protect the locking devices. This means welding lock boxes whenever feasible and using heavy-duty, rustproof locks.

Key Locks

Key locks are the most popular lock types because they can be readily placed on the *inside* of the gate and only people with a key can gain legal access to the cave. Copies of keys should be kept at a minimum to avoid illegal duplication and to simplify the tracking of each key. The designated manager (owner, tenant or caver) should have the original key. A "loaner" key should be used by whichever group has permission to enter. Many cavers believe that the managers should keep all sets of key(s) except when one is currently being used. In many cases, no visits to the cave are allowed except when accompanied by one of the cave's managers.

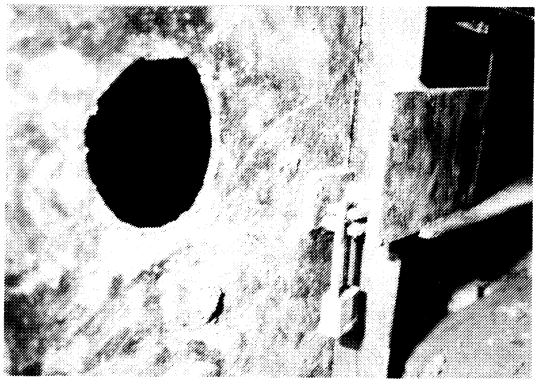
Combination locks

Combination locks are often used on gates where the lock is on the *outside* of the gate. Most of these locks have changeable combinations which are changed at regular intervals to prevent repeat unauthorized visits by past groups. The current combination should only be known to the managers and the current group of visitors. It is important to note that combination locks, housed in lock boxes, can be used on the inside of gates as long as the face numbers can be clearly viewed through a small mirror by the authorized visitor. The mirror should be one that can be easily and safely transported to the gate site. Small, nonbreakable mirrors are on the market. If the gate and lock design do not permit easy viewing from a mirror, then a combination lock should not be used inside the gate. It is recommended that exterior locks, except those designated as "weak links," be housed in lock boxes to deter vandalism.

Anchoring the Gate

A gate is only as good as its anchoring system. No matter how well protected and sturdy the lock may be, regardless of the strength of the gate material, if the gate isn't well anchored it's a mere pushover for the determined vandal. To be truly effective, a gate must be anchored into the floor (if not the bedrock, then a concrete footing) and the bedrock ceiling and both walls. Failure to anchor one side will create a weak link that may be all-too-easy for the vandal.

There are a number of ways to anchor a gate into bedrock surfaces. Two of the most



One of two opposing inside lock-and-pin sets of the gate to Breakdown Cave in Christian County. Even if vandals saw through the door hinges (located on the "in" side of the door), both left and right sides of the door remain locked in place!

The gate at Breakdown Cave in Christian County as seen from the "out" side. The door and frame were made from 1/4-inch iron plate by Don Rimbach and Earl Hancock. It was welded to a 400-lb. piece of railroad rail that was subsequently covered by a concrete foundation measuring 1.5 feet deep, 4.5 feet front-to-back and 9 feet from wall-to-wall. The hinges are located on the "in" side to deter hacksawing by vandals. The gate is located just beyond an entrance bellycrawl about 20 feet from the dripline.

common are drilling holes that are slightly larger than the diameter of bars or piping and inserting the gate material into the holes. Another common anchoring method is the use of expansion bolts that are welded to the gate material (bolts located on the "in" side of the gate material to prevent easy hacksawing or bolt cutting).

Installing "footing" in the sediment floor of the gate site is essential to prevent someone from digging under the gate. For a concrete footing, rebar should be used in a dug-out trench for reinforcement (this is my only recommended use of rebar in cave gates!) and the trench filled with concrete *after* the placement of gating material is complete, thus anchoring the vertical posts of the gate into the concrete footing. The trench and concrete footing should be installed wall-to-wall and as deep as necessary to prevent digging under the completed gate. The concrete footing of the Breakdown Cave gate is 18 inches deep (the trench was dug to bedrock), 4.5 feet from front-to-back, and 9 feet from wall-to-wall. Another style of footing is driving rust-proof stakes into the sediment, 6 inches apart, welded to the gate.

Door Styles

What kind of door should be placed in your gate? Some of the gating styles detailed above have involved door styles by default. But regardless of what kind of gate "wall" you're planning to build, the legal entry is an important consideration.

No Door

If your cave has more than one natural entrance, it may be wise to provide legal access to only one entrance. Thus, the other entrance(s) can be constructed with a design that allows only air, water and cave life to pass through the gate. "No door" gates are usually easier to maintain.

Solid Door

The use of a solid door is possible, but such a design restricts more air and water movement than, for instance, a door with an open grid design. This is especially true if the gate location is somewhat constricted already (remember, the smaller the passage, the larger the square-footage ratio between gate and open space at the gate site becomes). A solid door, however, may also be more of a difficulty for the vandal as it makes it more difficult (in many cases) to see the locking mechanism and more difficult to tamper with than an open grid door.

Open Grid Door

In this sense, one can include bars, piping and chain as material to make the "door." All are explained in the named gate styles section of this primer. If it is possible, this type of door should be used when the integrity of air, water and biological flow is important and the risk of vandalism is considered relatively low.

Maintaining Gate Integrity

Maintaining and monitoring a cave gate begins as soon as the gate is built. If the gate is not built of corrosion-resistant materials, then it must be sanded and painted at regular intervals, depending upon conditions. A cave gate in a constant temperature zone with a low humidity requires less maintenance that a gate that sees extreme temperature and humidity variations. Iron can rust quickly if the conditions are right, so the gate must be checked frequently and repainted as needed. The better you maintain the gate, the longer it will serve your interests.

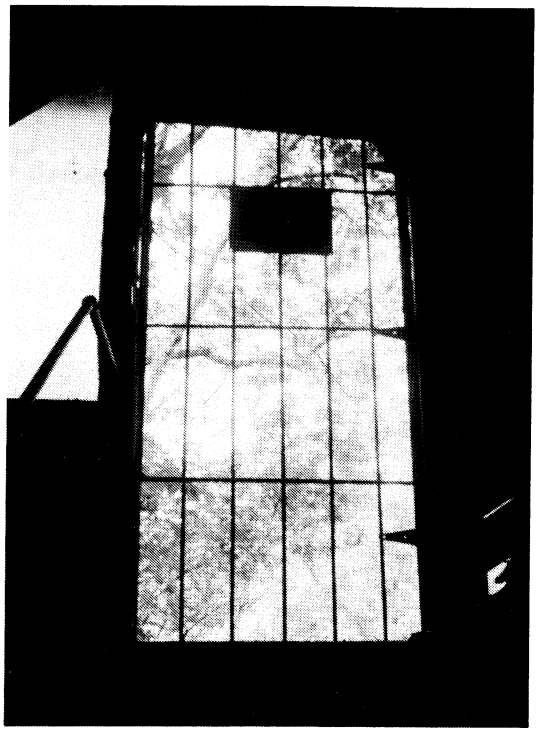
After first gating the cave, sanding and painting should be done before the metal has a chance to rust. The more a gate rusts, the less structurally sound it is and the shorter its life span. Following these chores, frequent monitoring should be conducted to (1) check the frequency of attempted vandalism, and (2) check the need for maintenance.

Most vandalism occurs within the first couple of years after the gate has been installed, especially if the cave was popular before it was gated. It may be necessary to erect a sign inside the gate explaining why the cave was gated and a telephone number for further information.

The gate material should be checked for corrosion and other weaknesses and the moving parts (such as door hinges and lock mechanisms) should be regularly oiled or greased to prevent their becoming "frozen by corrosion." You don't want a gate door or lock to be so rusted that legal entry is impossible.

Although sanding gate material can be accomplished with sandpaper and "elbow grease," cordless drills and sanders with appropriate attachments can save you a lot of unnecessary labor. Be sure to sand all rust from the metal. Painting over rust is a waste of time because paint will not adhere to metal if there is a barrier of rust. This void will enable water and air to travel to the metal, resulting in additional corrosion.

Paint should be "Rustoleum" or some equivalent that provides many months or years of dependable rust protection. I advise against the use of spray paint to paint gates. Spray paint releases a mist of paint that will enter your nose, mouth and ears (ordinary dust masks ***do not*** block out such mists). Also, these mists will be airborne and travel to nearby parts of the cave and find their way onto rock surfaces surrounding the gate. By brushing the paint on, mists are avoided and except for an occasional drip or incidental brushing against a rock surface, the paint stays within the framework of the gate. Even solvent vapors from your



The man-made "exit" opening of Cave Spring Onyx Caverns, located some 30 feet higher and 200 feet east of the natural entrance. Its rebar design is not bat friendly and easy to breach with a hacksaw. Its existence and location enabled the show cave section to dry out, which has destroyed the luster of many of its speleothems and allowed frost-wedging to damage many more.

The cave gate at the original commercial entrance to Onondaga Cave in Crawford County. Most of the entrance has been walled off to prevent illegal entry except for the "bat friendly" open-grid gate. The new entrance to this popular show cave is housed in the new visitor center and does not enable bats to use that entrance. Therefore, the open-grid gate at this entrance was built so that populations of bats and other life forms could still use the cave.

brushable paint, however, will escape. Painting should be attempted on the gate only when airflow is good and directed to the outside of the cave to prevent voluminous quantities of vapors from entering the fragile cave ecosystem or your own lungs!

Oiling or greasing moving parts should be done as often as needed. The caretakers of Breakdown Cave oil the locks, pins and door hinges on each visit to the cave. Visits normally average once or twice a month to ensure their proper working order. Axle grease can be used on exposed door hinges; "3-in-1" oil is good for all-around rust protection of locks. "Liquid Wrench" is always something handy to have in case a little corrosion has occurred that has made the lock or other moving parts difficult to operate.

Gate Signs

In most cases, there should be a sign posted *inside* the gate (safely away from the reach of vandals) explaining why the cave has been gated. Examples include such simple statements as "to protect the cave from further vandalism," "to protect fragile endangered species habitat," etc. Most people are understanding and will honor the gating intentions when they are explained to them. Only the worst of vandals do not pay heed to signs. If appropriate, you should include the name of the cave and an address or phone number of someone to contact on the sign if it is desirable to show them the cave by appointment. Sometimes this is how novice spelunkers are introduced to organized cavers. The Ozark Highlands Grotto, caretakers of Breakdown Cave in Christian County, have been contacted in this way, and some of the grotto's members were introduced to the organization through this contact.

The sign should be constructed of corrosion-resistant material such as aluminum or heavy-duty plastic, and should have either a protective canopy or be tilted slightly forward to prevent drippage from coating the sign with calcite. Sign companies can make good signs at a cost that most gaters may find affordable, but a strong aluminum sheet (or equivalent) can be painted

(neatly) and placed at little or no cost to do-it-yourselfers, so long as it is maintained (cleaned, painted, etc.)

Conclusion

No discussion on the subject of cave gating can be complete. New gating ideas, new gating technologies, as well as the variety of gating situations make any discussion incomplete. It is hoped, however, that the subject has been covered in such a way as to motivate potential gaters, landowners and cave managers into considering the subject and perhaps shed light on some of the considerations regarding how, where, and when to build cave gates. To those readers who enjoy crawling underground, it is hoped that this discussion has provided some explanation why more and more caves are being gated. Most of these caves are still open to some kind of controlled, legal visitation by contacting the cave caretaker(s). They may be the private land owners, managers of the land, other cavers, or federal, state, county or municipal authorities.

If you have some alternative gating methods or ideas, or have opposing views, your comments and suggestions are welcome. After all, when all has been said and done, we want to know that our efforts have resulted in the best cave protection methods at the least cost.

BREAKDOWN CAVE
CHR-153

This cave has been gated to prevent further vandalism.

You are welcome to visit this cave by contacting the caretaker, JON at 555-7231.

Visits are made by appointment only.

Trespassers caught will be prosecuted!

The sign at Breakdown Cave in Christian County.

Contact: Jonathan Beard, 923 Guinevere, Springfield, MO 65807.

Partial List of Gated Ozark Caves

Note: Only "main" or natural entrance is described.
MDC - Missouri Department of Conservation
DNR - Department of Natural Resources
USFS - United States Forest Service
NPS - National Park Service
NC - The Nature Conservancy

Arkansas

Commercial	Name	County	Owner	Type	Material	Location	Lock
	Alexander Cave	Stone	Private				
C	Blanchard Springs Caverns	Stone	USFS	Grid	Bar	Entrance	
	Boxley Bat Cave	Newton	NPS	Fence	Bar	Sink	
C	Bull Shoals Caverns	Marion	Private				
C	Civil War Cave	Benton	Private				
C	Cosmic Caverns	Carroll	Private				
C	Crystal Dome Cavern	Boone	Private				
C	Diamond Cave	Newton	Private	Wall	Door	Entrance	
	Fitton Cave	Newton	NPS	Grid	Bar	Entrance	Combination/external
C	Hurricane River Cave	Searcy	Private				
	John Eddings Cave	Newton	NPS	Grid			
	Little Bear Cave	Newton	Private	Wall	Door	Entrance	
C	Mystic Cavern	Boone	Private				
C	Onyx Caverns	Carroll	Private				
C	Spanish Treasure Cave	Benton	Private				
C	War Eagle Cavern	Benton	Private				

Illinois

	Illinois Caverns	Monroe	IDC				

Kansas

	Schermerhorn Park Cave	Cherokee	City	Grid	Angle iron	35 ft.	Key/internal

Oklahoma

	Christian School Study Cave	Delaware	Private	Grid			
	January/Stansbery Cave	Delaware	NC	Grid			
	Twin Cave	Delaware	NC				

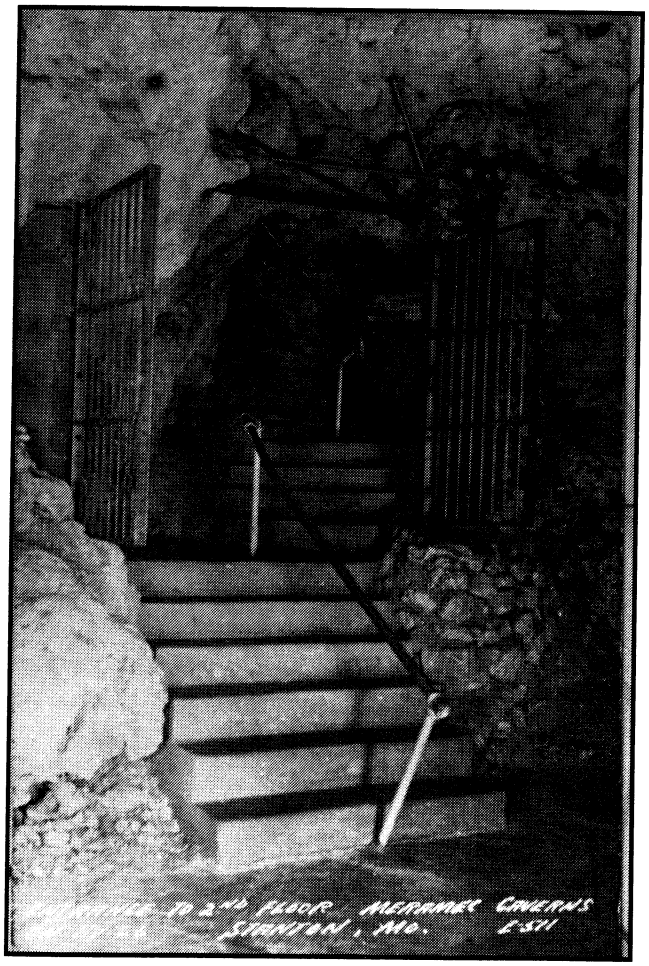
Missouri

Commercial	Name	County	Owner	Type	Material	Location	Lock
	Berome Moore Cave	Perry	Private	Barrel	Steel	Entrance	Key
C	Bluff Dwellers Cave	McDonald	Private				
	Branson Cave	Shannon	NPS				
	Breakdown Cave	Christian	Private	Grid	Bar	20 ft.	Keys/internal
C	Bridal Cave	Camden	Private	Grid	Bar/door	Entrance	
C	Cameron Cave	Marion	Private				
	Carroll Cave	Camden	Private	Grid			
	Cathedral Cave	Crawford	DNR				
C	Cave Springs Onyx Caverns	Carter	Private	Grid	Rebar	10 ft.	Key/external
	Crevice Cave	Perry	Private	Grid	Piping	Entrance	
C	Crystal Cave	Greene	Private	Door	Wood	Entrance	Key/external
C	Crystal Caverns	Barry	Private				
	Doling City Park Cave	Greene	City	Grid	Rebar	30 ft.	Key/chain
	Erie Sink Cave	Greene	City	Grid	Rebar	Entrance	
C	Fantastic Caverns	Greene	Private	Wall	Sheet metal	30 ft.	Combination/external
C	Fantasy World Caverns	Miller	Private	Wall	Door	Entrance	
C	Fisher Cave	Franklin	DNR	Grid	Bar	30 ft.	Key/internal
	Fourteen Forty Cave	Wright	Private	Grid	Piping	20 ft.	Key/internal
	Fox Creek Cave	Douglas	Private	Grid	Piping	10 ft.	Key/internal
	Graham Cave	Montgomery	DNR	Fence	Chain link	Entrance	
	Great Spirit Cave	Pulaski	MDC	Fence	Chain link		Key/external
C	Honey Branch Cave	Douglas	Private	Grid			
	Indian Creek Cavern	Stone	Private				
	Island Cave	Camden	DNR	Grid	Rebar	Entrance	Key/external
C	Jacobs Cave	Morgan	Private				
C	Little Honey Branch Cave	Douglas	Private	Wall	Sheet metal	10 ft.	
	Lon Odell Memorial Cave	Dade	Private	Culvert	Galv. steel	Entrance	Key/internal
	Lone Hill Onyx Cave	Franklin	MDC				
C	Mark Twain Cave	Marion	Private				
C	Marvel Cave	Stone	Private	Fence			
C	Meramec Caverns	Franklin	Private	Door		Entrance	Key
	Mushroom Cave	Franklin	DNR	Grid	Angle iron	Entrance	
	Mystery Cave	Perry	Private				
C	Onondaga Cave	Crawford	DNR				
	Onyx Cave	Crawford	DNR				
C	Onyx Mountain Cavern	Pulaski	Private	Wall	Wood	Entrance	
C	Ozark Caverns	Camden	DNR	Grid	Bar	50+ ft.	Key
C	Ozark Wonder Cave	McDonald	Private	Wall	Door	Entrance	Key/external
	Powder Mill Creek Cave	Shannon	MDC	Grid	Bar	50 ft.	
C	Rebei Cave	Wayne	Private				
	Rice Cave	Jefferson	Private				
	Rimstone River Cave	Perry	Private				
	River Cave	Camden	DNR	Grid	Rebar	10 ft.	Key/internal
	Roark Valley Cave	Stone	City	Grid	Angle iron	Entrance	Key/external
C	Round Spring Caverns	Shannon	NPS				
	Skaggs Cave	Pulaski	MCKC	Grid	Rebar	30 ft.	Combination/external
	Smallin Cave	Christian	Private	Grid	Rebar	700 ft.	
	Smittle Cave	Wright	MDC	Fence	Chain link	20 ft.	
C	Talking Rocks Cavern	Stone	Private				
C	Truitts Cave	McDonald	Private				
	Tumbling Creek Cave	Taney	Private				
	Turnback Cave	Lawrence	MDC	Grid	Angle iron	Entrance	Key/external
	Turner Spring Cave	Oregon					
	Watterson Cave	Wright	Private	Grid	Piping	Entrance	Key/internal
	Welch Spring Cave	Shannon	NPS	Grid			

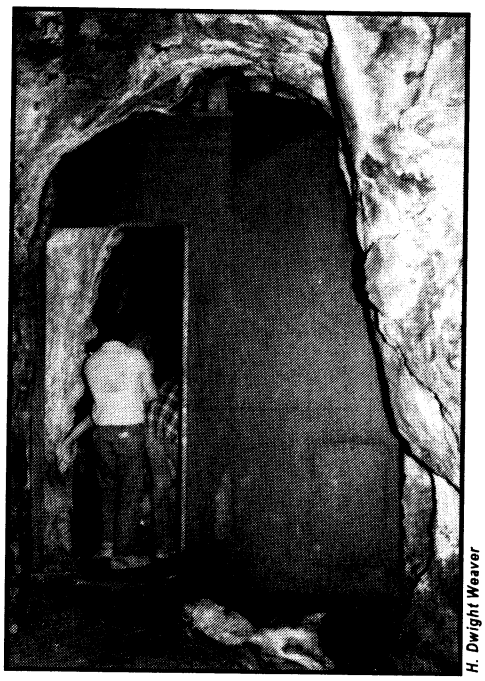
Gates of Yore

H. Dwight Weaver

Ozark Caverns (Camden County) entrance barrier, 1965. This balustrade of half timbers was constructed in 1951 when the cave was opened to the public. In 1956 a building was constructed in front of the entrance but not up against it. By 1964 the timbers shown here were in bad condition and the door had rotted from its hinges. The balustrade was removed in 1965. The cave was purchased by the state in the late 1970s and the building in front of the cave removed. Today, a "bat friendly" metal gate spans the passage a few feet beyond where this balustrade of wood once stood. The young lady in the photo is Karen Weaver, age five.



Left: Gate protecting the upper levels of Meramec Caverns (Franklin county), circa 1940s. Meramec Caverns has five levels. The upper three levels of the show cave are the most scenic. This set of metal doors and the staircase were removed at a later date and the passage enlarged to accommodate larger tours. Ramps replaced the stairs. *(From the postcard collection of H. Dwight Weaver.)*



H. Dwight Weaver

Entrance barrier inside the entrance to Round Spring Caverns (Shannon County), 1976. The wooden structure had several small openings at the top to permit air flow and bat movement. Water could also escape from beneath it.

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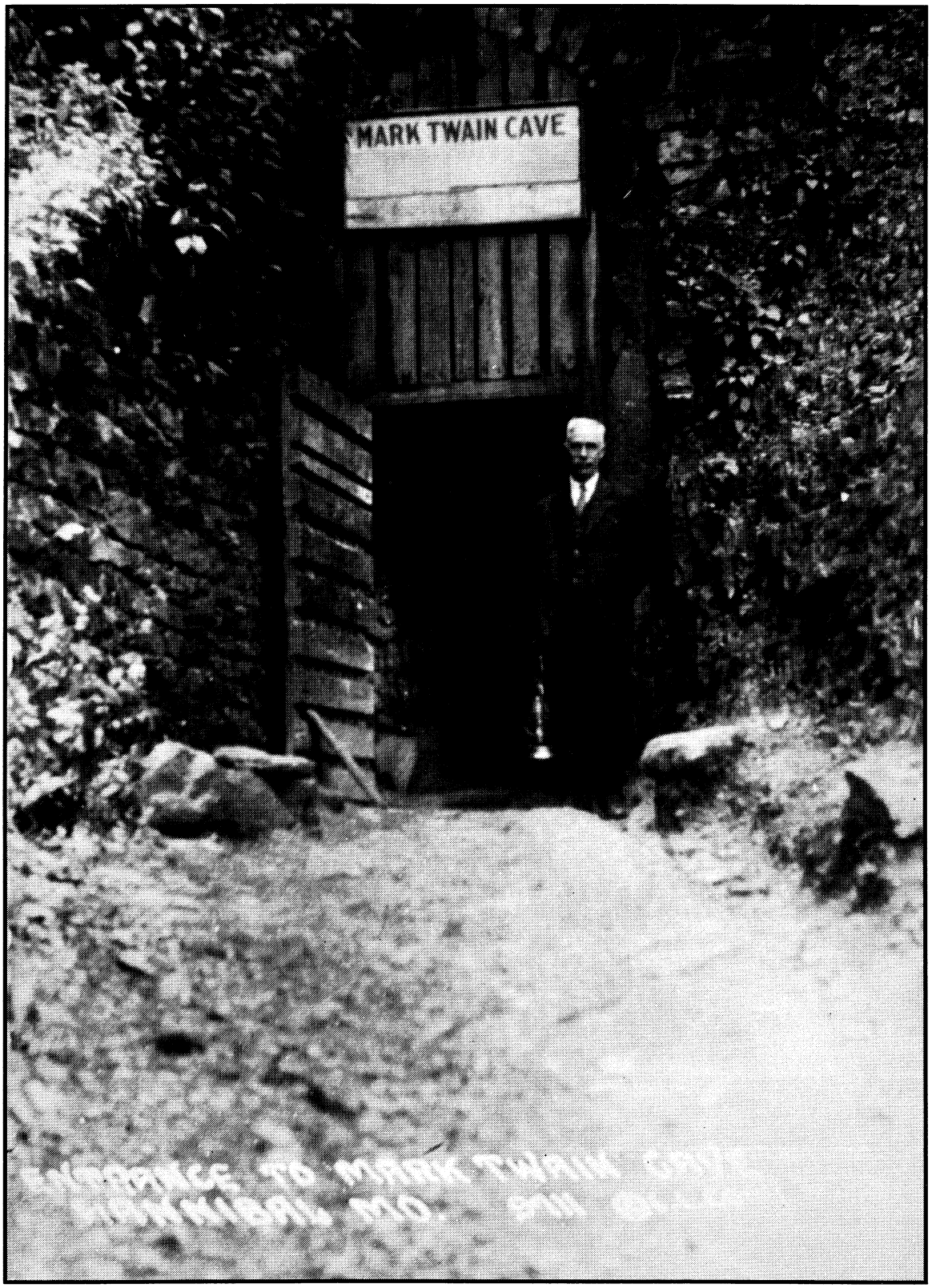
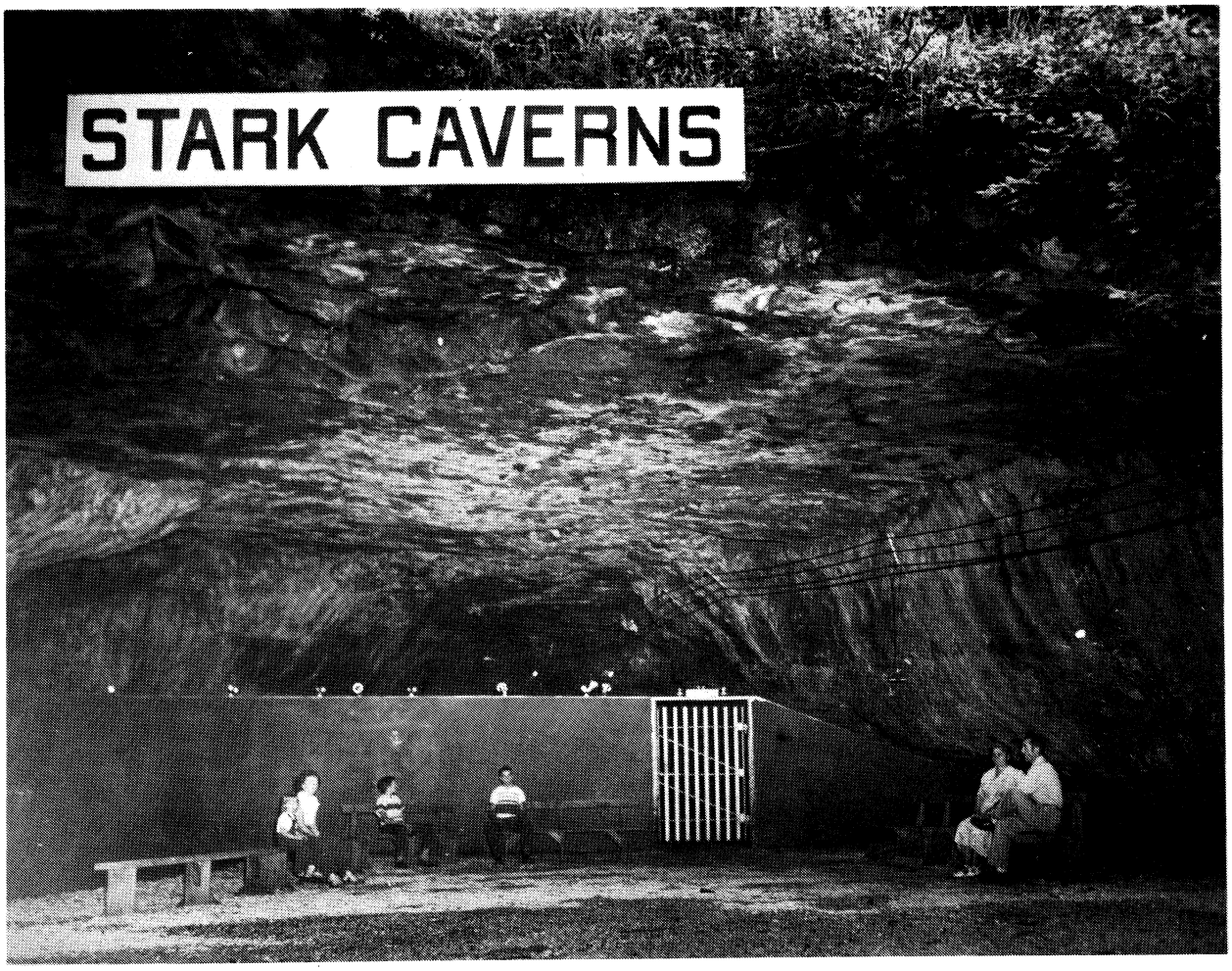


Missouri Caves & Karst Conservancy



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