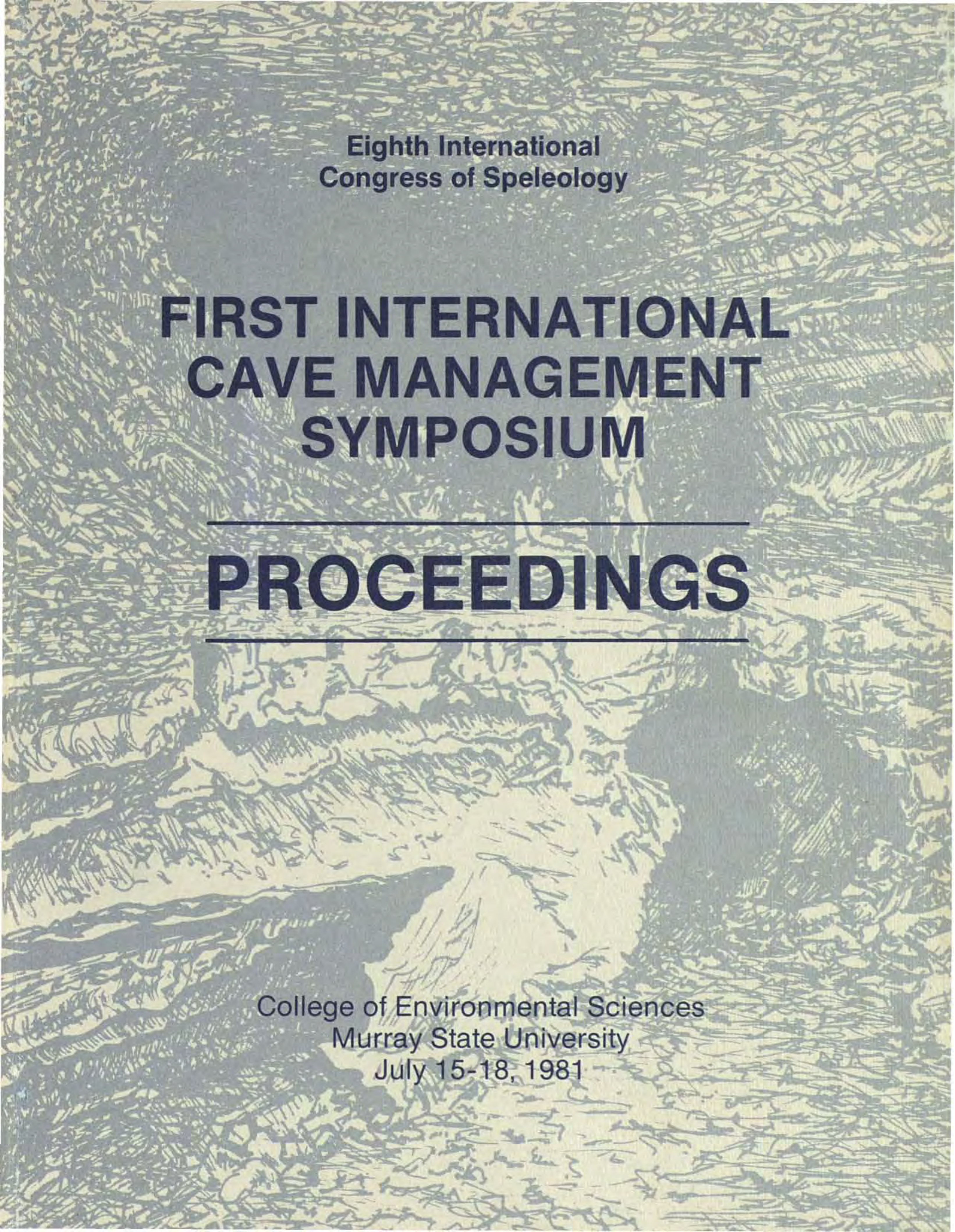

Eighth International
Congress of Speleology

FIRST INTERNATIONAL CAVE MANAGEMENT SYMPOSIUM

PROCEEDINGS

College of Environmental Sciences
Murray State University
July 15-18, 1981

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JOHN E. MYLROIE
EDITOR

Murray State University
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Cover drawing by
M. Elaine Lee
from a photograph by
Arthur N. Palmer

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The First International Cave Management Symposium could not have been held if it were not for the efforts of my colleagues on the Steering Committee of the Eighth International Congress of Speleology, who worked to put the entire international program together. Patricia Fink and the Tennessee Valley Authority assisted in the planning and logistics of the Symposium. In addition, the faculty, staff and students of Murray State University provided the skills and resources to allow the Symposium to be held on their campus in July, 1981. Special thanks in this regard must go to Phil Deaver, Director of the Continuing Education Office, Gary Boggess, Dean of the College of Environmental Sciences, Gena Wilson, Secretary of the Department of Geosciences, and Kay Cravens and Becky Latson, students.

The production of the Proceedings of the First International Cave Management Symposium was made possible by the Committee on Institutional Studies and Research grant number 776, which provided the support for the collection and editing of the data herein, and the College of Environmental Sciences, Gary Boggess, Dean, which provided the support for the printing of the document. The preparation of the manuscript was done by Gena Wilson, Secretary of the Department of Geosciences. Layout and drafting of the final draft was assisted by the diligent efforts of Brian Ashley, Becky Latson, Randy Pearson, Bruce Phillips, and James Van Dyke, students in the Geosciences Program.

A deep sense of appreciation exists for the people who helped sponsor the Symposium, and then worked selflessly to see that the efforts of that Symposium are preserved in this document.

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INTRODUCTION

John Mylroie

The First International Cave Management Symposium was held at Murray State University, Murray, Kentucky from July 15 to July 17, 1981. Forty-nine people from twelve countries on six continents participated in the Symposium, producing a true international perspective on cave management. A total of twenty-two presentations and one panel discussion provided a means of formal information exchange, while extensive informal activities were scheduled to allow a relaxed atmosphere for trading ideas and experiences. Of the twenty-two presentations, eleven have been gathered here as papers. A further seven papers are being reproduced from the Conservation/Management Session of the 8th International Speleological Congress, held on July 19, 1981. By combining the symposium and session papers in one volume, the international cave management effort relating to the 8th Congress can be unified.

In addition to the manuscripts from the symposium and the session, the symposium program with abstracts is included as a chapter to help complete the picture. A list of attendees and their addresses is included as a chapter as well. The final chapter contains the agenda of the inaugural meeting of the Cave Invertebrates Specialist Group (CISG), held at Murray State University on July 13 to 15, 1981. The CISG is a division of the Species Survival Commission of the International Union for the Conservation of Nature and Natural Resources. Further information concerning the CISG can be obtained from Dr. Frank Howarth, B.P. Bishop Museum, P.O. Box 19000-A, Honolulu, HI 96819.

The idea of an International Cave Management Symposium was first raised at the National Cave Management Symposium in Carlsbad, New Mexico in October, 1978. After discussions, Murray State University was selected as the site, and preparations began. The goal of the International Symposium was similar to that of the National Symposium (see also Rob Stitt's opening address "History of Cave Management Symposia in the United States of America: an Overview" in this volume), to gather together people with cave management interests from the commercial, government, conservationist, industrial and sport arenas to share concerns, outlooks, ideas and methods. The added attraction of the International Symposium was the chance to exchange information between countries as well as the various cave management interests. Reflecting back on both the International Symposium and the 8th Congress, it seems that people the world over share the same worries and views on cave management as Americans do. Much more heartening, however, was learning of their successes and their methods, which may lead to better cave management in North America. Hopefully, some American ideas will prove helpful to those from overseas. The end result of all of this appears to be that the caves of the world will be better off, at least a bit anyway, because of this meeting of people. If nothing else, the fellowship of diverse people drawn together over their common interest in caves will promote understanding among nations as well as the preservation of caves.

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HISTORY OF CAVE MANAGEMENT SYMPOSIA IN THE UNITED STATES OF AMERICA -- AN OVERVIEW

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ABSTRACT

The term "cave management" in the United States of America includes the management of all caves, including wild caves and show caves by a variety of managers: cavers, private landowners, government agencies on both the Federal and State levels; for a variety of purposes, including preservation, recreation, tourism, and industrial uses.

Cave management in the U.S.A. undoubtedly began in the last century as private cave owners began exhibiting them to the public, but it was not until the middle of the twentieth century that cavers--active users of caves--and cave owners, primarily in the various state and federal agencies managing land containing caves, began to carry on a serious dialogue about cave management.

This dialogue led to the first National Cave Management Symposium in Albuquerque, New Mexico in the fall of 1975. The approximately one hundred attendees produced the first of many volumes of symposium proceedings and began a series which has culminated in this International Cave Management Symposium. Since Albuquerque in 1975, national symposia have been held in Mountain View, Arkansas in 1976, Big Sky, Montana in 1977, Carlsbad, New Mexico in 1978, and Mammoth Cave, Kentucky in 1980. In 1979, many regional symposia were held, and this tradition carried on into 1980 and 1981.

Formal cave management in the United States probably began with the opening of the first commercial caves in the early part of the Nineteenth Century. The establishment of cave National Parks and Monuments in the early Twentieth Century led to the assumption of cave management techniques by agencies of the Federal Government, as well as some state and local governmental bodies. By the time of the advent of organized speleology in the U.S. (in the 1940's), however, there was little communication among the various agencies, corporations, and individuals managing caves. Each group managed caves for their own goals and purposes, and there was a general lack of information transfer and coordination. Although a sizable body of information on speleology began to appear in the literature, there were few written materials dealing with the subject of cave management per se.

Members of the National Speleological Society became interested in the problems of cave conservation (as opposed to strict preservation) in the early 1950's, and began working with landowners and agencies to further their goals of wise use. By the late 1960's cavers had discovered that if they did the work, and actively involved

themselves in cave management, that they could have a significant influence on the cave management policies of various Federal agencies, especially on the local level. New Mexico cavers, in particular, began working with local officials in the Bureau of Land Management (BLM), National Park Service (NPS), and Forest Service (USFS) to actively manage caves in Southeastern New Mexico. It soon became clear to many cavers that there was a need for communication among cavers and agencies engaged in cave management.

I believe that the idea for a cave management symposium began when a group of New Mexico cavers, of whom I was one, pondered the question of how to encourage communication among cave managers over a few beers in Bill Bishop's living room in Albuquerque in the fall of 1973. How, we asked, could we get various cave managers talking to one another, as well as to us? The answer seemed to be: get them together in the same room to discuss the problems of cave management and share their solutions with one another. A Symposium! Mammoth Cave seemed like a good place to have one--or perhaps Carlsbad?

I was in the process of moving to New York. To my surprise, several months later I received a phone call from Don Sawyer of the BLM's Roswell District--at the time probably the Federal employee most concerned with cave management. Don reported to me that his agency, with active support from the state office, was preparing to set up a cave management symposium for the fall of 1975. Would I be willing to help out? During the ensuing months we burned up the phone lines for many hours. Don unfortunately had to retire due to medical problems before the symposium actually occured, but other BLM people carried on, and in concert with representatives from other federal agencies in New Mexico, cavers, and commercial cave owners, finally in October of 1975 produced the first symposium in Albuquerque.

Sponsored by the National Speleological Society, the Cave Research Foundation, the Bureau of Land Management, the U.S. Forest Service, the National Park Service, and the National Caves Associaton, the Albuquerque Symposium concentrated on providing to about 100 participants a basic overview of cave science and management methods. The program was broken up into the categories of Cave Resources; Resouce Management; Visitor Management; Safety & Rescue; Cave Management Aids; and Objectives, Policies and Plans of Agencies. The proceedings, published by Speleobooks, provided a general overview of the field and became a basic reference source on cave management.

Participants in the Albuquerque Symposium felt strongly that another symposium should be held in the following year, and an invitation was extended from the USFS management of Blanchard Springs Caverns in Arkansas to hold the 1976 Symposium near there. So it was that we gathered again in the fall of that year at nearby Mountain View for what was turning out to be the second annual symposium. Based on suggestions from Albuquerque participants, the program here concentrated on cave management approaches and techniques in four areas: carrying capacity of caves; cave inventory, valuation, and assessment; subsurface management as a component of general land management in soluble rock landscapes; and the management of commercial and high value caves.

The third annual symposium, held at Big Sky, Montana in October 1977, concentrated on the development of

cave management tools and techniques--a how-to session, as it were. Particular emphasis was given to the management of non-limestone caves: lava tubes, ice caves, and glacier caves.

The 1978 Symposium held at Carlsbad, New Mexico, became a practice session. After discussing various aspects of inventory taking, the participants went to the field and actually inventoried caves. At that symposium, it was decided to skip 1979 for a national symposium, and instead to encourage regional symposia aimed at more in-depth analysis of local problems. At least three of those (Western, Rocky Mountain, and Eastern) were held during the fall-winter-spring of 1979-80. The 1980 National Symposium was a precursor of this 1981 International Symposium at Murray, Kentucky held in conjunction with the International Congress of Speleology at Bowling Green, Kentucky.

The cave management symposia have proved their value in several ways. They have provided a forum for cave managers to meet and discuss their mutual problems. They have enabled the publication, in concise form, of a large body of works on cave management. They have encouraged an ongoing interest in cave management on the part of a large number of land managers, cavers, and cave owners. There are some significnt improvements that should be made, however. In particular, the participation of private landowners and commercial cave operators should be encouraged more. More prompt publication of proceedings would put information into the user's hands sooner. The participation of the academic community should be encouraged to a greater degree.

Because agency personnel working with caves seem to change frequently, there will continue to be a need for education and information exchange. There are pressing problems of cave management which remain. These factors should lead to a long series of successful symposia in the future.

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Papers Presented at the First International
Cave Management Symposium, July 15-17, 1981,
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CAVE MANAGEMENT FOR THE ENDANGERED INDIANA BAT (MYOTIS SODALIS) AND GRAY BAT (MYOTIS GRISESCENS)

JOHN T. BRADY

Team Leader, Indiana/Gray Bat Recovery Team
St. Louis District, Corps of Engineers

INTRODUCTION

The Indiana bat and gray bat both have been designated as endangered species by the U.S. Fish and Wildlife Service, and are protected under the Endangered Species Act of 1973, as amended (U.S. Fish and Wildlife Service, 1978). The Indiana/Gray Bat Recovery Team was appointed by the U.S. Fish and Wildlife Service to prepare a recovery plan for the gray bat and revise the recovery plan that was prepared for the Indiana Bat in 1976 (Engel, et al., 1976).

Distribution

The Indiana bat is found in the midwestern and eastern United States, from extreme northern Florida north to Vermont, Michigan, Wisconsin, west to Iowa, Arkansas and eastern Oklahoma. The winter range is primarily in Missouri, Indiana, Kentucky, and Tennessee.

Gray bat populations are found mainly in Alabama, northern Arkansas, Kentucky, Missouri and Tennessee, but a few occur in northwestern Florida, western Georgia, southeastern Kansas, southernmost Indiana, southern and southwestern Illinois, northeastern Oklahoma, northeastern Mississippi, western Virginia and possibly western North Carolina (Hall, 1981; Tuttle, 1979).

Habitat Requirements

1. Indiana Bat. Depending on local weather conditions, Indiana bats are in hibernation from October to April with some arriving at the hibernacula as soon as early September (LaVal, et al., 1977). Indiana bats have specific requirements for hibernation, generally choosing roost sites within caves or mines which have stable temperatures of 4 to 8 C allowing the bats to maintain a low metabolism and conserve fat reserves until spring (Humphrey, 1978). The bats usually hibernate in large, dense clusters of about 300 bats per square foot (Hall, 1962; Engel, et al., 1976; Clawson, et al., 1980).

Current studies indicate that females form nursery colonies mostly in riparian and flood plain areas of small to medium sized streams (Humphrey; et al., 1977; Cope, et al., 1978; Sparling, et al., 1979; Gardner and Gardner, 1980). Riparian habitat was found to be occupied from mid-May until mid-September (Humphrey, et al., 1977).

2. Gray Bat. The gray bat is, perhaps, the most restricted to cave habitats of any U.S. mammal (Hall and Wilson, 1966; Barbour and Davis, 1969; Tuttle, 1976a). With rare exceptions (Hays and Bingham, 1964), it roosts in caves year-round.

Because of highly specific roost and habitat requirements, fewer than 5 percent of available caves are suitable for occupation by gray bats (Tuttle, 1979). Colonies move seasonally between unusually warm (14-25 C) and cold (6-11 C) caves. (See Figure 1.)

Most winter caves are deep and vertical; all provide a large volume below the lowest entrance and act as cold air traps. A much wider variety of cave types are used during spring and fall transient periods. In summer maternity colonies prefer caves that act as warm air traps or that provide restricted rooms or domed ceilings that are capable of trapping the combined body heat from thousands of clustered individuals (Tuttle, 1975; Tuttle and Stevenson, 1978). At all seasons, males and yearling females seem less restrictred to specific caves and roost types (Tuttle, 1976a).

Summer caves, especially those used by maternity colonies, are nearly always located within a kilometer of rivers or reservoirs (rarely more than 4 km) over which the bats feed (Tuttle, 1976b).

Reasons for Decline

Human disturbance is the most serious cause of population decline for both species. Hibernating Indiana and gray bats are vulnerable and can loose as much as 10 to 30 days of fat supply per disturbance (Tuttle, pers. comm.). Gray bats are also vulnerable in maternity caves when flightless young are on roosts and thousands may die from a single disturbance. Most human disturbance is the result of people who don't know any better, but there are also cases of deliberate vandalism against both species.

Other reasons for population declines are flooding, ceiling collapse, especially in abandoned mines, careless handling of bats by biologists, commercialization of caves, exclusion of bats by poorly designed gates, changes in cave microclimate by opening of additional entrances or blocking air flow by poorly designed gates, flooding of caves by reservoirs, clearing of forests, and pesticide poisoning.

Cave Management

Signs, fences, and gates may be required to reduce or eliminate human disturbance at Indiana and gray bat caves. Generally, Indiana bat hibernacula should be closed to human entry between 1 September and 30 April. Figure 1 shows when the different types of gray bat caves should be closed.

1. Signs. At a cave which is infrequently visited, or easily observed by its owner, a sign alone may be adequate to prevent disturbance. Under certain circumstances, a sign might call unnecessary attention to a cave, in which case the management agency might opt for placement of the sign inside the cave. Signs must be of durable construction and fixed solidly in place to minimize vandalism, and should not be placed where bat movement or air flow might be impeded. They must be located where potential violators can see them, and should be placed just behind the gate or fence if such a structure has been erected.

Wording will vary from cave to cave, depending on the history of use of the cave by both bats and people. If law enforcement officials are to have a strong case against violators, the sign must contain a warning message similar to that of the upper half of the sign shown in Figures 2 and 3. All signs should include interpretive messages, as exemplified by the one

shown on the lower half of the sign in Figures 2 and 3. The sign in Figure 2 is used at gray bat summer caves in Missouri, and is especially suitable for maternity caves; Figure 3 is used at Indiana bat hibernacula. The interpretive message has been modified for certain other types of gray bat caves as follows: (1) for gray bat hibernacula - "The gray bat, an endangered species that hibernates in this cave, must survive the winter on stored fat. When disturbed, they arouse, using up this fat. Bats that have been aroused two or three times may die before insects on which they feed are again available in spring." (2) caves in year round use by gray bats - "The gray bat, a highly beneficial endangered species that occurs in this cave throughout the year, is intolerant of disturbance. In the summer, baby bats may fall to their deaths if disturbed. In the winter, bats may arouse from hibernation, using up the stored fat they need to survive until spring."

At some caves visitor entry may be permitted during seasons when bats are not present. A smaller sign containing that message, plus

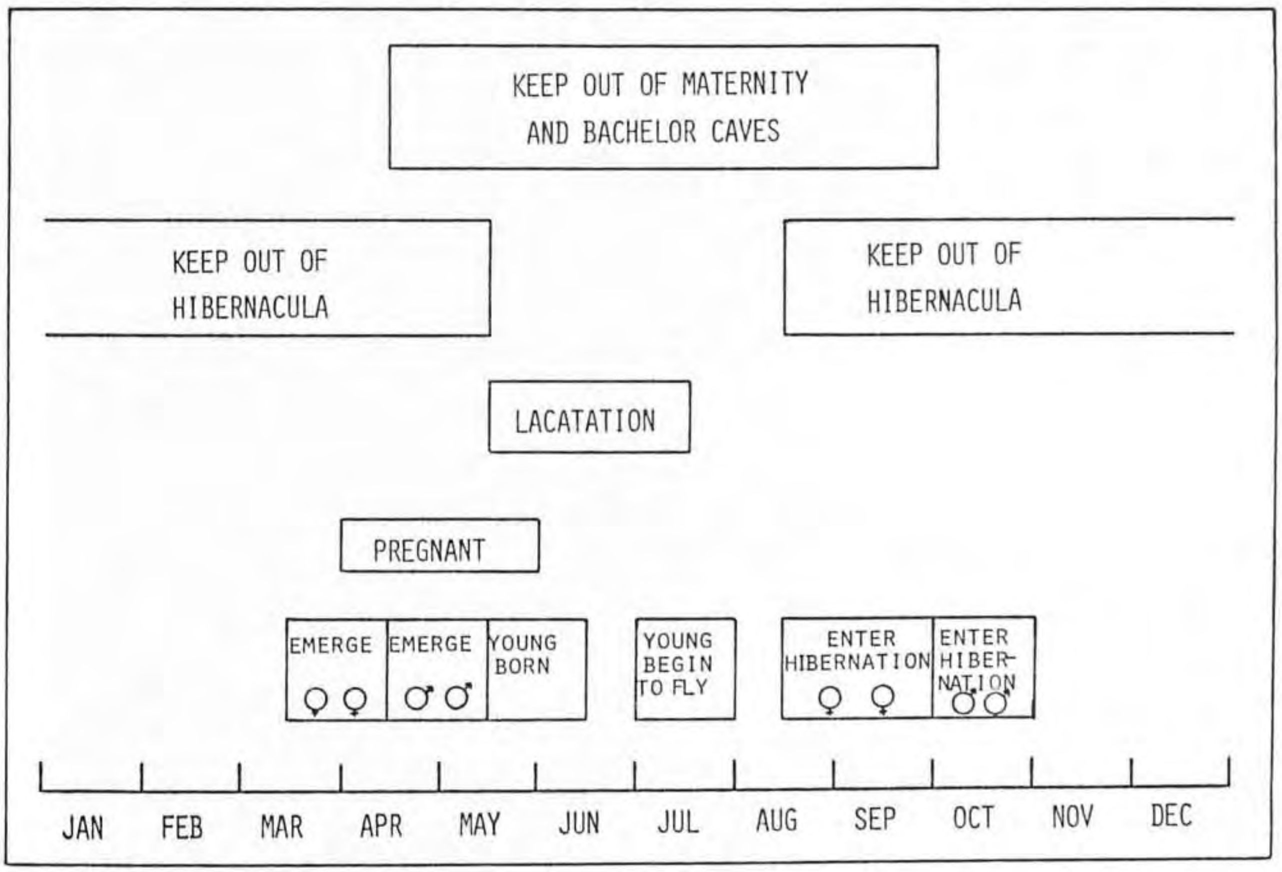

Figure 1. Annual chronology of the gray bat (Myotis grisescens), showing seasons when caves should not be visited. Some maternity and bachelor colonies naturally leave their caves as early as 1 August annually, and at such locations entry is permissable thereafter.

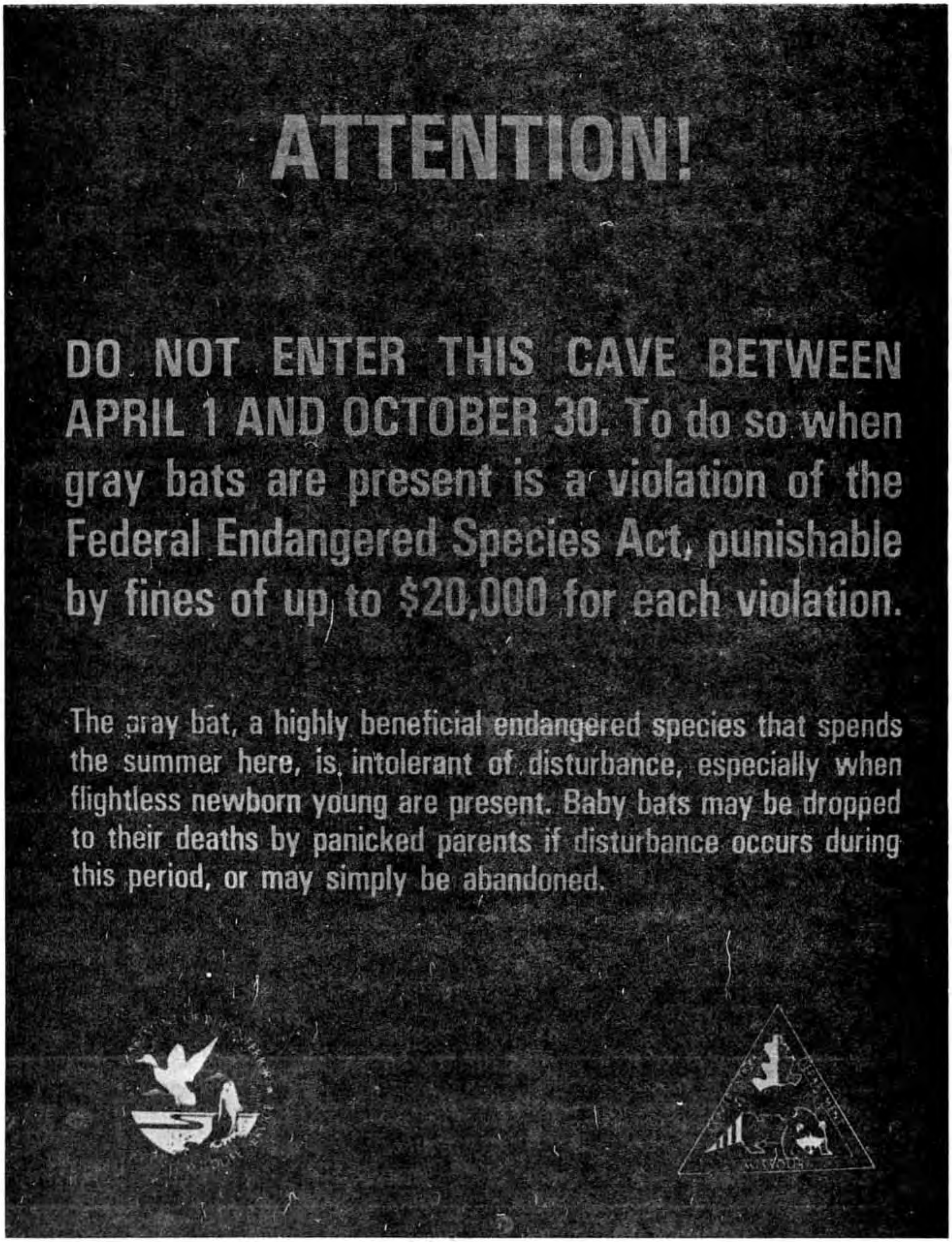

Figure 2. Warning sign used on a gray bat maternity cave by the Missouri Department of Conservation.

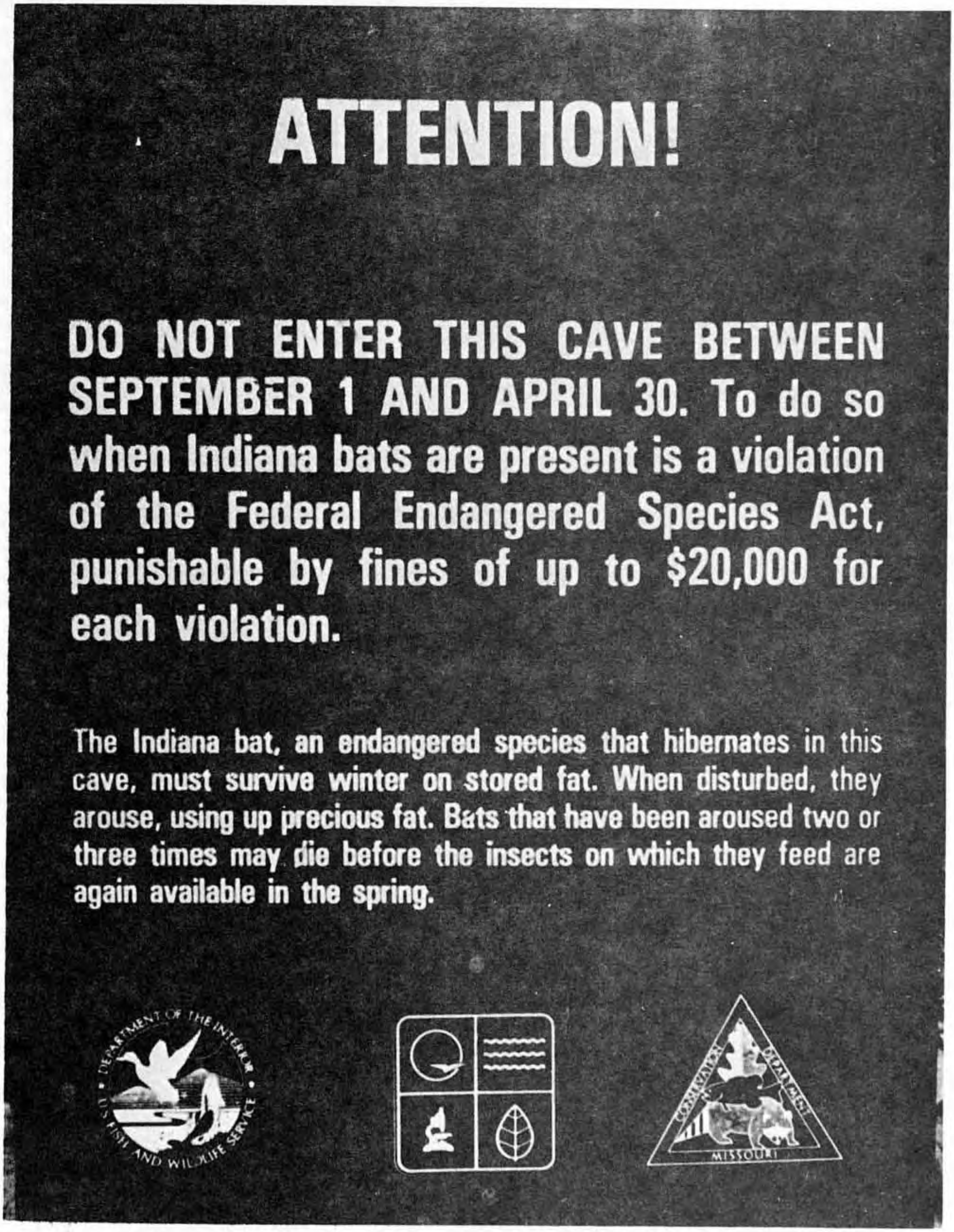

Figure 3. Warning sign used on as Indiana bat hibernaculum by the Missouri Department of Consermation.

information on how to obtain a key to a gated cave or other pertinent details, might encourage the cooperation of spelunkers.

In cases where a cave is located in a public use area, the management agency may wish to use a more detailed interpretive message. For example, a sign with the following wording was posted at Blowing Wind Cave, National Gray Bat Sanctuary in northern Alabama:

BLOWING WIND CAVE

Wildlife Sanctuary -

Unauthorized Entry

Prohibited

"This cave is a critical habitat for endangered Gray and Indiana Bats as well as for threatened Eastern Big-eared Bats and the Tennessee Cave Salamander. As a result of human disturbance, all of these species have decreased dramatically in numbers, requiring protection from unauthorized entry. When this cave was purchased by the U.S. Fish and Wildlife Service in 1979, populations of all but the Gray Bat were nearly extinct here, and even this species had been reduced to less than half of former numbers.

Gray Bats have declined by more than 54 percent throughout much of their range in the last six years alone. Due to this cave's unique structure and strong, seasonally reversing air flow patterns, it is the most important summer cave known for gray bats. It contains roughly a quarter of all known gray bats and the colony here is the largest anywhere. With careful protection it is hoped that this colony will soon recover to former numbers (between 250,000 and 500,000).

These bats are very beneficial and deserving of human understanding and protection. Individuals often eat 3000 or more insects in a single night, including many harmful kinds such as mosquitos. Insects, eaten nightly by the whole colony number roughly a billion and weigh more than a ton!

Since thousands of these bats sometimes die from a single ill-timed disturbance of their roost, human entry into this cave must be carefully controlled. Please help us protect them. You are welcome to quietly watch the emergence and return of these bats at dusk and dawn each day from April through September (flights are especially impressive in July and August); however, penalties for unauthorized entry beyond this gate, or other molestation of endangered species, range up to fines of 10,000 and/or imprisonment. Also it is illegal to damage Federal property. For further information you may contact the Wheeler National Wildlife Refuge, P.O. Box 1643, Decatur, AL 35602."

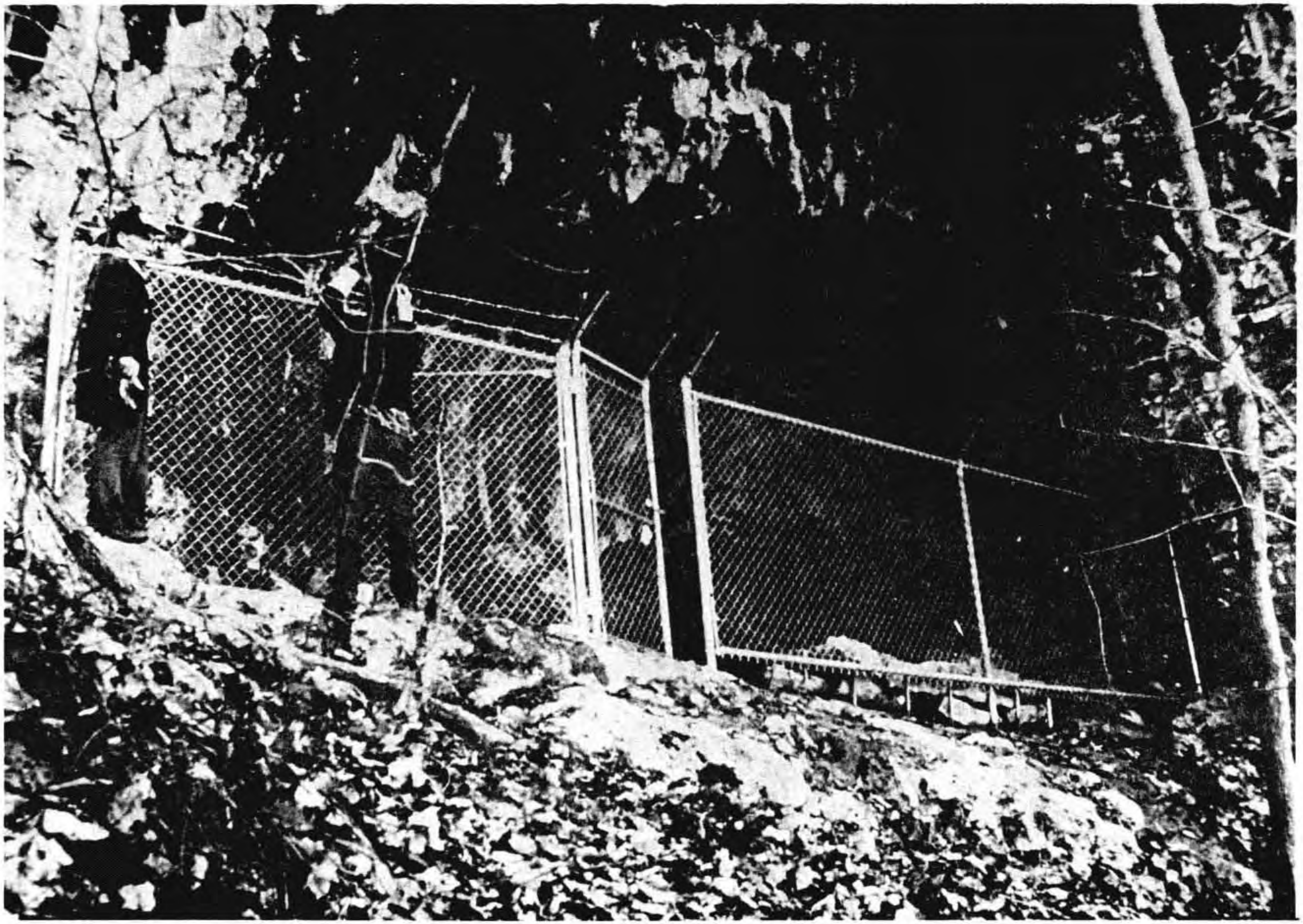

Figure 4. Fence erected at Norris Dam Cave, Tennessee by Tennessee Valley Authority (Photo Credit, R. Currie)

2. Fences. Although fences may not afford the same level of protection as steel gates, the presence of a fence makes it clear that unauthorized entry is illegal. Fences may be less expensive than gates, but are easier to climb or cut. Nevertheless, some caves are impractical to gate, due to size or configuration of entrances, or because gating would result in probable abandonment of the cave by bats. Chainlink, barbed-wire-topped fences (Figure 4), with posts set in concrete are best. Barbed-wire should not extend into flight space required by bats. Several fences have proved highly effective in reducing human disturbance, permitting gray bat maternity colonies to increase greatly in size. Fences also have been used successfully to protect caves with flooded entrances adjacent to reservoirs (Figure 5).

3. Gates. Gates must be used only with extreme care to avoid detrimental effects. They should not be used at gray bats' summer caves unless free flight space can be provided above. They should not be horizontal or used in entrances smaller than 6 feet in diameter. Gates in small entrances are most likely to restrict air flow or increase bat vulnerability to predation (Tuttle, 1977; Tuttle and Stevenson, 1978), leading to abandonment by the bats.

Welded steel bar gates provide the most secure means of preventing human entry into a cave. Even the best-designed and well-built gate can be vandalized. Routine inspections will identify damage so that repairs can be made promptly.

Each gate must be designed specifically for the cave to be protected, considering numbers of bats, type of colony, air flow, and entrance size and shape. In spite of the number of variables involved, certain generalizations about gate design can be made.

Gates should be constructed of steel bars of sufficient size to be invulnerable to bolt cutters. Steel bars 3/4-inch to 1-inch in diameter (ASTM* A 242) are recommended. All welds should be made carefully, using arc welding equipment.

Access openings in gates should be constructed to the same standards, with the most durable hinges, hasps, and locks. In a situation where vandalism seems likely, weak-link design may be employed. The lock, hasp, or some other easily replaceable portion of the gate should be relatively weak so that vandals will not try to breach the main body of the gate. Locks should be chosen with care, as many common types are extremely easy to force open.

Free ends of all bars should be grouted into solid rock. In some caves, it may be necessary to pour a concrete footing (although it should not rise above original ground level), or to dig through a deep clay or gravel fill to reach the underlying floor.

Openings in gates through which bats are expected to fly should be approximately 6 inches vertically and at least 24 inches horizontally. Lengths greater than 24 inches between vertical bars increase the probability that the bars can be spread by use of hydraulic jacks.

Unfortunately, a simple vertical gate (Figure 6) seldom can be constructed at a cave with a sinkhole entrance. Horizontal gates have two serious drawbacks: (1) bats are reluctant to fly up through such a gate; (2) a horizontal gate may become blocked with debris, preventing entry and exit by bats, as well as blocking normal air flow. A solution is provided by a "cage"

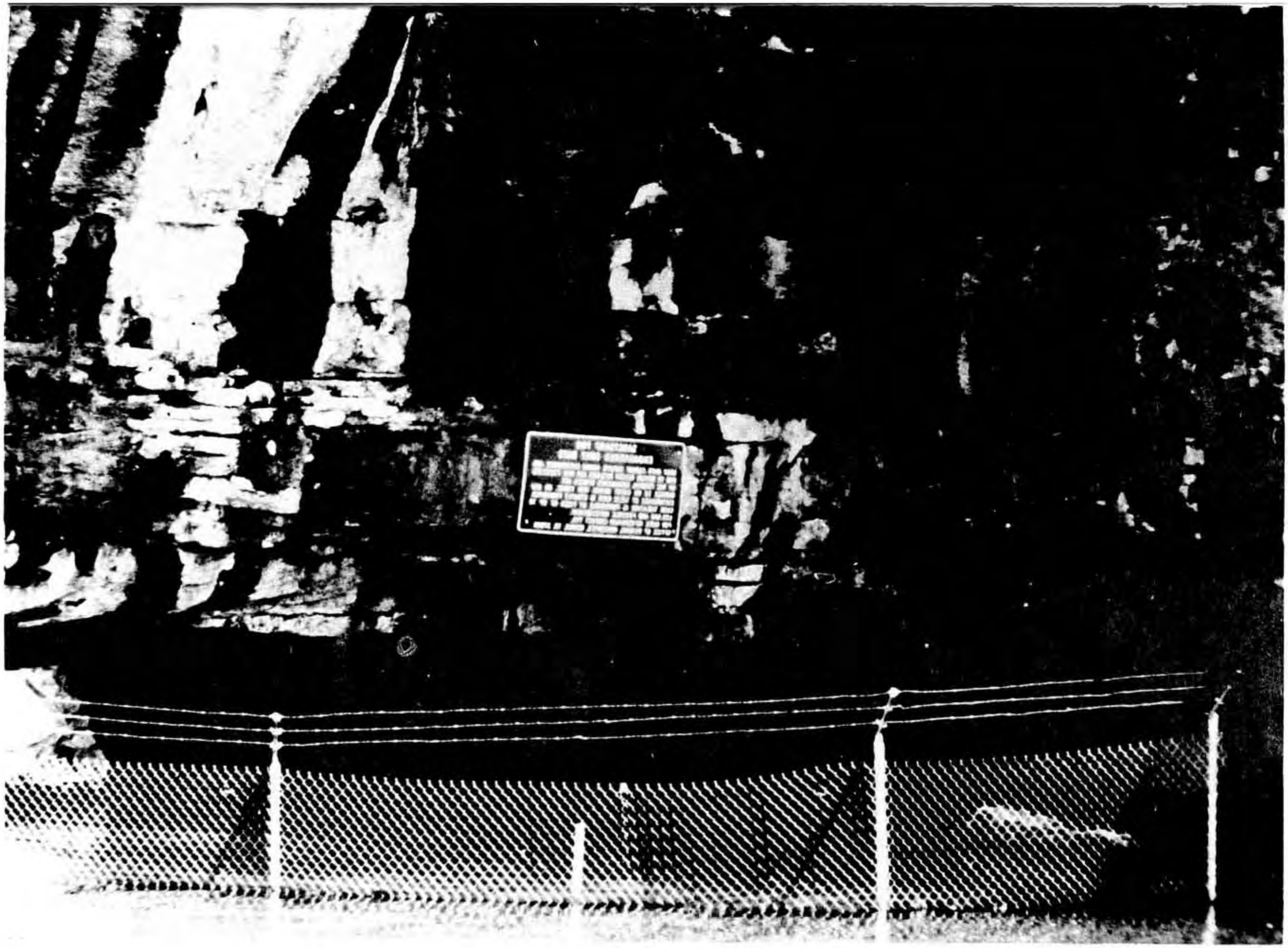

Figure 5. Fence erected at Hambrick Cave, Alabama, by the Tennessee Valley Authority. Fence is located approximately 30 feet from cave entrance (Photo Credit-Tennessee Valley Authority).

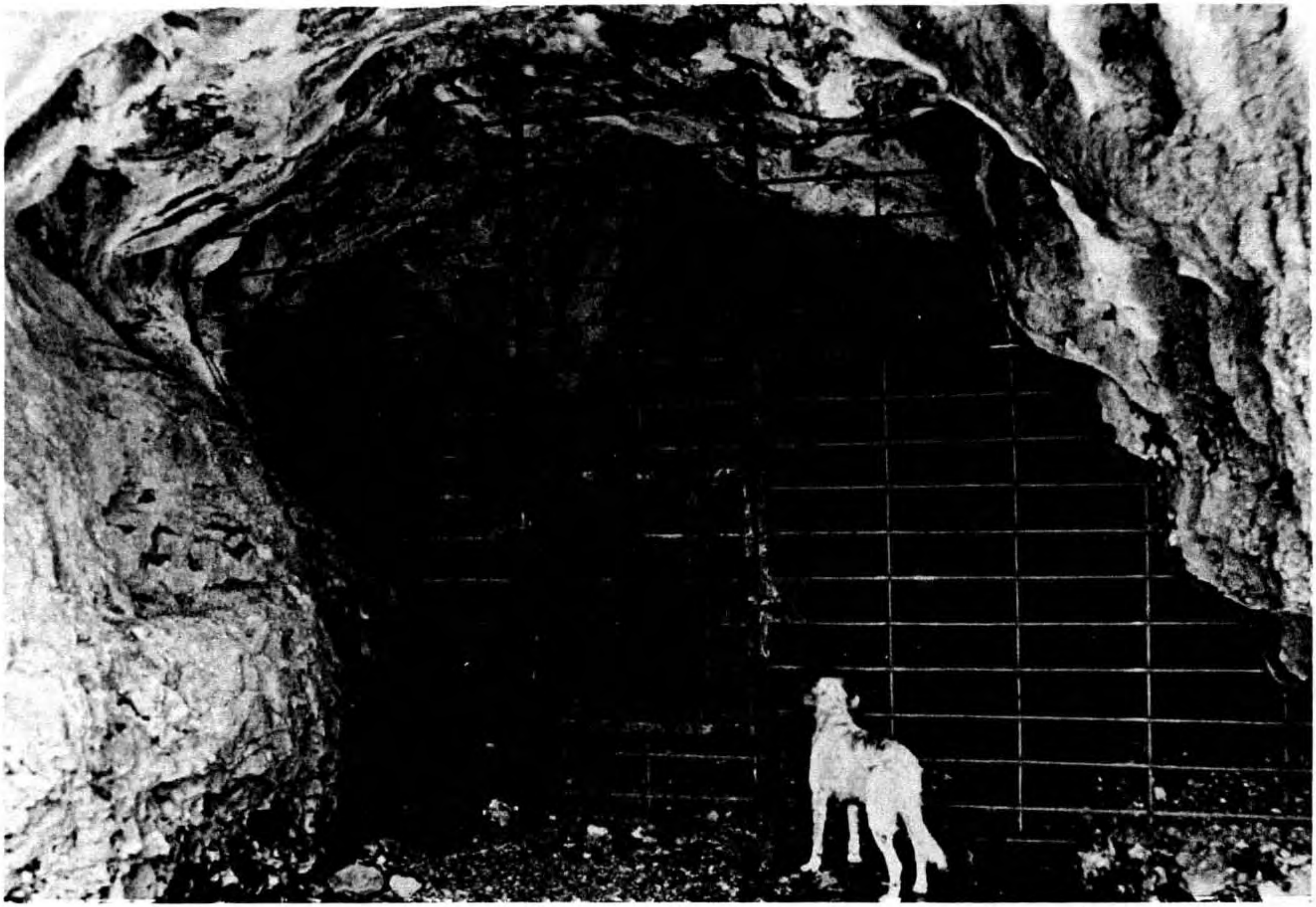

Figure 6. Great Scott Cave gate erected by the Missouri Department of Conservation (Photo Credit - R. Clawson)

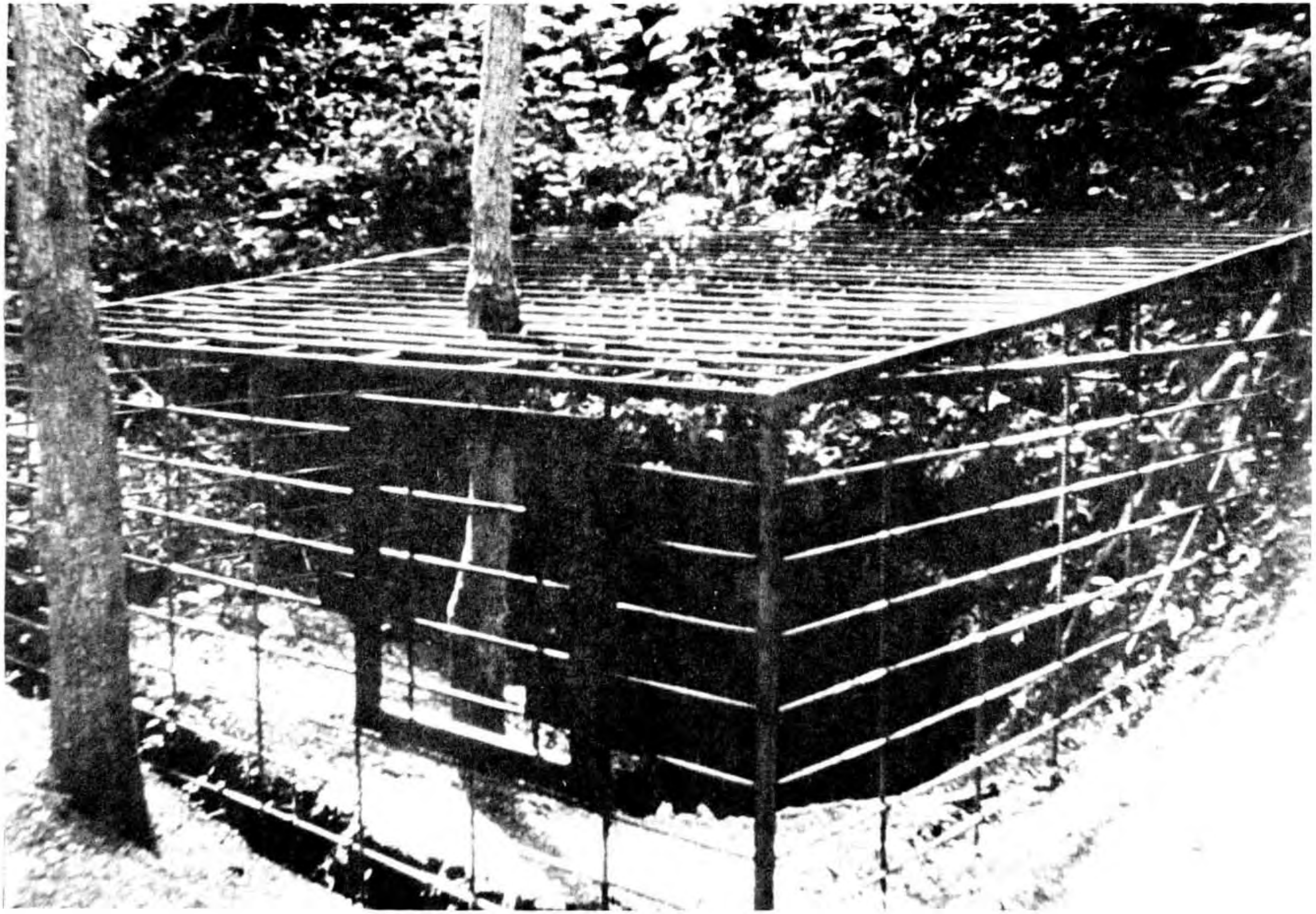

Figure 7. Bear Cave gate (a "cage" gate) erected by the Missouri Department of Conservation (Photo Credit - R. Clawson)

gate, similar to that shown in Figure 7.

Although gates that cover entire entrances may provide maximum security, their use should be restricted. Pregnant gray bat females and females with young apparently will not fly through them. Until a full gate can be designed that proves acceptable to gray bats using maternity caves, such caves must be "half-gated." A half-gate is practical only in a large cave entrance, where it extends from the floor part way to the ceiling. It should allow adequate space through which bats may fly (at least 3 feet of space and preferably more, depending on entrance width and colony size). It is relatively easy to climb over a half-gate unless the top is designed to make the climb difficult (Figure 8).

Full gates have one additional limitation which cannot be overcome by the half-gate design. Gray bats are apparently very sensitive to any gate or other structure placed across a small entrance (less than 6 feet in diameter). One such cave, when gated, was promptly abandoned by a bachelor colony of 40,000 bats that had been present the previous year.

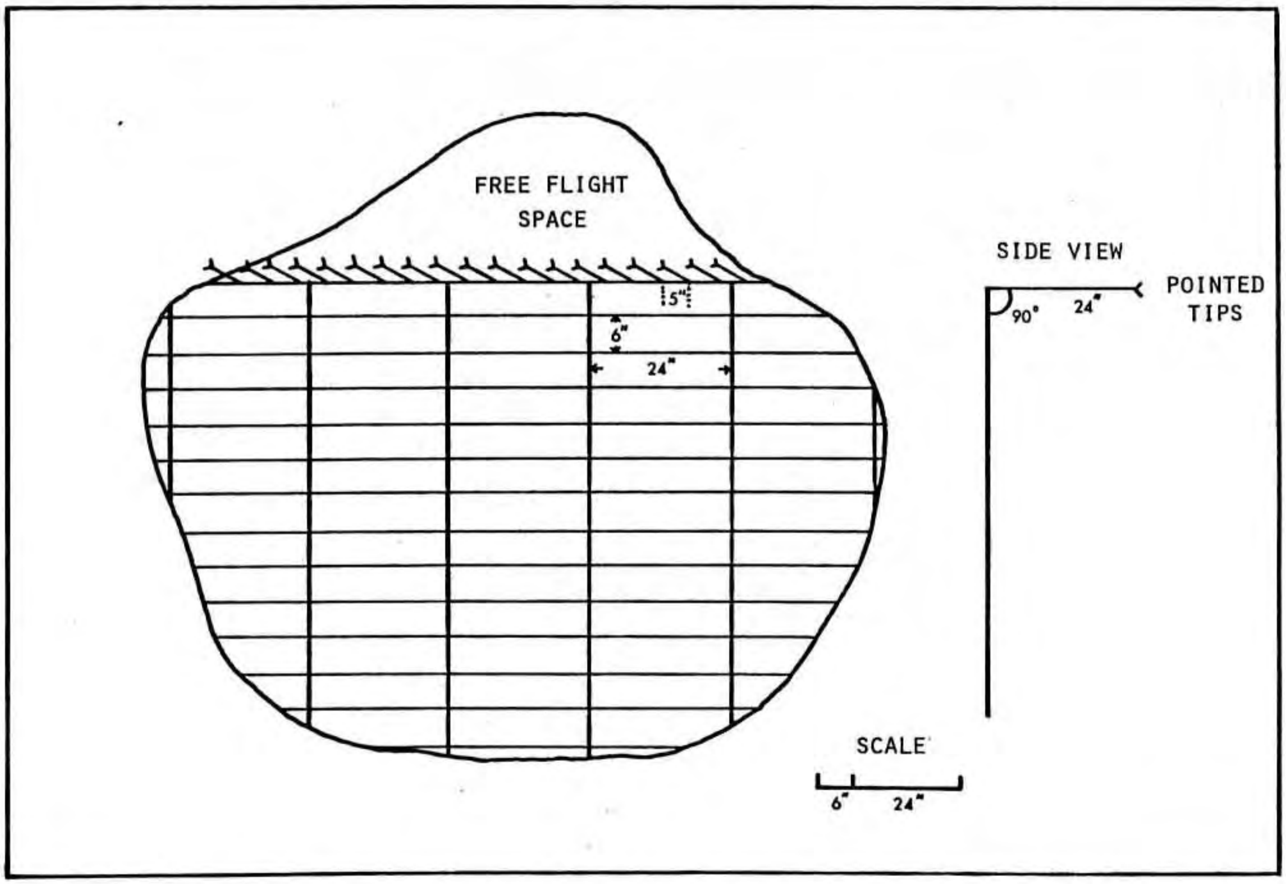

Figure 8. Drawing of a gate with free flight space, adapted from Blackwell Cave Gate, U. S. Army Corps of Engineers, Kansas City District.

4. Restrict Approach to Cave. Few people find caves without the aid of trails and roads. Obliteration of jeep and foot trails may greatly reduce human traffic to the caves. The Tennessee Valley Authority has blocked boat approaches to two of its caves, preventing access. Other opportunities for restricting approach may present themselves at specific cave sites.

5. Levees. The Kansas City District, Corps of Engineers has successfully used an earthen levee to protect a gray bat cave from flooding at Harry S. Truman Lake in Missouri. Care must be taken to prevent water from backing up into the cave, behind the levee.

6. Resource Groups and Agencies. No modification should be made to either an Indiana bat or gray bat cave without consulting the appropriate Regional Director of the U.S. Fish and Wildlife Service.

The following groups and agencies have had the most experience with bat cave management, and can be consulted for advice when management actions are being planned:

(1) The Recovery Team,

(2) U.S. Fish and Wildlife Service, Region 4,

(3) Missouri Department of Conservation,

(4) Tennessee Valley Authority, Office of Natural Resources,

(5) U.S. Army Corps of Engineers, St. Louis and Kansas City Districts.

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THE GUACHARO CAVE

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Abstract

Guacharo Cave is Venezuela's largest cavern (10,200 meters explored). The tourist sector (about 1,200 meters) harbors the largest known colony of oil birds in the world (about 19,000) and has an interesting fauna (rodents, bats, spiders, centipedes, and miriads of insects). Due to the fact that the birds bring seeds in their crops and regurgitate them, the cavern's Humboldt Hall (759 m long) holds a number of seedling forests during the breeding season. The tourist sector can be divided in three successive sections: a) Humboldt's Hall, b) the Hall of Silence (240 m long), c) the Precious Hall (100 m long).

The beautiful cavern has been developed for tourism having in mind two parameters: (1) keep the cave as wild and as natural as possible, (2) give the visitors minimum adequate facilities. For this, a rock slab walkway 1,500 m long with four well spaced and ample areas and a number of natural rock bridges were constructed. All possible effort was put in camouflaging as best and as safely as possible the full walkway. No railings of any sort appear and steps only when necessary. Due to the birds, no electric light has been installed. The results have been rewarding: 65,471 visitors saw the cave during 1979. No accidents have been reported and wheelchairs for disabled can reach 400 m in Humboldt Hall. A visitor with two artificial legs managed with reasonable ease the full tourist development. Guides with gasoline lanterns lead the tourists.

Introduction

The Guacharo Cave, by far the largest so far explored in Venezuela (10,200 meters known so far) and, without question, one of the most complete caverns to be seen anywhere in the world, was first seen by Europeans in 1657 (de Bellard, 1960). Explored by Humboldt in 1799 (Humboldt, 1956), Codazzi in 1835 (Codazzi, 1835) and by the Speleological Group of the Venezuelan Society of Natural Sciences in a methodical and systematic way starting in 1951 (de Bellard, 1968), the cave's first sector now called "the tourist sector" has been vandalised since 1900, perhaps earlier.

Besides its spectacular crystals, speleothems of every variety and color, gypsum river, etc., the Guacharo Cave is an incredible fauna and flora sanctuary. Its colony of some 19,000 guacharo birds (oil birds, Steatornis caripensis Humb.) live in the first hall and have been fully protected since 1949 providing, without question, one of the paramount attractions offered by nature to the visiting tourists (de Bellard, 1979).

Both in 1953 and 1974, absurd plans to illuminate the cavern with powerful lights were prepared and

engineered. The 1953 project was rapidly stopped after the birds left their nests by hundreds and began to abandon the cavern. The 1974 project, disregarding the previous experience, included the construction of a massive concrete walkway all through the tourist sector (some 1,500 meters).

Alarmed by the information received, the Venezuelan Government's Ministry of the Ambient and Renewable Natural Resources and the Speleological Group of the Venezuelan Society of Natural Sciences, working in a joint team, stopped altogether the irresponsible project which would have probably wiped out the guacharo colony there, so far the largest colony of Steatornis known in the world, and severely affected the troglobites and troglophiles of the cave (Ad Honorem Commission, 1975).

The experience never the less helped to point out that the very large numbers of visitors entering the cave then (40,264 in 1974; 46,241 in 1975) would welcome and applaud any reasonable tourist development made in the cave. This view was jointly appreciated by the above mentioned Ministry and by the speleologists and conservationists of the Venezuelan Society of Natural Sciences. So both institutions planned and developed a master project aimed at the betterment of the wild conditions still to be faced by all visitors entering the cavern.

The Project

The principal aims of the new project were:

(1) to keep the cavern as wild, natural and unspoiled as physically possible;

(2) to give the visitors of the cave the minimum adequate facilities and safety.

With these two parameters in mind, the Government project was carried out and executed as follows by the already mentioned Ministry of the Ambient, the Ministry of Agriculture and Livestock and, principally, by the National Parks Institute (Institute Nacional de Parques 1980).

During July 1976 a specially designed limestone slab walkway was constructed without railings, banisters or lights of any sort, and the use of bridges (over the cavern rivulet) and stone steps was reduced to the absolute minimum.

The first lap, easily covered even in wheelchairs, permits the visitor to enter Humboldt's Hall (759 meters long) up to the horizontal depth of 400 meters. Thousands of guacharo birds live in the nooks, crevices and balconies of this sector right up to the ceiling, some 40 to 45 meters above the rivulet. The walkway is 2 meters wide but widens considerably to form small plazas in six selected sites. Four somewhat camouflaged bridges span the cavern rivulet. Although easily identifiable, the walkways and plazas made of limestone slabs match very well the surrounding rockfall and therefore fit in perfectly with the natural structure seen all around. A well hidden water line allows the cleaning of the walkway for the full initial 400 meters, thus simplifying the maintenance. This first span required the handling of 3,026 cubic meters of rock, guano and earth at the cost of U.S. $42.000 (at 1976 rates).

The second lap, 600 meters long and 2 meters wide, covers the second half of Humboldt's Hall right up to

the small crevice which connects with the second hall of the cave, known as the Hall of Silence (some 240 meters long). In this sector, limestone gravel was used and compacted for better footing. Two bridges span the rivulet in this part and 253 cubic meters of rock, guano, earth and gravel had to be handled. Footsteps were made in site with the original rocks found and a large plaza was erected at the point where Humboldt turned back finalizing his visit of September 18, 1799. A simple marble slab with a brief inscripton marks the place and constitutes the only non-natural item in the cavern. The cost of this second lap mounted to U.S. $59,000 (1977 rates).

The third and last lap was developed from the entrance crevice to the Hall of Silence up to the Hall of the Breasts, the very extreme corner of the tourist sector, itself the final room of the Precious Hall (some 100 meters long). This span is 800 meters long, has seven bridges and the walkway is somewhat reduced in comparison with the previous sections. Forty-eight cubic meters of rock, gravel and earth had to be handled in this part, and the cost of the third lap mounted to U.S. $22.000 (at 1977 rates).

The total cost of the full works developed in the cave mounted to U.S. $123,000. The complete walkway is 1,800 meters long and occupies an area of some 4,500 square meters.

The Results

This magnificently designed walkway has given immediate and most unexpected dividends.

Before, since the cavern floor was uneven and irregular and visitors were not limited to a certain trail, the latter walked all over the open areas, got extremely dirty in the mud, wet to the knees in the rivulet, and inadvertently killed thousands of all sorts of troglobites, troglophiles, guanobies and plants growing from the seeds dropped by the guacharo birds after feeding. The so called "cave rats" (Heteromys anomalus and Proechimys guyannensis) were scarce and fishes were rarely seen in the rivulet.

Nowadays the cavern reminds those who entered thirty or more years ago, of the very scenes they saw back in the late 1950's: millions of insects live all over Humboldt's Hall; spiders, centipedes, millipedes and rodents have multiplied; fishes of the cavern stream are no longer a rare sight and beautiful dense little seedling forests of laurels and palms greet the visitors with their pale yellow leaves and pallid stems, a most unforgettable sight for those who visit the cave during the breeding season of the guacharo birds.

Visitors are conducted by guides using Coleman 300 candlepower gasoline lamps (which eventually will be substituted by adequate and sturdy electric lamps) and are instructed to stay at all times on the walkway and plazas. During 1979, visitors came to see this spectacular cavern from all over Venezuela and from overseas, and their number summed 65,471. Although the walkway and plazas are extremely simple and somewhat camouflaged, no accidents have been reported so far and a visitor with two artificial legs managed with acceptable discomfort to walk the full tourist sector, that is, 1,800 meters.

We feel that this philosophy of trying to keep this magnificent cavern as wild looking as it possibly was back in 1657, gives the visitors the additional thrilling

experience of a visit to a very large natural and untouched, semi-virgin cave, a nowadays rare sight if we consider the tourist caverns open all over the world. If we add to the previous statement the fact that visitors to the Guacharo Cave arrive all the way from Caracas city on an asphalted road that allows the finest cars to park within 80 meters of the huge cave entrance, we feel we have managed to give a most unusual experience to any caver and naturalist that comes to this grandiose cavern.

If only the indispensable artificial elements are incorporated into nature so as to guarantee a very safe visit to prudent and averagely careful visitors, the two principles can be kept and exercised to the benefit of Nature and man's unbending desire to know more.

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KARST CAVE MANAGEMENT MODELLING IN THE TRANSVAAL

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Abstract

The necessity for a management model for use in Transvaal karst cave areas is evident from the occurrence of both intentional and unintentional exploitation of cave resources. Such modelling is complex, depending on the specific region and the individual cave to which it is applied. The concern of the paper is with the general requirements, nature and feasibility of such modelling. Both physical and social environmental considerations are incorporated. The model is based on the most extreme conditions of susceptibility to disturbance of a cave system, that is on a static cave. Its nature varies from descriptive to mathematical. The success of the model as a management tool is dependent upon its flexibility permitting modification for individual applications and ease of interpretation. Many of the general principles are transferable to caves in other rock types and/or in other geographical regions.

Introduction

Models are tools used in scientific research or in planning and control to represent reality. They are subjective approximations consisting of "a simplified structuring of reality which presents supposedly significant features or relationships in a generalized form" (Haggett and Chroley, 1969, p. 22). They are valuable in that they obscure much of the detail of the system, allowing the basic components of reality to dominate, thus facilitating understanding and behaviour prediction of the system (Lee, 1973). Models have been used in the environmental field for about the last 20 years (Deininger, 1973), where they have achieved some measure of success (Vansteenkiste, 1978). Resource systems are always models or abstractions and simplifications of reality. They have great potential value, if only to compare decisions with the optimum situation (O'Riordan, 1971).

To date there have been few attempts to model total environmental systems (Deininger, 1973; McHarg, 1973; Spofford, 1973). Karst cave ecosystems have been particularly neglected. Systems of classifying caves according to their contents and hazards have been devised (Larson, 1980; Trout, 1978). Several studies, as for example in the Waitomo area of New Zealand (Nelson, 1975), have provided recommendations for improvements to individual caves. Forssell (1977) and Stitt (1977) have respectively considered carrying capacity in relation to management, and the human surface and subsurface impact on caves based on the countryside model proposed by Nicholson (1972).

A model, while used as a reference or ideal situation, must include some compromise in terms of individual applications, while demanding that disturbance of the system is minimized. Such modelling

is as complex as the ecosystem in question, but is essential in the optimization of any natural resource, particularly those of a finite nature.

The karst cave resource potential in the Transvaal is limited, requiring appropriate planning and management. Management must embrace the whole ecosystem and not only isolated facets. Although caves approximate closed systems, cognizance must be taken of the surrounding systems upon which they are dependent.

The intention of the present paper is to examine the general objective, requirements, nature and feasibility of such a model, as it applies to the Transvaal suite of karst caves. Many of the general principles are applicable in other karst regions.

Construction and Objectives of the Model

The construction of dynamic environmental models involves four fundamental stages (Devereaux, 1978; Vansteenkiste, 1978):

- The determination of model objectives, requirements and structure based on available experience.

- Parameter identification and development of a strategic management plan.

- The design and installation of monitoring control systems, and the initiation of action.

- Validation of the model by testing it against reality.

The validation of the model is the most difficult step in its construction because of the paucity of available data, particularly for a total environmental system. Consequently it is a step which is frequently omitted, although it is only once a model has been tested against reality that it can be used with any confidence.

The objectives defined in a karst cave management model should be designed to initiate comprehensive planning for environmental quality (McHarg, 1973), and thereafter to provide the guidelines for future management practices. They should be idealistic while maintaining some degree of realism. The ideal of reversing the ecosystems to pristine conditions is obviously unrealistic in this situation. More judicious would be the optimization of the resource through its wise use, tending towards multipurpose use, thus helping to alleviate land demands. Any alteration of the existing biological and geological features of a cave must thereby be minimized (Palmer, 1980). Such a policy allows for three levels of cave disturbance, each being selectivly encouraged. These levels are the undisturbed ecosystem, the controlled or limited access system, and the commercially developed cave. In terms of an optimization policy emphasis is on the first two categories, with limited but important recognition of the third in a few selected cases. Under no circumstances should uncontrolled exploitation of the resource be tolerated.

Such objectives are demanding on the nature of the model for successful resource management.

Requirements of the Model

The requirements of any model involving ecosystems are dependent upon the nature and resource potential of the ecosystem.

The model must be comprehensive in all respects. It must encompass

planning and environmental quality considerations, as well as the total environment, including both physical and social aspects. In the case of cavern systems the disturbance of the physical environment by Man (as part of the social environment), intentionally or unintentionally (Figure 1) is the primary concern of the model. These can only be incorporated into a total ecosystem model by using appropriate individual subsections within the framework of the total management model.

The intention of the model must be to allow for the most extreme case, that of a sack cave with restricted entry, a situation typical of most Transvaal caves. Such an ecosystem is particularly vulnerable to any disturbance, the major controls being atmospheric and hydrological. This vulnerability is enhanced in Transvaal caves by limited rock porosity and passage dimensions resulting in poor ventilation.

The model must be based on the existing management structure consisting of involved parties, and machinery such as commercial control and legislation. Within this framework allowance must be made for three existing levels of management - national, provincial and individual clubs, caves and speleologists. These should be viewed as important foundations for the creation of awareness amongst both the general and involved population, and upon which overseas experiences may be based.

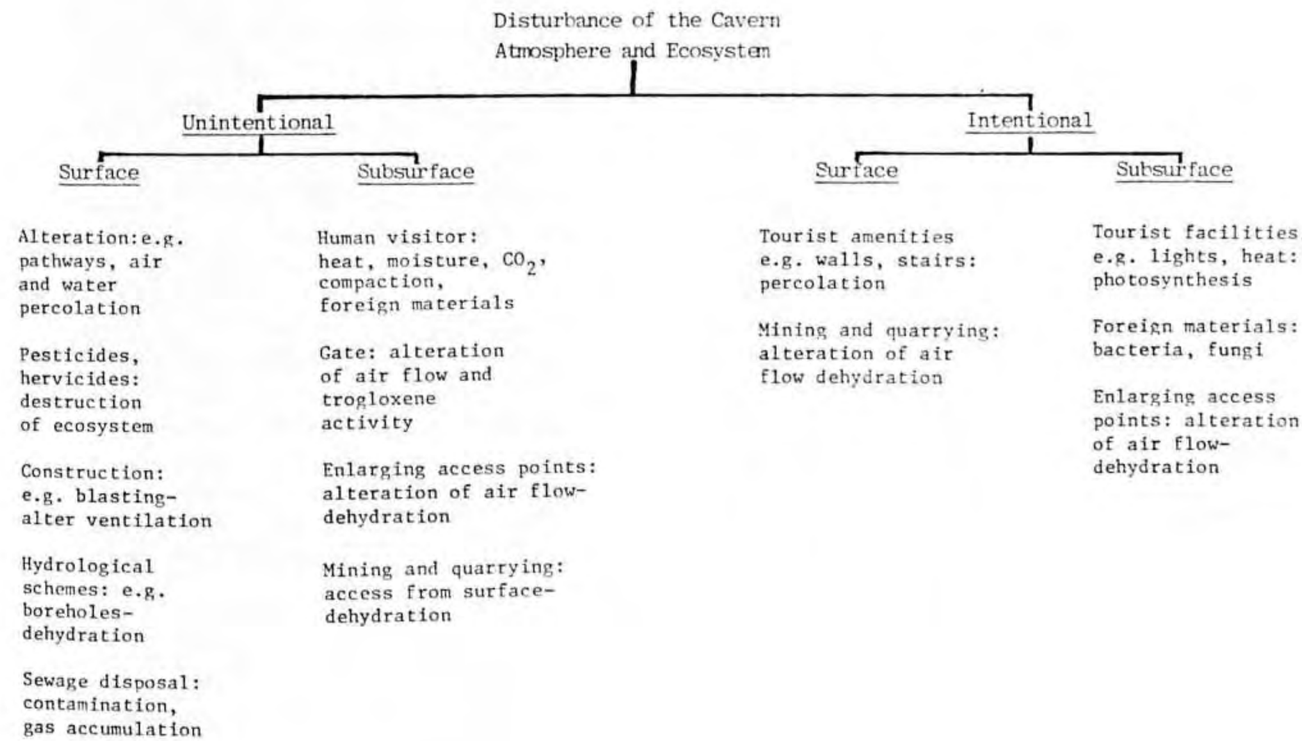

Figure 1: Intentional and Unintentional Disturbance of the Cavern Ecosystem by Subsurface Intrusion and Surface Alteration

It is essential that the model should embrace an understanding of the biophysical environment involved. Relatively little is known about cave management (Gallagher, 1980), a situation which necessitates immediate amelioration through research.

The model must be as objective as possible.

The model must be dynamic, being continually improved according to the latest knowledge and experience gained. This is in accordance with the dynamics of the ecosystem itself.

The model must be flexible in that each system is to a greater or lesser degree unique. However, this flexibility should not supersede the management objectives of the model.

The model must be stringent in its provision of controlling guidelines for all aspects of the resource. However, a balance must be sought in order to preserve the flexibility.

Ease of interpretation, facilitating utilization and communication, is essential in order to optimize the model as a management tool for both laymen and experts. However, the oversimplification which reduces the value of the model must be avoided.

These requirements for a karst cave management model may appear idealistic. In terms of the objectives of the model they are essential premises upon which to work. In reality some compromise has to be accepted, but these at least would provide the initial guidelines.

The Nature of the Model

In accordance with other models of environmental systems, a model of karst cave management requires an heuristic approach (Vansteenkiste, 1978), using smaller units in its construction, but being validated in situ against a complete system. The model should essentially be analytical, but should include systems analysis and simulation in appropriate sections.

Some of the major modelling problems are encountered in defining and quantifying environmental qualities and other public policy objectives (Deininge, 1973). In its overall framework the model would comprise a number of both descriptive and mathematical sections. The descriptive sections are the most subjective and hence are the weakest link in such a tool. They pertain for example to the problem of vandalism. They must be minimized, but are essential members as they provide the only method of including such system features. In addition, they are probably the most easily interpreted sections of the model, and as such are vital, particularly to the non-specialist.

Numerical sections are more precise, therefore more objective, and are consequently the most valuable modelling techniques. They are dependent upon exact measurements, for example of temperature, humidity and carbon dioxide. On the basis of these measurements various characteristics may be calculated. Thence visitor hazards and ecosystem impacts may be interpreted, prior to compliance with the remainder of the management objectives.

Descriptive and mathematical components contribute to one major management model. The flexibility of the model is thereby enhanced, while its subsection stringency is preserved. The application of the model will vary according to the nature of the individual ecosystem. In general stringency will be reduced in most systems as vulnerability is decreased through

ventilation or management policy. In most instances in the Transvaal application will vary through larger systems as conditions, for example in entrance zones, are different from those in deep cave areas.

Feasibility of Successful Modelling

Successful modelling of ecosystms is essential in sound management practices, but the features required to render a model successful are several and complex.

The flexibility of the model is perhaps the most important consideration. Both in itself and in its application and usage it must be versatile. Without this feature a rigid model is of little use. It provides no guidance and allows no exception.

The model itself may be perfect in its stated form, but may collapse completely with ineffective or inappropriate utilization. Man must derive the relationships and select the inputs for the model (O'Riordan, 1971). The effectiveness of this process is a function of the framework within which it is being used, as well as of the objectivity of the user. Without a background of sound ecological and management principles in this utilization, the model cannot be successful, through no fault of its own.

The dynamics of ecosystems demand that managment models should also be dynamic. The incorporation of research results into the model must be timely, very often a difficult undertaking in terms of data processing and of communication of modification.

The feasibility of karst cave management modelling in the Transvaal is dependent on the model itself and the competency of the user, in objective interpretation and implementaton. The model is regarded as a feasible necessity for the optimization of finite resources. Its successful use is possible depending upon human objectivity at all stages of development and utilization of the model. Its overall success is directly related to understanding of the complexity of the ecosystem.

Conclusion

At the present time there is no single solution to the cave management problem. The only certain method is one which is applicable to a single cave at a particular moment in time (Wilmut, 1972). However, it may be concluded that a management model is essential for the optimization of the karst cave resource potential in the Transvaal. Its success depends largely on the comprehenisveness and flexibility of the model, and on the ecological objectivity of the resource developer.

An environmental management model is complex. It may appear to be totally impractical, but the compensations in terms of the benefits derived therefrom far outweigh the problems. There are problems in the development and utilizaton of any such tool, but the task is not impossible. The model building and associated management practices are long-term undertakings which will benefit both the physical and social components of the environment.

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PROBLEMS OF MANAGEMENT OF TRANSVAAL CAVES

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Abstract

The management of karst caves is interpreted as the process which optimises the resource potential of the cave. This proces varies considerably between caves, from an undisturbed ecosystem to commercial development. The problems involved is such management are considerable. They vary from common problems of awareness of involved parties and exploitation of the resource to problems more specific to the Transvaal area. These latter include aspects such as culture, population distribution and mining practices. Contrary to these problems there are few current positive aspects to management. It is imperative that the most pressing of the problems, in the fields of awareness, distribution and administration, should be minimized as soon as possible. The problems of management are not seen as being insurmountable, but rather as long-term undertakings on the part of all concerned parties.

Introduction

During the last 15 years, Man's preceived need for control has led to a change in approach to the natural environment. Conservation has become strategic management, the process whereby a predetermined objective is obtained (Devereaux, 1978). This involves the wise use or optimization of resources (Usher, 1973), including raw materials, amenities, recreation and scientific interest (Black, 1964). Such an approach is effectively a compromise providing the best means of serving all interests (Wilmut, 1972), but is essential particularly where finite resources are involved. Problems of awareness and implementation of such management are considerable throughout the world, but are perhaps most critical in the developing nations where degradation of the environment is serious.

Awareness of both the problems associated with the management of karst caves and of the necessity for management of karst caves is a relatively new concern involving few of the general population. The general inaccessibility and ecosystem stability of karst caves are such that few people recognize their fragility or resource potential. In the Transvaal cave numbers and locations, and population awareness necessitate management of the ecosystems. Their potential is considerable, but only in as far as it is recognized and optimized. As the population pressures increase (currently at approximately 3.5% p.a.), so do the pressures on tourist amenities and therefore on wilderness areas. In order to avail future generatons of the cave resource, the problems

inherent in sound management practices must be minimized. These problems are not unique to the Transvaal area, but serve to illustrate those which must be acknowledged and those of priority.

The necessity for and problems confronting the successful management of Transvaal karst cave are examined in the present paper. The possible methods of overcoming such hindrances are alluded to. The general principles are transferable to other karst cave areas.

The Necessity for Karst Cave Management

The necessity for management of karst caves is obvious only to those persons actively involved in scientific studies or recreational pursuits within cave ecosystems. Amongst these few it is generally accepted that management is necessary in order to derive the best possible value from the site, although this value is relative depending upon time, place and circumstances (Whitfield, 1980).

Caves form one of the best and possible last wilderness resources (Stitt, 1976) available to Man, but unlike natural areas their extent cannot be increased (Wilmut, 1972). They belong to all Men, who are entitled to at least a limited share of their resource value. With the increasing demand for outdoor recreation, and therein a growth in the number of cavers and other interested persons (Clawson, 1966; Hamilton-Smith, 1967; Wilmut, 1972), management is essential. Man has no moral nor ethical right to deprive future generations of the resource, through damage which mars beauty and is irreparable, or which deprives society of knowledge through the destruction of specimens or data (Hamilton-Smith, 1967). Each cave ecosystem must be recognized as an individual resource which has a limited carrying capacity in terms of disturbance to the ecosystem. It is according to the carrying capacity that each system must be managed in order to achieve optimal returns.

The objectives of the management program must be clearly defined in terms of the level of impact acceptable to the cave manager (Fletcher, 1980). Ideally this should entail a reversal of ecosystem damage to pristine conditions (Ela, 1976), requiring the integration of the cave and surface area management plans. Such is seldom possible and a compromise situation has to be accepted. The case for many caves is too late as there have been few positive actions. Consequently the situation now is basically one of rescue as available preventive measures are inadequate.

The Present Status of Transvaal Cave Management

The present status of karst cave management in the Transvaal is based upon national and provincial legislation of 1978-1979, pertaining to the defacement and preservation of cave formations. Indirectly this act protects most of the ecosystem as it relates to atmospheric disturbance and the introduction of foreign materials. The provincial legislation forms a subsection of the Nature Conservation Ordinance for the Transvaal, and as such falls within the jurisdiction of that Department. It has not yet been tested but is strongly supported by speleologists and Nature Conservation officials.

Apart from these persons and the associated legal control, various other parties are or should be involved in the management of local caves (Table 1). Most cave owners, public or private, exercise some control over their caves (Larson, 1977).

In all instances at present, management tends to be sporadic and uncoordinated. The general public, from amongst whom problems of the casual visitor are derived, are not involved. Where parties are aware of the implications of disturbance, steps are being taken to minimize damage to the ecosystem while at the same time promoting the wise use of the resource. Problems are greatest where commercial gain is involved. In the the 'wild' caves there is evidence of wear and tear from cavers, still at a low level as most caves are subjected to less than four visitors per month. In certain particularly vulnerable instances caves have been gated to prevent further wanton destruction.

The hesitancy of the local population to venture underground is an additional positive factor, without which disturbance is likely to have been much greater. This characteristic extends to most private cave owners, who are also hesitant about promoting the disturbance by others of their subsurface property. The isolated nature of many individual caves also assists to some extent in their protection.

PARTY	ESTABLISHED AREA OF CONCERN
Department of Water Affairs, Forestry and Environmental Conservation	Permits to enter forest and water reserves
National Parks	Act protecting geological forms
Historical Monuments	Act protecting individual sites e.g. Sterkfontein Cave
Department of Defense	Permits to enter military areas
Homeland Governments	Permits to enter
Peri-urban Board	Deterrent notices at caves
Provential Nature Conservation	Legislation and ranger control
Environmental Organizations	Conservation areas e.g. South African Wildlife Society
University Scientists	Restricted access to sites
Speleological Organizations	Conservation - cleaning, gating
Gem and Mineral Clubs, Gemstone Retailers	Speleothem supplies
Private Property Owners	Subjective control e.g. Sudwala

Table 1. Parties to Whom Cave Management is of Concern in the Transvaal

Cooperation and communication between involved parties is one of the most vital aspects of management. Locally this situation is advantageous in that there is some cooperation between most cave owners, scientists, speleologists, the provincial authorities and conservationists.

The present management situation is one of a lack of coordination, based mainly on limited awareness. The machinery exists for the initiation of a management program, and the officials are receptive to advice. However, there remain several problems to the successful management of Transvaal caves.

Management Problems in the Transvaal

The successful management of karst cave resources is a complex task. It involves both tangible and intangible disturbances. Surface and subsurface intrusions, both intentional and unintentional, must be recognized and controlled according to the merits of each cave. This is obviously particularly difficult where population pressures are high corresponding with complex surface alterations and multiple subsurface disturbances.

There are two basic considerations in the management of karst caves (Godfrey, 1976), namely the destruction of the resource itself and the management of people, both of which are interrelated, the more so at the actual management stage. In the Transvaal these problems may be grouped into four main areas.

Geographical considerations:

Geographical problems are some of the most difficult to control in the Transvaal as they are allied to distribution and to politics. The major concentrations of caves are remote from the main population centers, and correspond with areas of rough terrain (Figure 1). The resultant limited accessibility further complicated by the surface climate and vegetation characteristics, and by the small and inaccessible nature of the caves themselves, renders them particularly difficult to control.

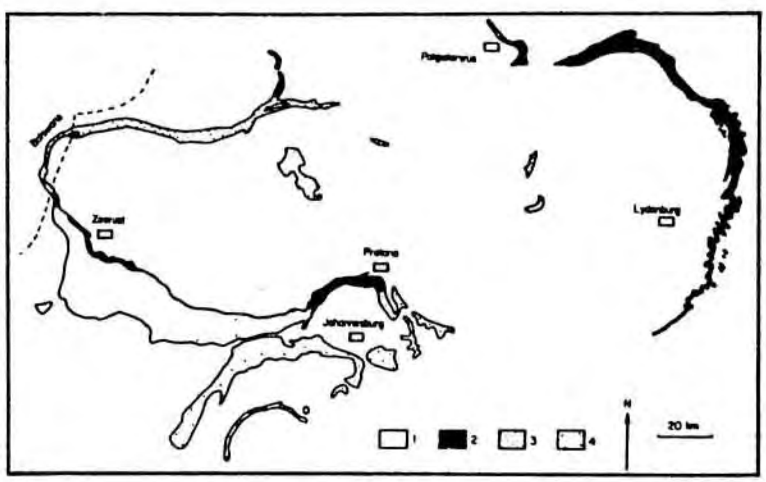

Figure 1.

Morphological Types Associated with the Dolomite.
(1) Plateau type, (2) Escarpment type, (3) Bushveld type, (4) Vaal River type. The escarpment topography (2) is particularly broken and inaccessible. (After: Martini and Kavalieris, 1976).

Many of the dolomite areas occur within the independent homelands of Venda, Lebowa, Gazankulu and Bophuthatswana (Figure 2). This situation renders decentralized administraton and control, as well as appreciation of the problem, major issues. Currently, only the Transvaal and Lebowa authorities appear concerned about some of the caves within their jurisdiction - both being directly involved through possession and at least partial recognition of a number of valuable cave resources.

Physical considerations:

Physical and biological considerations relate to the destruction of the resource itself, particularly as it is irreplaceable and unextendable. Pollution of the system or of the surrounding environment, particularly water and atmosphere, are major problems. They are usually long-term and initially unnoticed, resulting in the destruction of habitats especially those of fauna which by virtue of their small numbers are already endangered (Stitt, 1976). The occurrence of Daughters of Radon, high carbon dioxide concentrations, Histoplasmosis and other physical hazards are also regarded as management problems. All of these factors contribute to the carrying capacity of the system.

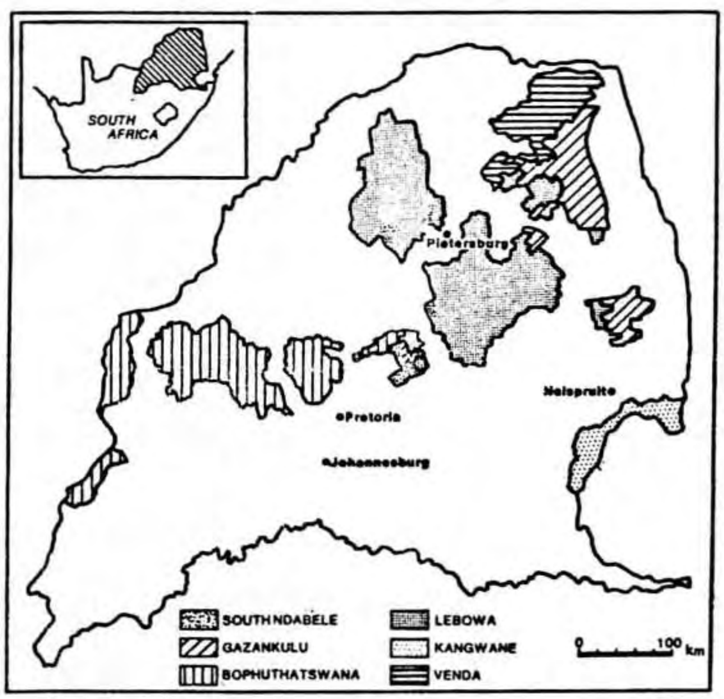

Figure 2.

The Location of Homeland Areas in the Transvaal.

Social considerations:

Perhaps the most urgent problem facing the successful management of Transvaal caves is that of lack of knowledge and awareness. As with all other facets of the environment, concern is slow to be realized, and is generally manifest only in certain centers. This leads to a failure on the part of most persons to recognize the significance of the cave resource (Nieland et al, 1980). In addition, because of the lack of information and understanding as well as the haste usually involved in resource development (Fletcher, 1980) the details of disturbance are unappreciated. Hence much damage results. The education process is slow in such a situation and time is of the essence in any successful management program. The dispersion, diversity and non involvement of the general population renders their awareness of and concern for the karst cave resource almost non-existent. Three small speleological groups in the area provide little contact with persons who are actively involved or concerned. The three tourist caves are taken for granted, and there is little more concern for the issue in general. In addition, speleology is not recognized as a science (Hubart, 1976), and thus has little official support. As Usher (1973) concludes, therefore perhaps the most vital part of any management program is the education of the recreational user. This would obviously be most effective through the use of sound interpretation programs. At the same time however, the short duration of interest by conservation-committed speleologists does not provide continuity for any management program.

All resource management problems are related to the increased leisure time and mobility of the population. The result is an increased recreational demand from both the greater total population and the changed characteristics of society itself. The situation is further compounded by the paucity of karst caves in the rest of South Africa. Most of the ever-increasig South African population and many foreign visitors are forced to rely upon the Transvaal caves.

Related to the problem of lack of awareness is thoughtless exploration resulting in abuse of the resource. This applies to both the casual visitor and the trained speleologist. Wear and tear on the system is dependent upon organization and control. More severe is the intentional destruction which results from speleothem collection. Industrial and construction impacts, which have economic and political backing, are more difficult to combat, but precedents in terms of the preservation of scientific sites have been set throughout the world.

Local problems are also rooted in the cultural diversity of the area. Peoples of at least six Black and four White groups each with its own language, beliefs, traditions and superstitions occupy the area. Of these only the white English-speaking peoples are really involved, thus rendering numbers limited and management practices few.

Economics of control and exploitation are involved in all management problems. A resource which provides an economic return is frequently considered more valuable than one which has no obvious return or requires investment. In addition, the expenditure of large sums on control or other management measures is often regarded as being of limited value because of the low priority rating of the resource.

Management program considerations:

A sound management program can only succeed with planning, control and effective implementation. Management program problems are essentially those of trained manpower and expertise, although other problems such as economics cannot be ignored. The major manpower source is nature conservation officials and active speleologists. Expertise is required initially for compiling a comprehensive cave resource inventory. Thereafter management alternatives must be considered and priorities established, according to the pre-determined management objectives. Legal protection is of particular importance at this stage.

None of these problems is mutually exclusive. They must be considered for the total suite of caves, and for individual systems. They are multiple and complex, far exceeding the prevailing positive factors. With enlightened leadership and the correct controls they are not insurmountable. Given a sound management framework which recognizes the necessity for compromise, the most urgent problem is education, which must form an integral part of the on-going management program. The initial input must be rapid and thereafter must be long-term and dynamic, and must interpret the cave resource as a viable portion of the total environment.

Conclusion

The problems of karst cave management are similar throughout the world, although each area has certain unique aspects. In the Transvaal the basis has been laid for future management programs. All concerned parties must be involved in order to enhance the cooperation and communication potential of specialists. Recognition of the urgency for a comprehensive, dynamic, long-term plan for the entire resource is vital, and will provide guidelines for the individual systems. The greater the delay the greater the potential problems for future management initiation and progress.

Acknowledgement

The assistance of Mr. P.J. Stickler in preparing the diagrams is acknowledged.

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THE RESOURCE POTENTIAL OF TRANSVAAL CAVES

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Abstract

The resource potential of karst caves in the Transvaal is assessed in terms of both the positive and negative aspects of interaction between Man and the cave environment. Caves in the area have had uses varying from places of shelter, to sources of fertilizer and to tourist attractions. Superimposed on these positive aspects of the ecosystems are the hazards to Man, which are of varying significance in different caves. These negative features include the occurrence of Histoplasma spores, and of high concentrations of both carbon dioxide and of radon. With recognition of the balance between the positive and negative aspects of the resource, and with sound management practices, the potential of the individual cave ecosystems may be realized. This potential will increase over time as population pressures on wilderness areas increase and as cultures adapt to changes in lifestyle. It is imperative therefore that the total resource potential of the cave systems in the Transvaal should be acknowledged, and that thereby mismanagement of the resource should be avoided.

Introduction

Resources, constituting materials which are useful or valuable to Man (Haggett, 1975) have been recognized throughout the time Man has been on the surface of the earth. O'Riordan (1971, p. 3) has pointed out that this concept is now more complex, being rather a "functional relationship that exists between Man's wants, his abilities, and his appraisal of his environment". They vary in nature from the dominant finite resources to scarcer renewable resources. Being restricted in their usefulness by Man's abilities, most have both positive and negative values with the former predominating and rendering them of value. It is this relationship between the positive and negative aspects of a resource which determines its potential usefulness.

The goals involved in assessing resource potential are related to the improvement of environmental quality or the more equable distribution of social welfare (O'Riordan, 1976). In particular, in the case of natural resources such as karst caves, this must relate to the optimization of wilderness areas essential for leisure-time pursuits. Karst caves as sheltering places, and subsequently with more diverse uses, have been recognized as resources for about the last three million years. Their potential is limited according to their finite nature.

In the Transvaal, South Africa, approixmately 300 caves are known in the Precambrian Malmani Dolomite, a true dolomite rich in manganese and iron. They are distributed in an

arcuate belt (Figure 1) surrounding the Bushveld Igneous Complex, and are dated as having opened as much as 3.7 million years ago (Partridge, 1973). The area is located in a summer rainfall region, varying from semi-arid to sub-tropical in character.

The intention of the present paper is to examine the resource potential of Transvaal karst caves. The past and present uses of the ecosystems are considered prior to assessing the future situation. Both the positive and negative aspects of the resources are considered in an attempt to arrive at a fair evaluation. Management practices are alluded to in the light of the future resource potential.

Transvaal Karst Cave Resources

Karst caves in the Transvaal tend to be limited in occurrence and dimension varying from systems barely penetrable to Man to a maximum of 11 km of passage. Entrances vary from single to multiple, and from sinkhole to walk-in or crawlway. The caves are characterized by collapse features, by old, largely-inactive stalactitic decoration with a predominance of aragonite, and by a general lack of water. Deep cave temperatures approximate 18 C and relative humidities of 98%. The caves are characteristic karst cave ecosystems, but due to limited passage dimensions and porosity of the host rock, tend to be very stable and hence very vulnerable.

Figure 1.

The Distribution of the Malmani Dolomite in which the Karst Caves of the Transvaal, South Africa, occur (after Truswell, 1977).

Most of the caves occur in areas remote from centers of population (Figure 2), and are themselves generally of limited access because of their small dimensions. In addition, the cultures of the Afrikaans nation and of the local African tribes have been responsible for limiting the full development of cavern resource potential. Both groups, particularly the latter, are superstituous of the underground world and hence are reluctant if even willing to venture inwards.

The resource potential of a karst cave or of a suite of caves is dependent upon system characteristics and upon its relationship to developers. The potential of the system itself is limited by its carrying capacity, including its accessibility, and by its threshold and resilience level to disturbance (Krutilla, 1971). The occurrence of obstacles such as health hazards and of cultural limitations act to limit a cave's potential. The use of resources is also inextricably bound to environmental perception and cognition (Simmons, 1974), which in turn are dependent upon knowledge and awareness. Environmental resource pressures and the question of supply and demand are also fundamental in the determination of resource potential. All these factors are determinants of cavern resource potential in the Transvaal.

Uses of Transvaal Caves:

For the last three million years

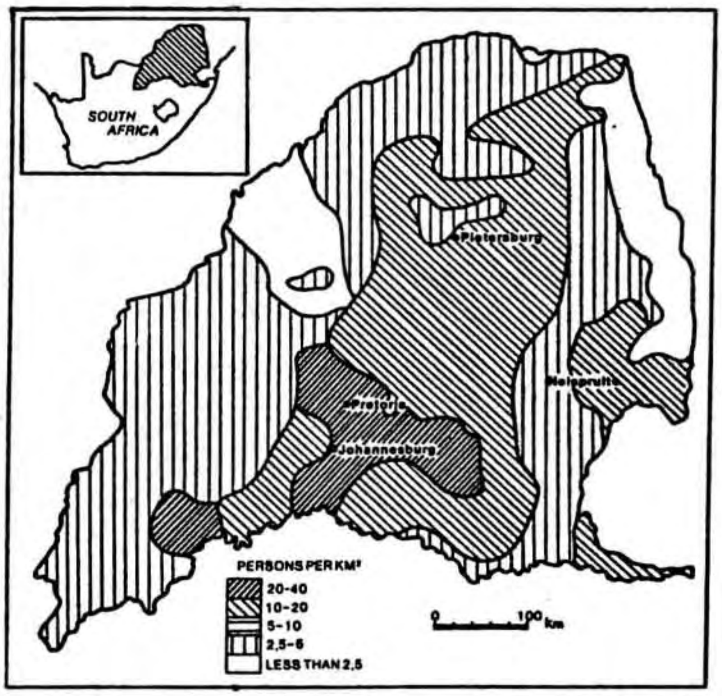

Figure 2.

The Distribution of Population in the Transvaal.

Transvaal caves have had varying uses, typical of those throughout the rest of the world. These have ranged from places of shelter and sources of minerals and other raw materials, to recreational centres and natural laboratories. Optimization of the resource has however been limited particularly by inaccessibility, lack of awareness and cultural considerations.

The local use of accessible caves and especially of entrance areas has been extensive as places of shelter throughout the history of mankind. The earliest known hominid fossils have been excavated from cave sites such as Sterkfontein. Subsequently many caves have provided places of refuge for the local peoples during times of conflict, as at Makapansgat and Sudwala during the mid-nineteenth century. Currently caves in remote areas are used by guerrillas for shelter and arms caches.

The local peoples have had many additional uses for the dolomite caves. These range from burial sites to witch-doctor's retreats. The Rain Queen of the Venda people reportedly lives in a cave. Medicinal substances are frequently stored underground. Most caves are attributed with strange mystical qualities and with the presence of ancestral spirits.

The Krugar Millions are yet rumored to be buried in a cave. More tragically, in many farming areas caves remain important refuse pits. A local game reserve uses a cave on its property as the lair for its leopard. On occasions one of the western Transvaal gold mines dumps slimes into a cave on its property.

As sources of minerals the caves are limited in value. Deposits are not generally economically viable, although calcite was mined for building purposes early in this century. Dolomite is quarried, sometimes intruding into cave systems, for flux for the iron and steel industry. Guano is removed intermittently for fertilizer. One of the most profitable sources of income from caves in recent years has been the sale of speleothems. Water which does occur in the local caves is mainly of water-table origin, and is occasionally used for irrigation.

The aesthetic attraction and consequent recreational use of Transvaal caves started in 1904 with guided tours of Sterkfontein. This venture had a chequered career until it was taken over by the University of the Witwatersrand in 1958. Echo and Sudwala caves were opened to the public during the 1960's. Speleological organizataions have been active in the area since 1956, and currently three small groups operate. They are concerned mainly with the sporting and conservation aspects of the science. Other parties including nature conservation and wildlife societies have recently become interested in the cave resource, for educational and protection purposes. It is presently in the recreational sphere that the major use is made of Transvaal caves.

Natural laboratories have flourished in local caves in the palaeontological, archaeological, geomorphological and geological fields. More recently climatological, bat and environmental studies have been undertaken. The biological resources are apparently fairly extensive, but little work has been done in this field so far.

Many of these undertakings have resulted in damage to the ecosystem, in some cases irrevocable. Plans have been mooted for future oil storage in some of the cavernous

dolomite. In addition, more reliance must be placed on the water resources for increasing food production. The major future resource potential of this suite of caves lies mainly in the recreational and scientific fields. There are presently plans to open two further caves to the public - Wolkberg to tourists, and one on a nature reserve for educational purposes. However this method of wilderness optimization in the face of increasing pressures can only provide a valuable resource if it is carefully managed. Balanced against these uses of caves must be the problems involved in the development of the resource.

Negative aspects of Transvaal cavern development:

The negative aspects of the cave resource are not unique to the Transvaal area, but possibly occur with varying relationships to those in other regions. They are related to both the damage caused to the ecosystem by intrusion, either direct or indirect, and the detrimental impact of the cave system on the human visitor. Until it reaches extreme proportions when the ecosystem, and therefore the resource itself, is destroyed, disturbance of a cave is perhaps the least obvious of the obstacles to resource development. In most instances this resource potential, or at least the detail, cannot be recouped because of the long time periods involved.

The occurrence of sinkholes upon dewatering of compartments with mining operations has resulted in spectacular damage in the West Rand area. The town of Bank was abandoned in 1971 after major subsidence. Instability within a cave system, accentuated by long undisturbed periods, is a common feature evidenced by rock breakdown and boulder chokes. Inexperienced persons endeavouring to negotiate such features are the most exposed to these dangers. Inexperienced persons falling or becoming lost within a cave are possibly the most frequently encountered hazards.

The entrance areas of caves, especially sinkholes, may intermittently host poisonous snakes such as cobras, which are usually more hazardous for having fallen into the cave, being unable to escape and being short of food.

Diseases contractable by humans include Benign Pulmonary Histoplasmosis, which has been responsible for at least three deaths in the Transvaal during the last five years - generally through incorrect diagnosis. However in most cases an immunity to the recurrence of the disease is the result. Fungal skin infections, believed to be Sporotrichosis, for which there is presently no known cure, have occurred as isolated cases during the last two years. Hypothermia and exhaustion are possibilities in all caves under conditions of prolonged exposure, prolonged submersion or injury.

The most common of the hazardous gases recorded is carbon dioxide. Concentrations of up to 3.5% by volume have been measured, although these may be exceeded under poor ventilation conditions. Such concentrations are particularly hazardous to the inexperienced visitor, such as the local farmer attracted by guano deposits, who is unfamilar with the physical effects and associated hazards of the gas.

Recent preliminary studies of the occurrence of the radioactive, -emitting Daughters of Radon have indicated that prolonged exposure to the atmosphere in certain caves could be dangerous. Working levels of up to 1.6 have been recorded during spring in the remote areas of

some caves. It is anticipated that these levels could increase during summer when ventilation is decreased and is usually outward in direction.

These negative aspects are obviously of particular significance to speleologists, scientists and tourist cave personnel, who, through prolonged exposure, are subjected to considerable risk. They are of little concern to the occasional tourist visitor to a cave.

The Resource Potential of Transvaal Caves

In assessing the potential of any resource, the positive features of that resource must be balanced against those which are negative. In order to do this effectively, caves must be considered individually and as members of the general suite of caves in the area.

When considering the suite of known Transvaal caves it is apparent that they are a definite resource. However, the resource value varies between caves, with one positive aspect usually prevailing. When aesthetically attractive caves are reasonably accessible, several have been or are being developed for tourists. Such high intensity recreational use, while usually devastating the ecosystem, is beneficial for the wilderness experience of recreation, the educational and the commercial ventures, and thus the sacrifice of the ecosystem may in certain circumstances be deemed worthwhile. Others which are particularly vulnerable or dangerous have been gated to prevent vandalism or accidents. Scientists and speleologists find other caves attractive for research or the athletic and psychological challenges provided. A number of caves are subjected to limited disturbance, or if they are presently unknown to virtually no disturbance, in order to promote the ecosystem itself.

The resource potential must increase as the increasing pressures of population, and leisure time, and the reduced cultural barriers place greater demands on karst cave wilderness areas. These will be both intentional and unintentional pressures in the form of direct intrusion into the cave and disturbance through surface alterations.

The very occurrence of karst caves in the Transvaal - in dolomite and under low rainfall conditions - dictates limitations to the resource. The number, magnitude and accessibility of the caves are all compounded by the hazards which are prevalent to a greater or lesser degree in all of them. Such factors are seldom encouraging to visitors. With sufficient economic or other incentives, the level of resource development can be high, although it can be contained by scientific management through education and sound administration.

Despite the negative aspects of the Transvaal cave resource, the potential for use remains high. Differences between caves must continue to be recognized in order to optimize their individual potential which must, of necessity increase over time. With sound management practices, damage to the ecosystems can be contained, and the exposure of visitors to hazards may be controlled, both leading to optimization of the total resource.

Conclusion

The resource potential of Transvaal karst caves is considerable, but must be recognized in terms of individual systems as well as in terms of the known suite of caves. It must be further recognized in terms of the balance

between the positive and negative aspects of the resource.

Although the karst cave resource has been variously used in the Transvaal for the last three million years, the future increased pressures anticipated will dictate that these uses are limited mainly to the recreational and educational fields and that due cognisance is taken of the various hazards involved. Such can only be done within the framework of sound environmental management, according to which the resource potential is optimized. Education and awareness are the basic requirements for such administration.

Acknowledgement
The assisance of Mr. P.J. Strickler in preparing the diagrams is acknowledged.

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A COOPERATIVE PROGRAM FOR THE CONSERVATION AND MANAGEMENT OF CAVE RESOURCES ON MOST MISSOURI PUBLIC LANDS

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ABSTRACT

The Mark Twain National Forest, Missouri Department of Conservation, North Central Forest Experiment Station-Columbia, Missouri and Missouri Department of Natural Resources recognized the need for a comprehensive cave management program. Since October, 1978, these agencies have been engaged in a cooperatively funded cave inventory project. Since the initiation of the study, valuable data on Missouri caves resources has been gathered. Before the project is completed in August, 1982, steps to provide protection for a number of caves will be taken.

During the inventory thus far, 211 U.S. Forest Service caves, 62 Department of Natural Resources caves and 62 Department of Conservation caves have been inventoried. There remains approximately 80 caves on the combined agencies lands to be found and inventoried. Caves are readily acquired by the three cooperators of the study for endangered species and as natural features.

Two caves in Missouri have been designated as Missouri Natural Areas so as to preserve examples of cave ecosystems for future study and enjoyment. In addition, several other caves have been included as significant features and others are being considered for such designation.

Information programs, training, and public participation projects and programs have helped to elicit needed support for cave conservation and protection.

Missouri has strived to produce a quality cave inventory which should identify some of its cave heritage as a quality resource. Completion of the cooperative project should contribute to a better understanding of cave resources on Missouri public lands and provide successful solutions to cave management problems.

INTRODUCTION

Missouri is known nationally as the cave state. According to Vineyard (1981) over 4,200 caves are known in Missouri and more are being discovered each year. Caves are an integral part of Missouri's natural resource and outdoor heritage, but like all environments, caves face irreversible degradation. Increasingly heavy, uncontrolled use of caves in recent times has resulted in the deterioration of some Missouri cave resources. This fact, combined with the need to access and evaluate caves on public lands prompted a cooperative cave resources inventory.

Beginning in October, 1978, the cooperative project was signed into

effect by the Missouri Department of Conservation, Mark Twain National Forest and the North Central Forest Experiment Station-Columbia, Missouri. The Missouri Department of Natural Resources joined as a cooperator in the project in September, 1980, while the North Central Station withdrew from the project. The inventory is scheduled to continue through August 31, 1982.

Missouri's cave inventory project was initiated under the Missouri Department of Conservation's Design program. Funds from the Design program were matched by the U.S. Forest Service and Department of Natural Resources to support this cooperative study. This first time cooperative study offered a chance to identify and record some of Missouri's cave wildlife and heritage features, as well as a chance to plan for the future and leave for tomorrow's generations the beauty and enjoyment possible in a quality cave environment.

Caves are an abundant resource in Missouri and there is an important need for their protection. There are clear incentives for the cooperative cave project. These incentives are geared toward the end goal of conservation and management of cave resources for recreation, scientific study and habitat preservation. Some of these goals of the cave inventory project are discussed below in greater detail.

DELINEATION OF CAVE RESOURCES

Several tracts of land were bought specifically for their caves and other tracts had caves as incidentals to other features. The Missouri Department of Conservation currently owns 74 caves, including some recently purchased caves used by endangered species of bats (discussed in detail under Natural Areas and Rare and Endangered Species). Other caves which could not be acquired were leased, so that responsible management practices could be properly executed.

The Department of Natural Resources has purchased caves and cave tracts and currently manages over 90 caves in the Missouri State Park System. Their most recent acquisition was Onondaga Cave, a registered National Natural Landmark. This most recently acquired State Park contains several other caves, one of which is Cathedral Cave, ranked tenth longest in Missouri. McDowell Cave, now a part of Lake of the Ozarks State Park, is an important cave to the gray bat (Myotis grisescens).

There are approximately 243 caves found on Mark Twain National Forest lands, and they have given priority to the purchase of caves and cave tracts as habitat for federally listed threatened and endangered species. In conclusion, the ownership and ongoing acquisition of caves for protective management by both state and federal agencies has become a reality in Missouri.

WILDLIFE RESEARCH

An important incentive of the cave inventory project was to promote wildlife research. The objective was to widen the scope of cave research programs and emphasize basic research on rare, endangered, and non-game species. The ultimate goal was to identify and establish protected areas for rare and endangered species of bats, certain fishes and crayfishes, as well as other cave related fauna.

Protective management of caves and cave related resources cannot be successfully accomplished without first identifying the elements of the cave environment, and this requires an inventory. Although

comprehensive in scope, the primary objective of the study was to produce a biological inventory of the cooperative project caves. Limited by techniques, time and seasons, it was hoped that sporadic collections of quantitative data such as species occurrence and distribution would identify areas of research need. The information collected would also make it possible to develop preliminary cave management practices.

Data were gathered on all species found in study caves, although special emphasis was given to federal and state listed endangered species. Representative collections of invertebrate species were made and are being identified by professional taxonomists throughout the United States and in Canada. A total of 242 species of invertebrates have been identified from some 3,100 specimens collected from study caves during the course of the inventory. These invertebrate collections have in some case generated taxonomic studies of certain species. For example, 16 of the species collected during the inventory were undescribed species, new to science. Some invertebrate species not only represent state distributional records, but are in some cases very restricted in occurrence. Oftentimes these animals are restricted to a particular cave system and occasionally known only from a single cave.

Vertebrate species were usually not collected, but examined, identified, recorded and left unharmed. Over 50 species of vertebrate animals have been identified from the caves under study. Additional distribution patterns and population records of species such as the southern cavefish (*Typhlichthys subterraneus*), the gray bat (*Myotis grisescens*) and several species of salamanders have added significantly to our knowledge of these animals.

The tremendous amount of data generated by such a large scale biological inventory made it necessary to store the information on a computer program. This data base system will make such a large amount of data more comprehensible and will aid in developing more intensified research on non-game cave fauna in Missouri.

NATURAL AREAS AND RARE AND ENDANGERED SPECIES

Natural Areas

The Missouri Department of Conservation and Missouri Department of Natural Resources cooperatively administers a statewide natural areas system. Recently, the Mark Twain National Forest has joined by agreement to register qualifying areas on their lands.

Natural areas are broadly defined as virtually undisturbed ecological communities or geologic sites, representing Missouri's natural heritage of plants, animals and geology. Under this definition, a number of caves qualified for natural area designation. At present, two caves have been designated cave natural areas and more caves are planned to be designated. A section of one cave is being considered for nomination as a unique geologic natural area. If the portion of cave is so designated, it will be the first of its kind in Missouri.

Cave natural areas received special management considerations which were designed to provide total protection to the cave. For example, one cave natural area was closed to public use. The cave's delicate ecosystem remains undisturbed and is restricted to scientific study. Other cave

natural areas will undoubtedly be open to public use, but only under controlled access. Management of caves as natural areas has served to permanently protect such areas and preserve faunal communities and significant geological features. They can be thought of as living museums.

Rare and Endangered Species

Largely due to Missouri's cave management programs, 29 known bat caves enjoy some level of protection (LaVal and LaVal, 1980). Fourteen of the caves were gated or fenced and 19 caves were signposted. Twenty-two of these caves are owned or managed by state or federal agencies in Missouri.

Caves in Missouri provide 4 hibernacula and 9 maternity sites for the gray bat (Myotis grisescens) and 13 hibernacula for the Indiana bat (Myotis sodalis). The protective management of bat caves in Missouri is essential to gray and Indiana bat population's because of such a great habitat dependency by the two species. For example, one state owned cave houses more than 50% of the known winter population of gray bats. Some new additional maternity caves and hibernacula have been identified during the cave inventory. Hopefully, immediate steps can be made to protect these caves.

Protective management of caves for federally listed threatened and endangered species, or state listed rare and endangered species has been a very successful approach to protection of the cave system as a whole. Also, the agencies have recognized the importance of protecting cavefish, salamanders and all forms of aquatic and terrestrial cave life not included on a state or federal list.

INFORMATION PROGRAMS

User awareness and education was necessary to gain support for cave conservation and management programs. Cooperation and support from the Missouri Speleological Survey Inc. was a great asset to Missouri's cave management programs, but yet, there was still much to be done to elicit support of the general public. The cave inventory has tried to add the call for cave conservation through articles in the Missouri Conservationist. A slide/tape program entitled "Understanding Missouri Caves" is also being produced.

The Department of Natural Resources has especially led the way in the area of direct public education about caves. Two Missouri State Park naturalists lead interpretive cave tours at three state parks, concentrating on cave systems, protection and management. Also, environmental education, cave workshops and classes are conducted. For example, living skills classes are led into Devils Icebox Cave at Rockbridge Memorial State Park annually.

Other public awareness and efforts of the cave inventory project were participation in speleology workshops, symposia and state and regional cave management meetings. A teaching aid in the form of a complete speleology lesson will soon be available.

Future plans will, hopefully, include a handout card on Missouri's "Cave Resources Act", which was drafted and heavily supported by the Missouri Department of Natural Resources, and Division of Geology and Land Survey. Additional television programs, printed materials and publications about caves and cave resources will serve to further educate the public about the need for cave conservation.

RESEARCH AND MANAGEMENT

From successful research come successful management techniques and a sound conservation program. The principal cooperators in the cave inventory have for years recognized the need for such a study, and in some cases have initiated specific research projects. For example, beginning in 1976, the Missouri Department of Natural Resources conducted a park resources inventory. This study established both a location and research base for its caves.

Given a recognized need for a more comprehensive and thorough cave management program in Missouri, the cooperative cave inventory became that much more important. The management recommendations resulting from analysis of the inventory data were to solve problems for which there had been no previous guidelines.

Development of a successful cave conservation program was dependent upon planning and management of the resource. The cooperative cave inventory was the avenue through which information on biology, paleontology, archeology, geology, hazards and public use of caves was gathered. This information, collected and recorded in a comprehensible and systematic form, provided the basis for a responsible management program.

One of the ultimate objectives of the cave inventory project was to develop specific management recommendations based on the elements indentified during the survey. Each element of content (biology, geology, etc.), hazards and public use was evaluated for each cave. Caves containing fragile ecosystems or other unique fragile resources were strongly recommended for protection. Rare and endangered species received special management considerations. From the data that were gathered, most caves will remain open for conconsumptive recreational use.

SUMMARY

The cooperative cave inventory project in Missouri was part of a significant increase in state and federal involvement in cave conservation and management. The cooperative project is funded by the Missouri Department of Conservation, Mark Twain National Forest and Missouri Department of Natural Resources. Between October, 1978 and September, 1980 the North Central Forest Experiment Station-Columbis, also provided supportive funding.

Since the project conception in October, 1978, inventories of 211 U.S. Forest Service caves, 62 Department of Natural Resource caves and 62 Department of Conservation caves have been completed. There remains a combined total of 80 caves to be found and studied before the project deadline of August 31, 1982.

The major goals of the cave inventory project were directly related to wildlife research, natural areas, rare and endangered species and information programs. The ultimate objective was to develop a comprehensive cave conservation and management program.

With the aid of the cave inventory project the cooperators have selected caves for purchase for the protection of rare and/or endangered species.

Through the Missouri Natural Areas System, qualifying caves have been designated natural areas and received special protective management. More caves are being considered for nomination as natural areas.

The cave inventory has identified new and exciting information on Missouri cave fauna. From the over 3,100 specimens that have so far been collected, 16 proved to be species new to science. These additional biological data have served as a base line study for more in-depth cave research.

Caves are a part of our wild, natural heritage and must be protected for the future. Cave conservation awareness programs in Missouri take on many forms, but the cooperators efforts have served to enlighten the public to the need for cave protection.

Successful cave management programs are still in their infancy in Missouri. The cooperators of the cave inventory project are working together toward the common goals of conservation, protection, enjoyment and enhancement of Missouri's cave resources.

ACKNOWLEDGEMENTS

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We greatly acknowledge the cooperation of the Missouri Speleological Survey, Inc. for the loan of their cave informaton. On occasion some of its members generously provided voluntary help. We are deeply indebted to the research and cooperating scientists of the Systematic Entomology Laboratory, USDA, and to cooperating scientists on the staff of the Department of Entomology, Smithsonian Institution. Additionally, we wish to extend our sincere thanks to each and every taxonomist who generously provided identifications.

Many thanks are due Elizabeth Cook, without whose generous help and planning the computerized cave fauna programs would not have been possible.

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Last, but certainly not least, our deepest appreciation is extended to the many people in U.S. Forest Service and Department of Conservation district offices and Missouri Department of Natural Resources State Parks for their valuable assistance in field work.

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THE CONSERVATION OF CAVE INVERTEBRATES

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ABSTRACT

The sometimes bizarre adaptations that restrict obligate cave animals to a life in caves, coupled with their island-like habitat, have reinforced the assumption that cave animals are somehow fragile and therefore lead an endangered existence. Although many cave animals undoubtedly are endangered, the development of management recommendations for their conservation is hampered by the lack of good ecological data concerning the requirements of the species. For example, what factors limit cave animal distribution; what are the significant perturbations; and how do these cause rarity and endangerment? Experimental ecological studies in caves are difficult since in few other habitats is man so clearly an intruder than in the subterranean world. Caves are a fragile window through which man can visit and study the fauna that lives in the unique environment within cavernous rock. Many caves threatened by land use changes have never been surveyed, and their biological resources remain unknown. Indeed, it has only been within the last decade that biologists have realized that highly specialized cave invertebrates live in lava tubes and in tropical caves. The following are some of the major threats to the cave ecosystem: 1) mining activities, 2) land use changes such as deforestation and urbanization, 3) alteration of ground water flow patterns, 4) waste disposal and pollution, 5) local extirpation of trogloxenes (a food source), 6) the introduction of non-native species, and 7) direct human disturbance from visitation.

While it is probably not necessary to convince cavers and speleologists of the value of conserving cave invertebrates, it is useful to reiterate some of the important justifcations (see also Orsak, 1981; Pyle, et al, 1981; and Iliffe, 1979).

First, because they are there. There is a strong moral and ethical standard that all species sharing our planet have a right to exist.

Second, aesthetics: There is something about blind, pale cave creatures that piques the curiousity of both laymen and biologists. That such animals exist at all seems incredible. Such interest certainly may be used to generate a desire to conserve species.

Third: Cave ecosystems provide a unique habitat for evolutionary and ecological research. The study of the adaptations of cave species to their environment has great potential for providing insights into general evolutionary processes.

Fourth: As environmental indicators. A large proportion of the U.S. and the world's population relies on subterranean aquifers for its domestic water. Native aquatic animals provide ready made indicators of water quality. Loss of a species through pollution would indicate a serious degradation of the water supply.

Fifth: Caves have many other intrinsic and extrinsic values, of course, and to protect a cave for its geological, archeological, educational, recreational or other values should provide some protection for its fauna (Schmidt, 1965).

Although additional pragmatic values could be cited, we may have more success in the public sphere if we rely more on the moral and aesthetic values.

In 1977 I proposed that the U.S. Fish and Wildlife Service place the no-eyed big-eyed hunting spider (Adelocosa anops Gertsch, Lycosidae) and its major prey species, the blind terrestrial amphipod (Spelaeorchestia koloana Bousfield and Howarth, Talitridae) on the federal endangered and threatened species lists respectively. During the review process the bureaucrats in Washington held a special workshop to determine a quota on how many amphipods the spider would be allowed to eat! This led to the political cartoon (Figure 1) which appeared in the MIAMI HERALD, in Florida. Clearly these two animals have been living together for millenia, and the fact that one of them eats the other is not the perturbation causing rarity. In fact, from an ecological perspective the question which should have been asked to ensure the survival of both species is: "How can we maintain the population of the amphipod so that it can feed the spider?"

The cartoon illustrates bureaucratic and popular ignorance of basic cave biology. The real solution for the conservation of rare invertebrates lies in an ecosystem or habitat approach. If the habitat of a species is protected that species can usually take care of itself. However, if its habitat is altered so that it no longer supports that species through its life cycle, the species is doomed to disappear no matter what steps are taken otherwise.

Why are cave invertebrates rare and endangered? In spite of the widespread assumption that cave animals are fragile, I believe that no species of plant or animal is inherently "fragile". Evolutionary theory predicts that species are admirably adapted to their natural environment. Extinctions are caused by novel perturbations. The response of a given species to a new perturbation is correlated with the type, timing, and severity of the perturbation; however, most importantly, the perturbation must be defined as the organism perceives it. For example a severe flood in a cave during the normal flood season may not be as detrimental to a cave community as a relatively minor flood occurring at an unusual time, or even as an absence of a flood during the normal period.

Certainly the extinction of species is a natural phenomenon. However, the quickening pace of man-induced extinctions should have everyone concerned.

The following are the major threats to the cave ecosystem.

1) Mining limestone and basalt for cement, cinder, building stone, and other products, such as at Batu Caves, Malaysia, as well as from the disturbance caused by the mining of materials found in caves, e.g. guano.

2) Land use changes in the vicinity of caves, for example, urbanization, deforestation, road construction, water impoundments, and other construction activities.

3) Alteration of ground water flow: for example, impoundments that flood caves, removal of ground water for urban and agricultural use, or channelization of surface water.

4) Pollution from waste water and sewage disposal as well as the use of cave entrances as garbage and offal dumps; the "out of sight, out of mind philosophy"; including oil spills, oil well leaks and road runoff.

5) Introduction of exotic plants and animals. Numerous facultative cave animals have been spread by man. These non-native species, both obligate and facultative, may pervade and often disrupt the ecosystem in unpredictable ways.

6) The local extirpation or extinction of food source animals and plants such as cave roosting bats, cave crickets, and, at least in Hawaii, certain trees. This threat clearly relates to land use changes in the vicinity of caves already mentioned, as well as to the next one, number 7.

7) Disturbance from human visitation. This last perturbation needs elaboration, for its effects are probably least understood, and yet disturbance seriously affects a greater number of caves. Actual collecting of specimens is

Figure 1. The proposal that the two cave animals from Kauai be protected under the U.S. Endangered Species Act attracted some attention since one species, the amphipod, is the major prey of the other species, the spider. This cartoon, which was created by Mr. Bill Kitchen, appeared on the front page of the MIAMI HERALD, Florida, on 7 December, 1977.

probably a minor factor except for some conspicuous species. The cave environment shares with other discrete habitats, such as montane bogs and sand dunes, a vulnerability to trampling and physical disturbance. However, the surface biologist often needs only to go 100-200 m away from a well worn trail in order to lay out his study plots in a relatively undisturbed site. On the other hand, since the cave is a discrete void in rock, the cave biologist is restricted to the same passages as every other visitor. Unless he can exercise unusual control over access, he can count on his study areas being crawled through, trampled, or even vandalized. Furthermore, tobacco smoke contains a powerful insecticide which, in the relatively enclosed cave atmosphere, challenges, if not kills, many cave invertebrates. In addition the smoke from torches and cigaretts lowers the relative humidity, further jeopardizing the terrestrial species. Hazardous refuse such as carbide and batteries left in caves by visitors adds another threat to cave life. Fortunately, with few exceptions, the disturbance from human visitation is reversible, that is the cave fauna often recovers in time after human disturbance ceases.

In spite of the difficulties in finding potentially good caves and field assistants, I was fortunate to have begun my survey in Hawaii before organized sport caving developed there. My field data on cave animal distribution show that, other factors being equal, species diversity and population levels of invertebrates in caves is inversely proportional to the level of visitation and human disturbance. For example, immatures of both the cixiid planthopper and the Schrankia moth feed solely on roots which penetrate the cave roof and are particularly sensitive to disturbance. If the roots are bumped or damaged, many nymphs fall to the floor. In passages where roots do not reach the floor, the nymphs may not find suitable roots, and they starve. Stepping on roots that do reach the floor may kill their distal portions thereby starving the nymphs already feeding on them. As a result the populations of these two species and their predators often reflect the level of human disturbance.

SOLUTIONS:

The top priority for the conservation of cave invertebrates is to conduct thorough biological inventories and ecological studies in threatened caves. In many instances the rarity of cave species is correlated more with the rarity of cave biologists than with the actual animal populations. There is an urgent need for biological surveys as new cave areas and new species are being discovered regularly. The inventory must be linked to an information retrieval system in order to analyze and utilize the data.

Cave biology is now in an expansive phase. Only a decade ago specialized cave animals, particularly terrestrial species, were thought to exist almost

exclusively in temperate limestone caves. Recent discoveries in both lava tubes and caves in the tropics have shattered that assumption (Howarth, 1980). Diverse faunas are now known from the Galapagos, Hawaii, New Guinea, Thailand, Sarawak, Central America, the Greater Antilles, and tropical South America. Thus the scope and horizons of biospeleology have more than doubled in the past ten years. Biospeleology may be 300 years behind some other biological sciences. For example, primate specialists are currently formulating conservation strategies for South American monkeys. Cave biologists, on the other hand, will first need an expedition to South America to find the cave animals, then describe them and work out their ecological needs before conservation strategies can be intelligently proposed. However, we may not have even 20 years to catch up with other conservation groups, if we accept the projections of continuing environmental degradation (National Research Council, 1980). Many threatened caves and cave areas have never even been inventoried, and their biological resources remain unknown.

There is also an urgent need for ecological studies, especially experimental ecological projects that are designed to determine (1) what specific factors limit cave animal distribution; (2) what the critical perturbations are; (3) how these cause rarity and endangerment; and (4) what mitigative measures will be effective.

Obviously we need to know the ecological requirements of the species concerned. Without this information the establishment of a reserve or management recommendations for a species may not benefit that species. For example, Harrison (1964), established the world's first earwig reserve in Niah Great Cave, Sarawak, in order to preseve a population of the bizarre, rare earwig, Arixenia esau Jordan, a representative of a small, poorly known but extremely interesting suborder of earwigs. Visitation to this room was restricted, and the collecting of earwigs from the floor was prohibited. Although the intent was highly admirable, subsequent research on the biology of this species has shown that it is obligately associated with the naked bat, Cheiromeles torquatus Horsfield, and that earwigs found on the floor in the "earwig sanctuary" had become separated from their hosts and therefore were doomed. This first "earwig sanctuary" no matter how well maintained and policed could not have had any potential whatsoever for the survival of the species for which it was created. Maintainence of adequate populations of the host bat is the most logical management strategy (Marshall, 1977).

A similar example concerns the Texas blind salamander, Typhlomolge rathburni in Ezell's Cave, San Marcos, Texas (Davis, 1972; Byers, 1977). The major population of the salamander lives in the Edwards Aquifer (Longley, 1978) and the major threats are pollution and drawdown of the water supply. The populations in Ezell's Cave makes little, if any, contribution to the survival of the species, but this small, protected population could be used as a research and education facility to enhance survival and public awareness of both the main population and its numerous associated cave invertebrates.

As I emphasized earlier, the major long-term strategy in the conservation of cave invertebrates is the protection of suitable habitats. No other strategy will work, although immediate threats sometimes require short term

solutions. Protection of the habitat may include the establishment of formal reserves as well as agreements with landowners and managers for the resources under their care. Cave reserves must be of sufficient size to support the ecosystem. In addition, they should include associated surface and underground environments that are vital to the cave species. Examples include overlying forests that provide food either directly into the cave or for foraging trogloxenes, major bat foraging habitats, and water sheds that supply water in sufficient quantity and quality.

Many researchers (myself included) feel that the major populations of most cave species live in the voids within the rock and enter human-size cave passages only where food and environmental conditions allow. Others feel that the major populations occur in caves but that the animals can use the smaller voids to migrate between caves. A few animals are thought to live only in caves and not to be able to exploit the smaller voids.

Even if the animals live mostly in the numerous smaller voids within cavernous rock, the only windows open for man to enter and study such fauna are caves, and rarely mines. If the caves are destroyed or so altered that their fauna is destroyed but the animals survive within unenterable voids out of reach of both the biologist and the lay public, then the animals, in a very special and narrow sense could be considered extinct. For even if the population lives on, the fact might remain forever secret. We might consider such cave faunas then as "biological phenomena", like the monarch butterfly roosts, buffalo herds, and bat flights, where the species itself is not endangered but a phenomenon associated with the species is highly endangered and is spectacular enough to warrant protection. Protection is now being sought for the monarch roosts, but it is too late for the phenomenal buffalo herds. Under this philosophy. cave reserves specifically for populations of spectacular cave animals are a worthwhile and logical goal for conservationists. In order to manage such reserves we still need detailed ecological data on the animal's requirements.

Education is another long-term strategy which can aid in finding solutions to conservation problems. Unfortunately, education can have capricious results, for one hard-core vandal, armed with the additional knowledge from an educational program, can irreversibly negate the beneficial activities of 100 good people. The two-edged sword created by education is a real dilemma for which we must find a solution (Wilmut, 1972; Day, 1980).

In cases where there is a strong negative correlation between the level of human visitation and the number of species present, recreational caving should be discouraged until adequate protection of representative caves is assured. Unlike other conservation groups which often publicize their cute, fuzzy critters in order to generate public support, we must be much more restrained in popularizing the cave fauna: because the increase in public curiousity leads to an increase in cave visitation. This is a paradox, for if the existence of these animals is not made public, then their habitats may be destroyed through ignorance during changes in land use. We must solve this paradox.

How does one sensitize cavers to respect the resources within caves? My experience has been that it is

fairly easy to instill a conservation ethic within the sphere of interest of an individual but much more difficult to instill such a feeling across many disciplines in any one individual. I have introduced many Hawaiian biologists to the wonders of Hawaiian caves, and all have been quick to agree with my own conservation feelings on the biological resources, but some have been slow, even recalcitrant, to understand that there might be other resources in the caves and blithely trample through archeological, geological, or other wonders. Conversely, geologists and archeologists have quickly grasped the significance of cave resources in their own field only to trample unknowingly through biological resources. Such sensitivity seems to accrue only after long experience in caves, that is only after the explorer has seen the degradation of cave resources for himself does he realize he is part of the problem. Unfortunately, there are not enough caves for every beginning explorer to learn this lesson on his own.

On a recent field trip with a biologist who quickly became impressed with the cave fauna and who carefully avoided breaking tree roots or disturbing the animals, I pointed out some rather nice sand castles built in the volcanic ash by dripping water. His reaction to this relatively rare phenomenon in Hawaiian caves was to suddenly stomp and kick his way through the whole display saying: "Sand castles! They look like just piles of sand to me !" I protested his actions rather vehemently, but I am afraid that I did not convince him that sand castles in caves have any use or aesthetic value.

In another instance I was in a newly discovered pristine cave with one of the most effective conservationists in Hawaii who is also an astute field biologist. He had gotten ahead of me, and imagine my shock when I rounded a corner in the cave passage and came upon the word SHIT written in 10-cm high black letters in a small patch of white cave slime. I caught up with him and gave him my lecture again on how graffitti begets graffitti in caves, but he was quite unconvinced because he felt that it was not a graffito since he was marking the location of a small pile of rat droppings which had some interesting insects on them and furthermore this was a pristine cave without graffitti and it was unlikely that graffitti artists or vandals would find it. Both of his arguments were patently false of course, and after some consideration I erased the word even though it virtually destroyed the remains of a rather nice patch of slime and its inhabitants.

Even though I remain somewhat skeptical of many education programs, show caves might provide a logical forum for public education displays. I propose that cave biologists encourage and assist private and public show cave managers in creating educational displays on cave life. These displays could include cave animals in natural surroundings in their native caves, either in terraria or peepholes within the cave. I believe that there would be economic gains for private show cave operators. With well executed displays much beneficial publicity could accrue, besides the major spinoff of having the managers learn to better understand and appreciate the rich resources under their care. Unfortunately, we would be in much worse trouble if show cave managers started exchanging fauna. In fact that prospect must be guarded against. Since Mammoth Cave is virtually the type locality of cave biology in North America, and the richness of its fauna is known world wide among biologists, the National Park Service could set an example in educating visitors to the wonders of cave animals.

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CAVE MANAGEMENT
THE BUREAU OF LAND MANAGEMENT APPROACH

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ABSTRACT

This paper deals with the Bureau of Land Management's philosophy and methods of managing cave resources on public lands in the United States.

Our approach is basically conservation/preservation oriented, with the objective of managing cave resources in coordination with other natural resource programs. This objective is accomplished through the preparation of comprehensive land use plans.

BACKGROUND

The Bureau of Land Management, also referred to by the less cumbersome title of BLM, is the United States' largest resource conservation agency. We have exclusive management responsibility for about 357 million acres (145 million hectares) or 56 percent of all federally administered lands. This land area is about 2 1/2 times larger than the country of France. These lands are owned in common by all citizens of the United States, and consist of areas which were not transferred to other federal agencies or acquired by states or individual citizens. BLM administered lands do not include National Parks or Forests, and are mainly located in eleven western states and Alaska.

BLM is a relatively young federal agency that was formed when the General Land Office and the Grazing Service were combined in 1946. The General Land Office was formed by Congress in 1812, to dispose of public domain lands and enforce mineral laws, while the Grazing Service was created in 1934 to administer grazing on public lands.

Recent management direction was given to the Bureau through two acts of Congress, the Multiple Use Act of 1964 and the Federal Land Policy and Management Act of 1976. These congressional mandates changed federal land management goals from a disposal policy to one of retention in public ownership.

Congressional funding currently emphasizes managing mineral resources for energy production, and enhancing rangeland resources. The Bureau's recreation program is but one of many resource programs which are subordinate to national priorities.

A comprehensive BLM recreation policy is still in the developmental stages, but our draft policy may indicate eventual program direction. Recreation management is intended to be service-oriented, which is accomplished by enhancing visitor experiences or protecting resources and visitors. Recreational values, including cave resources, are being managed under the broad principles of multiple use and sustained yield.

Cave and other recreational resources were not considered to be a Bureau management responsibility until the mid 1960's. It was at this time that members of the caving community contacted the Roswell, New Mexico District Office of BLM and informed them that a rancher, who leased federal lands for grazing, had denied them access to a cave located on his lease. This incident brought about an awareness by BLM of this unique resource. The Southwest Region of the National Speleologicl Society (N.S.S.) aided the BLM in obtaining additional information which revealed the extent of cave resources on public lands, and pointed out that mining, vandalism and rock collecting were rapidly destroying many of these caves.

By 1969 through the devoted efforts of a Bureau employee, Don Sawyer, the framework for a national level cave management policy was formulated. Although all of Don's recommendations were not implemented at the national level, he was successful in bring recognition to cave resource values and establishing program funding. Presently the BLM is actively managing caves in the four western states of Oregon, Wyoming, California and New Mexico.

MANAGEMENT PHILOSOPHY

At this time there is no Bureau-wide policy or guidelines specifically aimed at cave management and no federal statutes or regulations which address cave resource protection. For these reasons, localized BLM management efforts were developed using a "seat of the pants" approach.

BLM's recreation management philosophy is not to overdevelop recreation sites by filling every space with camp units, tables and toilets; nor is it to build them into existence by drawing in the public with lavish campgrounds. The recreation management philosophy is aimed at enhancing and protecting values which are presently being enjoyed by the recreationist. The manager accomplishes this goal by managing the natural resource setting, and the activities which occur within it. This general philosophy is also represented in BLM's cave resource management program. Developments made in the caves, such as trails and gates, are for the purpose of protecting visitors or cave resources, which also enhances visitor experiences. Full scale cave development or commercializaton to benefit the casual visitor or tourist is provided by the National Park Service or the private sector. Caving organizations including the N.S.S., Cave Research Foundation (C.R.F.) and others played an important part in developing this management approach.

MANAGEMENT METHODS

Recreation program emphasis fluctuates due to changes in value for a particular workload such as wilderness inventory. The recreation program must also compete for funds with other higher priority commodity resource programs. As a result of this yearly variation in funding, managers are required to use innovative approaches in order to maintain cave program integrity.

We have dealt with this funding

problem by sharing our stewardship with cave user-groups. By establishing a close working relationship with these groups we are able to draw on them for assistance with on-the-ground management. Strong public involvement and volunteer work has provided the Bureau with essential information and assistance. This approach has also been beneficial in providing grassroots support and serves as a base for information exchange.

Basic cave management is done on a case-by-case basis. Each cave requires a separate management evaluation based upon its intrinsic values. Cave management evaluation and plans are developed in a four step process:

1. Identification/ownership of cave resource;
2. Cave inventory, including classification and report;
3. Management evaluation and decisions completed;
4. Implementation of management decisions.

When a cave has been determined to be on federal land an inventory of physical and biological resources is performed. Inventory is done to determine the hazards and resource contents which are present. This information is used to establish cave management classes and serves as a data base for management decisions. These management decisions and protective measures are based upon the fragility of physical or biological resources and the magnitude of hazards which are present. Implementation may involve both on-the-ground actions (gating) and administrative actions (permit requirements).

The intensity and complexity of management needed for any particular cave is based on the potential for man-caused actions which may impact its integrity. This concept may better be explained graphically using management models.

EXAMPLE 1

Each of the boxes in example 1 (see figure 1) represent a management consideration which may deal with a specific cave. The size of each box is indicative of its importance, (big problem-big box). The diversity or number of management considerations (boxes) is depicted by the configuration of the model. The main management considerations that are intrinsic to any cave consist of the contents and hazards present. These factors provide the core of the model while other management considerations, shown as extremities of the model, may be less important or nonexistent at a particular cave.

EXAMPLE 2

Example 2 (see figure 2) represents a cave with the following management considerations: it has few hazards but has contents of some interest which deserve protection; the cave has been known by the public for a number of years and is readily accessible by an improved dirt road; oil and gas development is taking place in the same area as the cave.

EXAMPLE 3

Example 3 (see figure 3) represents a cave with the least complex management considerations: it has one room, a single passage and is small; it has no formations and little animal life, but may be of archeological interest; access is not difficult and the cave is known to the public.

As can be seen from the previous examples each cave may require a different level of management. We are presently using a three-tiered approach which is listed in the order of management involvement:

CAVE MANAGEMENT

1. Administrative measures;

2. Regulatory actions;

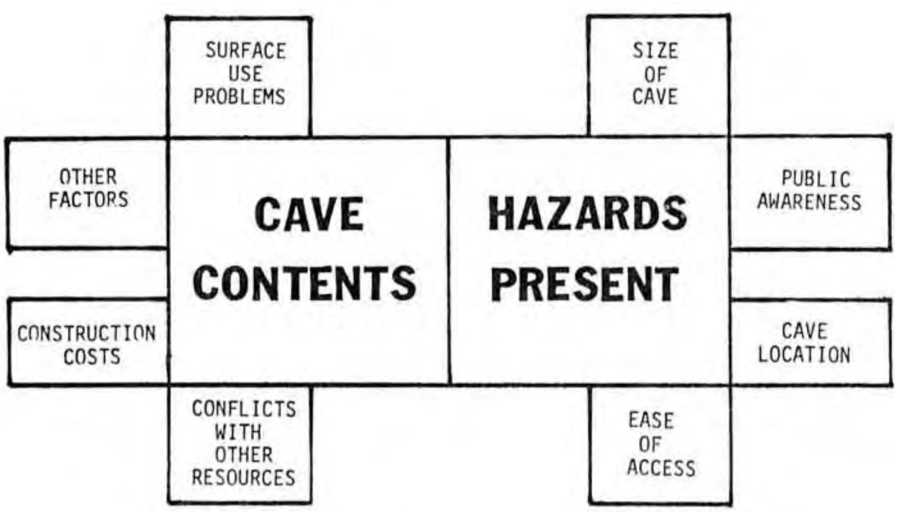
3. Physical controls.

Administrative measures involve the least stringent form of management. They could include signing, patrolling, public involvement, tours, cave talks, brochures, or other forms of public contact. This level is where public involvement and education is an important factor and can be built through administrative outreach programs.

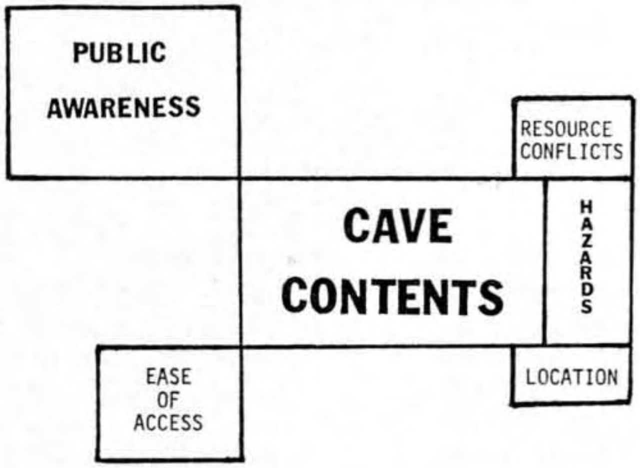
Where administrative measures are insufficient to protect the resource or visitor, regulatory actions can be taken. These actions may involve the requirement for cave entrance permits, passage and enforcement of state or federal laws, legal closures and signing.

If administrative and regulatory actions fail or are not sufficient to meet management needs then on-the-ground measures may be required. Physical controls may alter the natural setting, could impair some resources in the cave and should only be used when absolutely necessary. For example, installation of a gate to protect speleothems may inhibit the movement of a bat colony as well as have effects upon the cave's microclimate.

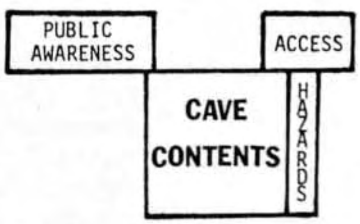
No cave management program will work without public support, which is the most important factor. BLM has achieved this support by sharing stewardship with the public. We have a good working relationship with the organized caving community - their involvement and volunteer work has and continues to provide a foundation for our program.



EXAMPLE 1



EXAMPLE 2



EXAMPLE 3

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EXPEDITION - CANGO 78

DAVE CROMBIE, DAVE LAND,
CHARLES MAXWELL, AND BRIAN RUSSELL

Reported by M. Schultz

INTRODUCTION

During the original exploration of Cango III a very simple line survey was produced to establish the approximate length and general direction of the cave.

In December, 1977, a low crawl was found at the extreme end of Cango III. It was explored and surveyed by D. Ellis and D. Land during a caving trip that lasted 26 hours and resulted in 290 m of new passage.

The crawl was revisited in June,1978, and extended for 90 m before it terminated in a complex junction area. There are a variety of possible solutions as to the way out of this area but no obvious route is apparent.

The need to join the existing surveys of Cango I and II to one detailing the crawl and terminal area became vital if further exploration of the cave was to be based on a logical approach rather than on random wanderings. The initial line survey indicated the amount of work that would be required to produce a detailed survey of the main route through the cave, all that remained was to find a suitable team.

The party was to consist of 4-5 cavers, who would be enthusiastic enough to spend several days underground and be able to work well together. By far the most sobering factor of the planned venture would be that we would be "locked in" by the sump that exists between Cango II and Cango III. Once inside the cave we would be committed to staying there until the surface party came in and pumped out the water in the sump. To get value for money, an underground stay of four days was planned, this would allow sufficient time for a detailed survey of the cave and maybe time over for continuing with the exploration work.

Like most expeditions, determining the needs and planning the mechanics of the venture became more of a traumatic experience than anything we encountered once in the cave. The more involved we became in the detailed planning the more the equipment list escalated.

The crawl between Cango II and III is some 150 m in length and is of the wet variety, hence not only would the equipment have to be kept dry but the actual size of the packs would have to be small enough to pass through the crawl.

On the 29th August D. Crombie and E. Russell drove to Oudtshoorn, taking with them all the equipment. C. Maxwell and myself were to fly from Cape Town early the following morning.

At 11:15 a.m. on the 30th August we entered the cave and began the chore of transporting all our equipment through some 1100 m of

cave to the site of our base camp. During the following 100 hours the team proved to be extremely compatible and full of enthusiasm for the project. Details from the Expedition log show that some 160 man-hours were spent on the survey, this does not include the calculations and plotting carried out each evening.

From the onset of the venture it had been decided that the survey should be of the highest accuracy possible. This had to be counter-balanced against the conservation of the cave of course. There were to be no indiscriminate wanderings through the cave just to obtain width of angle, hence the side walls of the cave were, in many cases, not visited owing to damage that would have been caused to the cave formations.

Whilst on the subject of cave conservation, I must admit that our prolonged stay in Cango III must have had some effect on the cave. However, we chose our base camp site to coincide with an area in the cave that would have a minimal effect on the main cave. No litter was left behind and we took great care not to go anywhere that was not necessary during the course of our work.

The party felt that our four day stay in Cango was a far better proposition than having to make several trips of short duration into the cave for the purpose of obtaining the survey.

GENERAL RESUME

30th August, 1978 (First Day)

Dave Land and Charles Maxwell arrived at Oudtshoorn Airport at 8:30 a.m. and were met by the other two team members, Dave Crombie and Brian Russell, who had begun to carry the general equipment and food into the cave the previous day, assisted by three Municipal employees. On their way to Cango the party visited the Town Clerk of Oudtshoorn to discuss the itinerary drawn up by the team leader, Dave Land, and the safety and communications systems to be used during the five days stay in the cave. The party turned their backs on a warm clear winter's day at 11:30 a.m. and entered the cave, each person carrying his personal gear and, after a strenuous journey through Cango I, Cango II and the stream passage, laden with equipment, the base camp was set up in the high level passage just before the first big chamber in Cango III. All the equipment was through the stream passage by 2:30 p.m.

Eager to get started, the party did a quick recce and began to position the survey beacons. Beacon 1 was located at the bottom of the ladder at the start of the first big chamber ("Krakatoa") with beacon 8 at the Intrusive Dyke and beacon 12 about 10 m past the Alpine Room.

The air at the camp felt better than in Cango II but the symptoms of a fairly high CO content in the air were still noticeable, such as increased breathing and pulse rate and increased tiredness after physical exertion, although resting did afford some relief.

The party's time was fully taken up with survey and exploration during the time underground, but it is unfortunate that the time and equipment were not available to monitor carbon dioxide levels, temperature, and relative humidity in various parts of the cave to serve as a comparison with Cango I and Cango II, as well as a means of recording these levels at the beginning and the end of the trip to ascertain the party's effect on the environment. Breathing rates and pulse rates could also have been

monitored during activity and rest to ascertain the environment's effect on the party. This will make an interesting and useful project during future trips into the cave. Although the carbon dioxide level was fairly high the party still managed to function well, both mentally and physically, sleep well and wake up refreshed. Nobody suffered from headaches while underground.

At 4:00 p.m. a technician installed the telephone link from the sump in Cango II to the base camp which was to be the only contact with the outside world once the pump at the sump between Cango II and the stream passage was switched off and the passage was once again sealed by water.

Every evening a Municipal employee would come through the cave to the telephone to make contact with the base camp. As an additional safety factor a small aqualung and diving mask were left in Cango III near the sump to enable one person to get through the flooded sump and start the pump or get assistance.

On the first night supper was prepared amid high spirits and enthusiasm, although the Optimus benzine stove would not operate without much pumping, indicating the poor quality of the air in the cave. Throughout the stay in the cave everybody ate heartily and the food was tasty and high in energy value. Water from the cave was used for cooking and drinking and was found to be very palatable. By 11:00 p.m. everyone was fast asleep, thankful for the plastic ground sheets and inflatable beds.

31st August (Second Day)

The party arose at 6:15 a.m. and left the camp at 8:00 a.m. with day-packs of food, water and survey equipment, returning at 6:00 p.m. after a full day's work. It was already becoming evident that much time and energy was to be saved by sleeping in the cave rather than making several day trips in and out again. Soon the party got into a smooth surveying routine under the guidance of the surveyor, Dave Crombie, and due to the compatibility of the team members, the morale remained as high as the productivity during the 100 hours spent underground.

Once the survey beacons, consisting of wooden dowels with reflective tape and numbered tags, were located, two cavers would tape the distance and measure the horizontal and vertical angles, estimating the height of the roof above the beacon. The other two caves recorded details of side chambers and measured horizontal and vertical angles and distances to each side of the main chamber. Where a taped measurement would have caused unnecessary damage to the floor or formations, the distance was estimated and recorded as such. Sketches were made of the extremities of the chambers, together with sinkholes, columns and other calcite formations and side systems. Various sinkholes and side systems were explored or noted for future exploration. During the day the survey progressed from beacon 12 to beacon 21.

It was noted that the cavers were becoming accustomed to the air and were performing better throughout the day. In the evening, while food was being prepared, the lamps were put on charge, the day's survey was reduced, using an H.P. 25 programmable calculator, and plotted and notes were written. By 11:00 p.m. everyone was sound asleep.

1 September (Third Day)

After rising at 6:00 a.m. the party left at 8:00 a.m. and returned to the camp at 3:30 p.m. to await a telephone check at 4:00 p.m. After a light lunch, at the beginning of the long crawl ("Pilgrim's Passage") near beacon 27, the survey progressed through to beacon 40 from where a survey had already been done to the last chamber ("Faa Chamber") in June, 1978.

After supper a survey was done from beacon 1, back past the camp towards Cango II, on the upper level until further progress was stopped by the same collapse that was found at the end of Cango II. In addition, an upper passage just before this collapse was explored, resulting in deeply cut hands due to sharp calcite crystals.

Once again sleep came easily to everyone by 11:00 p.m.

2nd September (Fourth Day)

Being a Saturday morning it was decided to make a late start, rising at 7:30 a.m. and leaving the camp at 8:00 a.m. Some unsurveyed sections were checked and loose ends tied up. The area on the south side of the large chamber ("Ice Palace" opposite the "Alpine Room") was explored and a beautifully decorated dry steam passage was found running approximately parallel to the main system, with an entrance near beacon 12, slightly back towards beacon 11. The running stream passage was explored from the fixed ladder just before the base camp for about 100 metrs, climbing along high clay banks that dropped down to the narrow stream below. Further progress was halted by a blockage on both levels.

Everyone in the party was feeling at home in the cave and the base camp was like a "home from home". The general atmosphere was very peaceful and the prolonged period of total darkness and quiet, far from being oppressive, was found to be relaxing and comforting. The only slightly unnerving thing in the cave was the "creaking rock" at the rubble slope at the start of "Krakatoa". This was a large rock hanging from the roof about 4 m in diameter and probably weighing a few tons that, in the silence of the cave, could be heard creaking ever so often and, on closer inspection, fine cracks could be seen running horizontally through it. This rock was right above beacon 1, which was surveyed in record time!

3rd September (Fifth Day)

As the main survey was complete, the morning was spent exploring two sinkholes in the first big chamber ("Krakatoa"). The first sink went down, through a clay hole into a beautiful stream passage that had water, but not running water, in it. In an approximately easterly direction a waterfilled sump was found and in the opposite direction the stream passage became tight. The second link led to a continuation of this stream passage, decorated all around with calcite formations, helictites and crystals, that was explored for about 100 m, at which stage it split into two more levels, all under the main system. The going was slow and often painful in this stream passage and time ran out with the frustating knowledge that the end had not yet been reached. From the map it can be seen that many more sinkholes were found in the cave, indicating the presence of this or other stream passages further on. The key to the cave, the present running stream passage, remained evasive and was not relocated further on. The sink just before "Pilgrim's Passage" had

previously been found to go nowhere, although this would have been an ideal place to relocate the running stream passage.

Sadly, the base camp was packed up and the party was met by a deputation consisting of the Town Clerk, the Mayor of Oudtshoorn, a number of Municipal employees and three S.A.S.A. members, which made the trip out an easy one. The entrance of Cango was reached by 3:00 p.m. and the first few breaths of fresh, snow-capped, mountain air was an unforgettable experience, charging mind and body with long-forgotten energy. An important aspect was the fact that, due to a common and important goal set for the expedition and the lack of spare time, the time went quickly and the enthusiasm never waned.

That evening a banquet was held in the Cango Caves Restaurant and the Town Clerk was presented with the rough sketch of 700 m of Cango III, the result of an extremely successful expedition, made possible by the combined efforts of S.A.S.A. and the Oudtshoorn Municipality.

THE SURVEY

The main objective of the expedition was to complete as detailed a survey of Cango III as could be obtained without undue damage to the delicately decorated areas of the cave. All four members of the team were actively involved in surveying, with two concentrating on the main traverse and two gathering detail information.

The survey equipment used consisted of two compass/clinometer sets (using Suunto KB-14/360 compasses and Suunto PM-5/360 clinometers in specially made housings) which were read to the nearest half degree and plastic coated steel tapes read to the nearest centimeter. Stations were marked with half meter long, 4 mm diameter, wooden dowels. An adhesive strip of red reflective tape, 12 mm wide and 20 mm long, was attached to the top of each dowel and oriented at right angles to the line of the traverse for ease of subsequent location of the stations. With our electric miners lamps these are easily visible at distances up to 30 m. Beyond that and up to 50 m the tape can still be seen. Survey readings were recorded in hard covered tachyometer books, using F grade pencils which were found to maintan a sharp point while not being so hard as to damage the moist paper. Sketches and notes were recorded in ring bound notepads (110 mm x 180 mm). New books were used each day to guard against damage to or loss of previously gathered information.

Stations were selected at points of change along the length and additional stations were used so that the maximum distance between any two did not exceed 50 m. All the stations were set out and labelled before readings were taken. One person took observations from one station, sighting on a light held at the adjacent station by the other person. Readings were taken in both directions over each leg of the traverse resulting in a reliable and accurate set of results. The day's readings were reduced each evening, using a programmable calculator. The position of the stations thus calculated were plotted on a large sheet of graph paper while in the cave, providing an additional check on the readings. Because of these checks it was also possible to monitor the performance of the team under those conditions. The same amount of work was done each day and quality was maintained at an extremely high level. The grade of the survey carried out in the manner described is classified at 6D (B.C.R.A. grading). Indeed,

the misclosure on the traverse over a total of 1900 m (950 meters out and back) was 3.20 m.

The final drawing up of the map was made after the expedition by again plotting the co-ordinates of each station on high quality graph paper. Detail information was then plotted from the framework of the main traverse and then a tracing was made of this and detail showing formation type and physical character added last.

CONCLUSION

Cango 78 is complete, the survey is drawn (see Figure 1) and is evidence of what can be accomplished for a very moderate capital outlay. If success is "doing what you set out to do", then Cango 78 was successful in every way.

The "locked in" syndrome, caused by the refilling of the sump, proved to be purely a psychological factor during the planning stage, once underground no one showed signs of any distress over the fact that there was a natural barrier between ourselves and the surface. In fact, it had a positive reaction rather than a negative one- we even went caving after dinner!!

In these days of superlative achievements our 100 hours stay in a cave is, probably, of little consequence, the fact that it is a South African record is, however worthy of note. If Cango gets much longer and increasingly more arduous then underground bivouacs will become the order of the day rather than the exception.

TRANSPORT OF FOOD AND EQUIPMENT

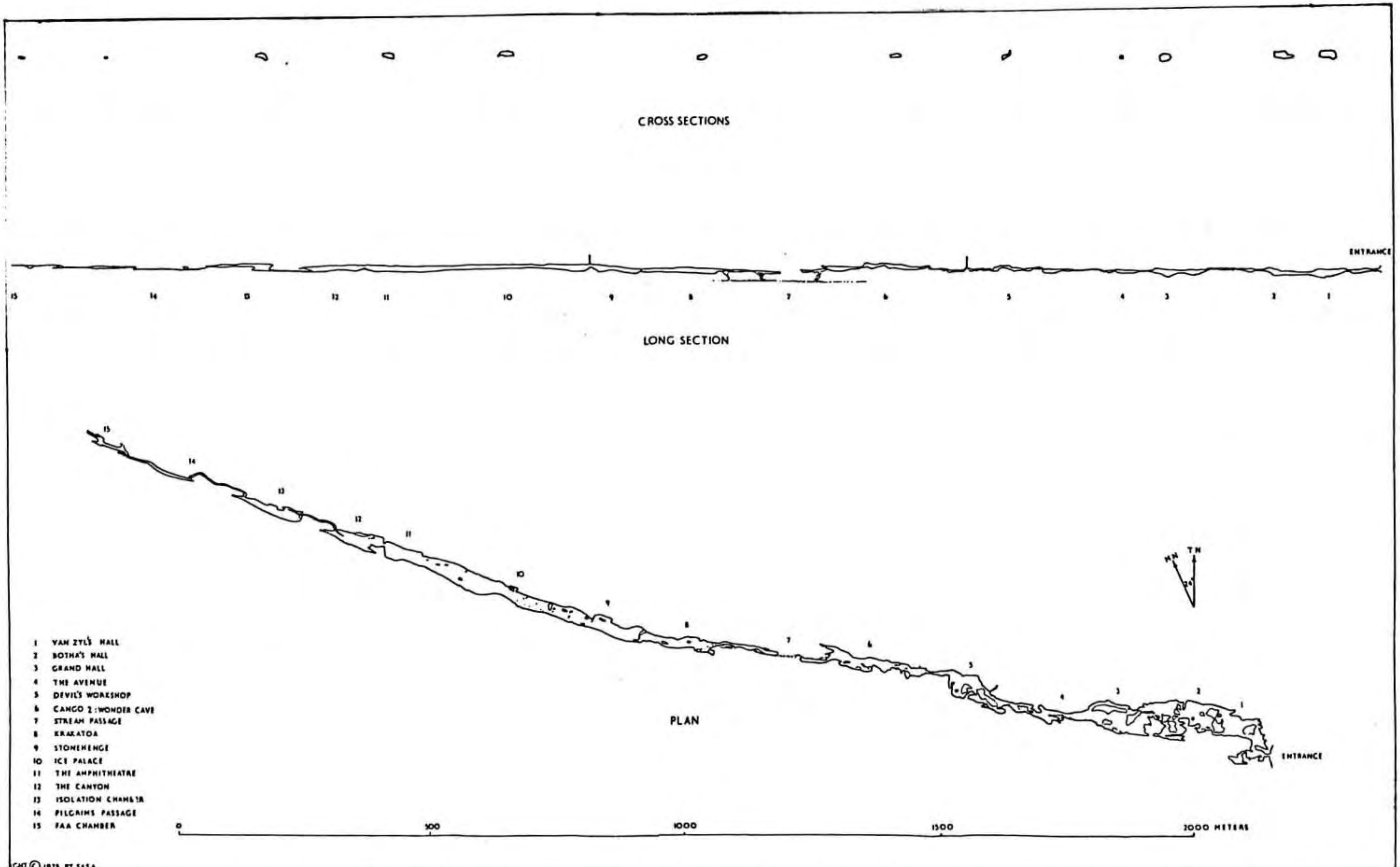
The gear had to be packed in such a way that it would be reasonable easy to handle through Cango I and Cango II, and also be safely conveyed through the wet, low stream passage between Cango II and Cango III. The size of package was chosen to optimize carrying effort and number of trips. Eight men-loads were used. Three different types of packages were used.

1. Personal gear was taken in by each individual in a military type kit bag, lined with a heavy plastic bag, with items such as sleeping bags also in smaller plastic bags to provide additional waterproofing.

2. Food and some equipment was placed in four square 20 litre paraffin tins, specially modified by the use of a yachting type plastic bulkhead hatch in the base, while the original handle was used for carrying purposes. A sled was constructed from a 1.6 mm thick sheet steel to enable two 20 litre tins to be pulled along the stream passage. These containers were waterproof and also served as a table at the camp.

3. Survey equipment, stoves, pots, rope, spades and tools were carried in a specially made aluminum tube 300 mm in diameter, 1 meter long, fitted with waterproof ends and a cone at one end to facilitate dragging through the stream passage. This container was extremely rugged, but was cumbersone and heavy.

The food chosen was to be nutritious, pleasant and appealing to all and able to last without refrigeration for the duration of the expedition. This was achieved by careful selection of a variety of foods. The quantity was to be



SURVEYED BY MEMBERS OF THE SOUTH AFRICAN SPELAEOLOGICAL ASSOCIATION 1956 TO 1978

Figure 1: THE CANGO CAVES SYSTEM

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sufficient to sustain the party for four days, with an additional day's supplies to spare. (The food cost R49-50 while the value of the food left over after the stay in the cave was P13-00).

Two Optimus benzine stoves were taken, but it was found that due to the poor atmosphere only the one which could be pressurized with a pump would burn. Cooking liquids were transferred from pot to pot before eventually being used in the preparation of food and being eaten. No cooking or washing-up water was disposed of in the cave as a result of this technique, and only a small quantity was carried out afterwards.

INTERPRETATION AS A PRIMARY TOOL IN CAVE CONSERVATION AND MANAGEMENT

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Abstract

Effective interpretation can be a valuable tool to aid speleologists in the presentation and perpetuation of cave resources. Since a majority of people are only occasional visitors to caves and they confine their visits to commercial or show caves, the burden of demonstrating the value of the underground realm lies almost entirely with the interpretive presentations available at show caves. A concerted effort must be maintained by the managers of show caves to demonstrate a high level of concern for conservaiton of their resource as well as in caves in general. From the instant a visitor arrives at a cave, he is influenced by every aspect of the operation -- the grounds, the facilities, the interpretive staff and the resource itself.

To be effective, interpretation must progress beyond the hypothesized speleogenesis of formations and include entertaining elements as well. Spontsneity, enthusiasm and expertise of interpreters becomes paramount. A review of some techniques in use at show caves in the United States demonstrates that creativity does not have to be sacrificed in achieving the conservation theme.

Speleologists can expect to be able to rally support for cave conservation only by fostering a genuine appreciation throughout the general population for the complexity of the forces affecting caves. When caves become important resources to everyone, the job of conserving them will become easier.

Cave conservation is a concern of only a small segment of the world's population. In fact, a majority of people have never experienced "wild caves" -- these are left to the adventurers. How does one answer the common question: Why go caving? For a speleologist, caves are natural laboratories providing conditions not found elsewhere and for the recreational caver they are new frontiers or challenges. But, what do they offer the general public? Until those of us who feel that caves should be conserved can realistically answer these questions in terms that are acceptable to people who know nothing about speleology, caves will succumb to other desires of mankind. They will be lost to mineral interests, energy projects, developers, rock hounds and other groups who do not or will not consider caves in their planning.

In the dawn of human history, caves provided a much more meaningful resource than they do today. Early civilizations found caves to offer a multitude of uses: shelter from hostile weather conditions, protection from predators, cold storage for supplies and even a place to express themselves through drawings on the walls. As people became more inventive they began to construct their own shelters that extended from the cave entrance and finally, entirely on the surface. Caves began to be ignored and an element of mystery and intrigue became attached to discussions of caves. The strange, different world of the subterranean realm became the

subject of folklore and exaggeration. Gradually, apprehension developed into fear and most people today find little of value, short of novelty to make caves and cave resources worth conserving.

The fact that cave resources are fragile and dependent on surface forces makes their preservation a difficult battle, especially without strong support of the population. As speleologists, we can scream about cave destruction all we want, but without public support, our energy is wasted as we lose battle after battle. The answer lies in an alternate offensive: the cultivation of a conservation ethic and cave appreciation in the general pubic. We must exercise great care however, in attempting to reach our goal. We cannot, nor should we, expect to convert every man, woman and child into an avid caver. To do so, would jeopardize the resources from another angle -- over use. We must proceed with a moderated outlook and try to convey to the public that caves are important non-renewable resources and should be preserved for the future generations.

Unfortunately, bringing caves to the surface through lectures, publications and photographs will not have much effect on people's thinking. It is only through personal experience that we seem to gain significant insight. Thus, we need to take the world's population caving! Of course such a feat is impossible, but it does pose a challenge. Probably the best way for the general public to experience a cave is in a commerical or show cave. The hardships and hazards are reduced and the route is generally tailored to make it an easy trip for everyone. Show caves are not threatening to most people and represent a novel form of entertainment for many. If we manage to get a person to take a cave tour, we have a captive audience -- this may be our only chance to convince him of the value of cave resources. I am not suggesting a "hard sell" but rather a subtle indoctrination. Only an expert interpreter can convey our message in such a manner that it is absorbed and implanted. When a cave visitor comes out bubbling with enthusiasm and excitement over the resource, we have made another convert. They can hardly wait to see another cave -- sometimes they want to go back through again! It is very rewarding to guides to know that they have accomplished such a feat.

One thing must be kept in mind throughout this discussion and that is: a visitor can be just as rapidly turned off to caves by a poor guide. In fact, it is probably easier to influence people negatively than to develop their enthusiasm. We may only get one chance to convert a would-be cave enthusiast and we must be sure that we put our best people (interpreters) where they can converse with the most visitors. This is a heavy responsibility, but good interpreters rally to the challenge. Actually, the effectiveness of any interpretive program lies ultimately with the individual interpreter's attitude, training and desire.

As important as cave interpretation is, all show caves in the United States do not operate with the same emphasis placed on interpretation. Different parameters cause interpretive presentations to vary a great deal. True commercial caves are businesses and their owners must make a profit to continue their operations. Overhead and expenses must be kept to a minimum to enable these owners to keep their admissions price to a level that the visitor will pay.

Some caves find the easiest way to reduce expenditures is to pay low wages to the guides. Such practices tend to recruit less than qualified individuals to fill the interpretive positions and the entire program suffers, and so does the conservation cause. I am not implying that all commerical caves operate in this manner but rather, where a profit or bust situation exists, it is more prevalent.

Government or publicly owned caves tend to operate at or below a break-even level. Thus, while the admissions price is usually lower, the subsidizing of operations by public funds enables these caves to put more funds into the interpretive program. This has a marked effect on both the philosophy and the techniques employed in interpretation.
Interpretation geared to a strong conservation theme is deemed inappropriate by many commercial operators and too often any conservation conveyed to visitors is more by accident than by design.
Most caves have realized that in order to protect their investment, they must curtail some practices that have historically been profitable. Such practices as the selling of speleothems in their gift shops have been contrary to the perpetuation of their own caves.
This is true even if the sales items are imported from a calcite mine (a cave mined for its saleable speleothems) because it encourages visitors to steal formations during tours because these rocks are marketable.

Interpretation of a cave is not totally limited to the tour of the underground. Well kept grounds, informative exhibits and friendly staff members set the mood and increase the visitor's responsiveness to the interpretive presentation. Long waits and large crowds should be avoided whenever possible as these factors tend to negatively affect visitors. A cave manager should place a strong emphasis on pleasing the "customer" if he wants to succeed. This is true whether there is a profit incentive or not. I have heard heated discussions between commercial cave owners and public cave managers as to the virtues of treating visitors well. Such arguments are totally ridiculous, because both groups can only survive by serving the public.

In order for an interpretive program to meet our goal of implanting a cave conservation ethic in every visitor, it must address the needs of that visitor as well.
Many people find science and scientific explanataions to be boring and even threatening, so scientific theory must be tempered with entertainment as well. While different types of entertainment appeal to different groups of people, one technique is universal -- enthusiasm. Enthusiasm is infectious and an interpreter who can foster enthusiasm in several members of a tour will soon have the attention of the whole group. The enthusiasm of a guide is not something that can be taught, but is a result of a combination of training, understanding, polish (self-confidence) and most of all, love of people and the cave. Some guides may never reach this level but it should be the goal of every cave manager to kindle this trait in all interpreters.

As I have stated previously, interpretive theory varies greatly from cave to cave and what may be very effective at one cave may be totally wrong at another. Through my observations at a number of caves throughout the United States, I have observed two distinct approaches emerging as controlling factors. I classify them as the commonplace approach and the unique approach.

The commonplace approach attempts to relate the cave to experiences visitors have had in other situations in their lives. Practices that fall into this category include what I term "fantasy tours". This is a tour that describes speleothems as looking like another object; e.g. a stalagmite that looks like a baby's bottle, a stalactite that looks like a pencil or a rock that assumes the shape of a famous person's profile, etc. Also in this category, I include the colored light shows, wax museum figurines and piped music. All these techniques attempt to entertain the visitor by presenting the cave trip as an extension of every day occurrences. Unfortunately, this approach has a tendency to negate the value of the cave as a resource because people tend to group it with other "sideshows."

The unique approach is on the other end of the scale. Caves are treated as unique and mysterious works of nature. These tours are more sensual experiences -- the stillness, the dampness and the fragility are all emphasized. Often the great age and the lack of adequate explanations are presented to encourage the visitor to acquire a questioning attitude and an intellectual curiosity about the experience. Some interpreters attempt to have their groups imagine how the first explorers must have felt -- their uncertainty, their fears and reservations. In this category, I would also include the organized spelunking tours, historical tours and candlelight tours. As an approach to cave conservation, this group of techniques has a strong positive emphasis because if we can get visitors to treat caves as unique realms, they will tend to view each cave as a separate, valuable resource.

In practice, each tour will have elements of both approaches but will tend strongly toward one or the other. As an additional measure, we must consider the visitors' attitude toward the tour as well. If we can agree that enthusiasm is a worthwhile goal, then we can extend the classification into a grid and define one end of an axis as "enjoyable" (including enthusiasm) and the other end as distracing or not enjoyable. Various factors will affect the placement of a tour on this grid. For example, a visitor who has waited a long time for a tour is already hovering toward the non-enjoyment end of the axis. In contrast, a visitor who finds the receptionist friendly and the exhibits pleasing may be well on the way toward the enjoyable end. Generally, the interpreter who leads the tour will be faced with a group that has already been conditioned before the tour begins. The guide can move the group along the grid only by overpowering the previous influences.

As far as conservation themes are concerned, the better tours are up and to the right (see Fig. 1). There are no numerical values assigned because the placement of the grid is subjective rather than objective. Philosophically,there is no measure of enjoyment, only obvious enthusiasm or disinterest. Also, there is nothing to keep a commonplace experience from being enjoyable, I have simply made a personal value judgement that the commonplace does not permit the conservation theme as well as a unique experience.

Conservation themes can also be demonstrated in other ways. For example, the touching of cave formations discolors them and reduces their growth. At Lehman Caves, we employ a box of pieces of broken speleothems at the entrance and pass them among the members of

the tour group with the understanding that they have been given the chance to feel "real" formations and they should not touch any in the cave. The practice seems to work quite well although there are still some individuals who find it necessary to touch a "wet one". Other caves have touch stones along the tour route and these are utilized in much the same manner.

Effective lighting is another way show caves can make their tours more enjoyable: the more indirect lighting used, the more intriguing the cave appears. Providing the visitor with a map of the cave helps most people understand where they have been and the understanding that often the surface gives little sign of the cave resource below. Any technique that makes a visitor think, will aid in the conservation cause. But the most important of all is the guide.

In summary, the most effective way to foster the conservation of cave resources is by presenting every cave visitor with an enjoyable and meaningful experience, thereby spreading the burden of the preservation ethic to everyone. Only by fostering a genuine appreciation throughout the general population, for the complexity and uniqueness of the forces affecting caves, can speleologists expect to be able to rally support for cave conservation. When caves become important resources to everyone, the job of conserving them will become easier.

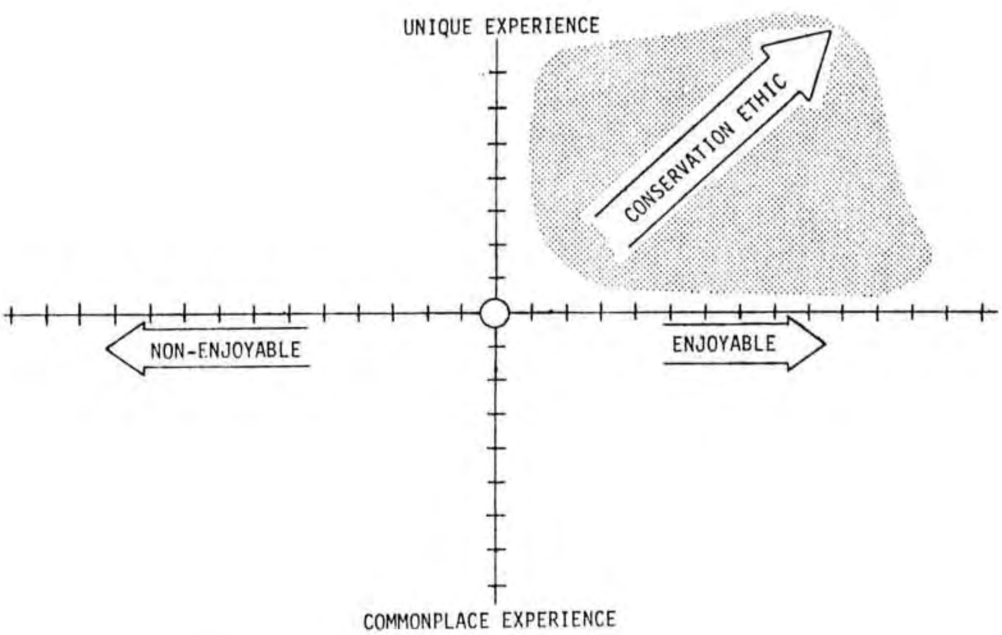

Figure 1. Grid of effective cave interpretation as it relates to the presentation of a strong cave conservation ethic.

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Papers Presented at the Eighth International Congress Conservation/ Management Session, July 19, 1981, Bowling Green, Kentucky, USA

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DIE EINGRIFFE IN DIE HOHLE VON POSTOJNS IM LICHTE DES UMWELTSCHUTZES

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Abstract

Postojna Cave is the longest Jugoslave cave which has already been open to visitors for one hundred and sixty years. It is unique regarding its morphologic, hydrologic, and biospeleologic specialties, and world-famed regarding its karst formation richness. That is why it is protected like a first class monument. Therefore, every interference in this cave region is exceptionally delicate, nobody but the staff of the Postojna Cave and official security institutions may decide on it.

My lecture shows the unusual richness of the karst formations in the caves which had - at the time when the number of visitors was constantly rising - to make way to tourist routes and later to one - and double tracked railway line which was laid in 1872. At the same time the lecture deals with interfering in the cave world to improve the routes in the cave, to place the electric bodies in it and to establish the biospeleological station in the cave, and specially to erect administration building and adjust the cave entrances. The most difficult problem was how to lay down the double tracked circular railway line, which would make it possible the cave to accept up to 12,000 visitors a day without interfering with the sintered cave galleries.

Signatures on the walls of entering passageways of the Postojna Cave supply proof that the cave had been already known and visited in the 13th century. According to the report of German biologist J. Seume in 1803, such visits had only been occasional. At such occasions a bundle of straw had been burnt in the entering part above the undergroundriver Pivka. Up to 1918 the cave had been open to public unprotected, unlit and with no guides. When the native man Luka Cec in 1818 had discovered the interior parts of the cave up to Calvary (now called Great Mountain), the cave suddenly became the center of the karst tourism. Owing to favorable siting along the European highway to Trieste, the cave has become widely known, and has become the general conception of the underground world. Immediately after the cave had been discovered, a special Cave Commission closed it in order to protect it from being robbed of dripstone formations. The Commission had some enthusiastic forwarding agents in its first secretary Joseph Jersinovic and in district engineer Alojz Schaffenrath; they bouth found an excellent explorer of the Postojna Cave underground world in the Count Frank Hohenwart. Schaffenrath's work was his outline drawing of the first artificial passage into the cave that came into existence in 1819 and is still in use now, while the oldest entrance was closed up with bricks by the cave administration. To make the newly discovered part of the cave accessible Schaffenrath had the first wooden bridge built across the

river Pivka in the Great Hall and a rocky staircase carved into nearly the vertical wall above the river Pivka. In 1830 Frank Hohenwart published the remarkable "Guide into the Postojna Cave for visitors"; in the end of the book he added 19 copper plates. From these plates can be seen, how rich of dripstone formations of the bottom of the cave still were at that time. Establishing the tourist paths in the cave, they both, the scientist Hohenwart and the practicioner Schaffenrath as well, were cooperating close together. Rocky blocks were removed from the way and put down into rocky cavities and depths so that the cave path has become passable. At that time only a narrow path was going through the cave which was essentially made better in the middle of the past century. The cave ground rich in stalagmites, has mainly remained undamaged, as the paths were running close to the walls and all the uneven paths were overcome by some stairs. One of the hardest places was at the overturned pillar, where tourists had to creep. Putting in order the paths through the cave, the miners from Idrijha had helped immensely; they had to pierce some narrow passages in order to link up the neighboring cave galleries. To protect the cave from being damaged the Cave Commission forbade to break up the dripstone formations (stalagmites and stalactites) and carry them away - immediately after the cave had been publicly opened. As this natural decoration was being immensely demanded by people, the Cave Commission made the sale legal. So from now on the dripstone formations were being cut off in the side cave passages not visited by tourists under the control of the cave secretary and were being sold in the stalls in front of the cave, as souvenirs. It was the speleologist L. A. Perko having become secretary of the Cave Commission in 1909, who again forbade selling the dripstone formations as early as before the first world war. Unfortunately still after the second world war each ten millionth and later each fourteen millionth visitor was given a pedestalled stalagmite as a souvenir which nowadays is severely forbidden. Two visits to Postojna have stimulated the Cave Commission to arrange the cave for visitors as splendidly as they could. In the middle of the 10th century the famous Vienna speleologist A. Schmidl came to see the cave and after him - in 1857 - the Austrian emperor Franc Joseph came to open the railway Vienna - Trieste. The Commission had a new bridge built across the underground river Pivka and Franc Joseps cave (now Little Cave) connected with the Emperor Ferdinand's Cave (now Old Cave).

The golden age of karst tourism began in Postojna in 1863 when Anton Blobocnik became the Cave Secretary. A new path was constructed to Great Mountain (Calvary Mountain), all the paths were protected by rail fence. From some road material in front of the Cave and from material of a buried cave passage a spacious plateau planted with trees was built. This was the new entrance, now serving as the exit out of the cave, which got an enormous, monumental iron gate in 1866.

For visitors - invalids and for remarkable guests - Mr. Globocnik had sedan chairs made. In 1872 the first track of the cave railway, 2260 m long, ws laid, which started at the "Pulpit" (see the plan, figure 1) and ended under the Great Mountain. Two coaches - each of them having two seats - drawn by cave guides began to operate on this railway. Building up the cave railway was the greatest and also the most fatal event for the cave: the beginning of a successive process in which the dripstone richness was being destroyed on the

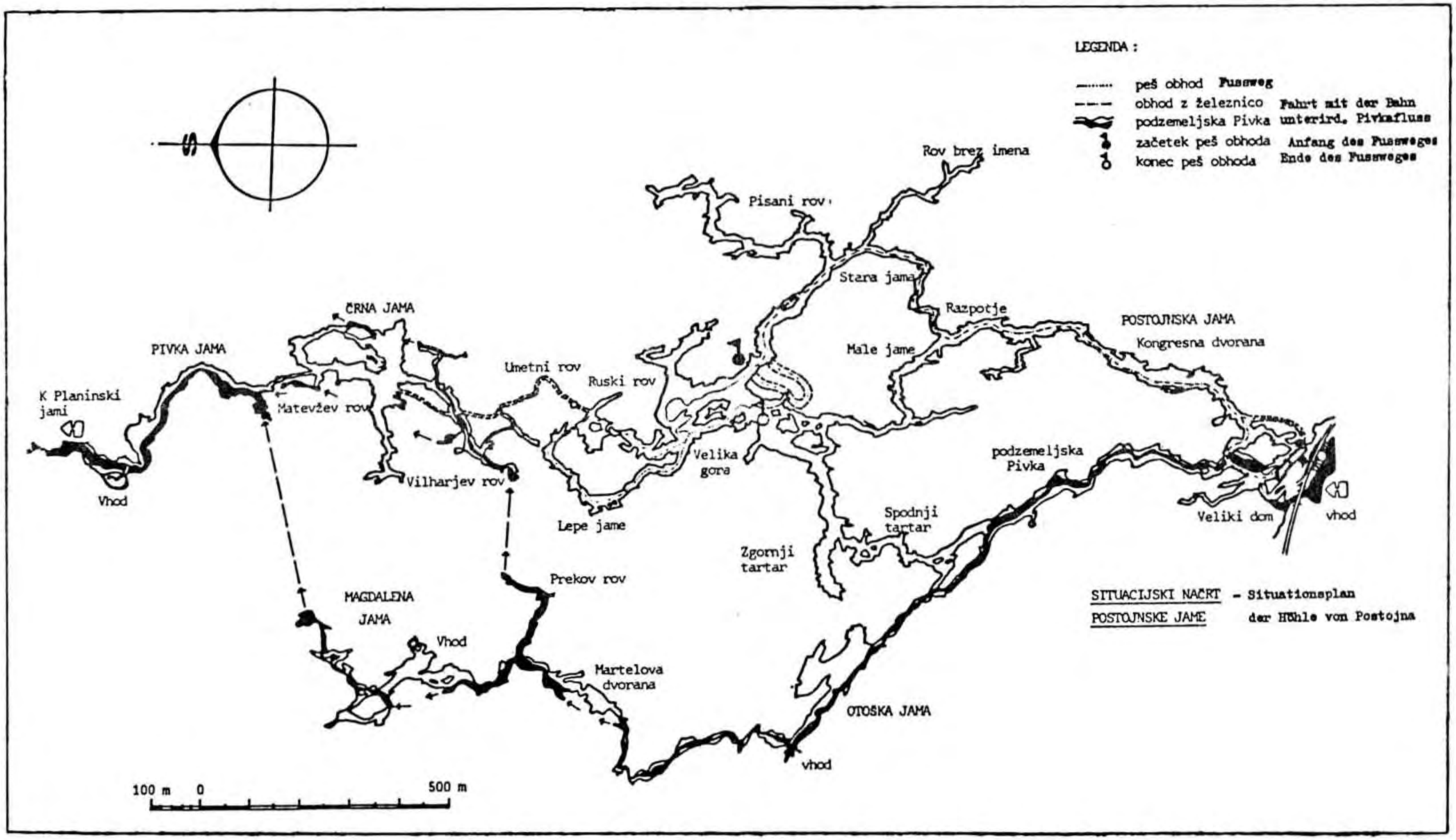
LEGENDA :
peš obhod Fussweg
obhod z železnico Fahrt mit der Bahn
podzemeljska Pivka unterird. Pivkafluss
začetek peš obhoda Anfang des Fussweges
konec peš obhoda Ende des Fussweges
Rov brez imena
Pisani rov
Stara jama
Razpotje
POSTOJNSKA JAMA
Kongresna dvorana
Male jame
ČRNA JAMA
PIVKA JAMA
K Planinski jami
Matevžev rov
Umetni rov
Ruski rov
Velika gora
Vilharjev rov
Vhod
Lepe jame
podzemeljska Pivka
Spodnji tartar
Zgornji tartar
Veliki dom
vhod
Prekov rov
MAGDALENA JAMA
Vhod
Martelova dvorana
OTOŠKA JAMA
vhod
SITUACIJSKI NAČRT - Situationsplan
POSTOJNSKE JAME der Höhle von Postojna
100 m
0
500 m

Figure 1.

cave floor and has slowly spread all over the cave floor. From the Hohenwart's guide-book containing Schaffenrath's plates, it is clear enough that the very dripstone richness of the cave floor is characteristic of the Postojna Cave. Dripstone formations on Great Mountain, in Varicoloured Gallery, Crystal Gallery and in some side passages give a clear proof of that.

So the Cave Administration was forced to sacrifice the floor dripstone formations in order to help tourism to advance. The Emperor Ferdinand's Cave (now The Old Cave) was robbed of all its stalagmites, as the floor has been levelled down. Most of these removed stalagmites were finally used as supporting walls for the cave railway or to fill in some deep holes or even to decorate the gardens of Postojna citizens (J. Sajovic, 1974, 24). At the same time all the stairs on Great Mountain were taken away by removing a part of the floor stalagmites and by excavating the path. A connecting passage in Franz Joseph's Cave (now Little Cave) was broken through as well and so this cave rich of dripstone formations has been included in the visiting area. People could walk from the foot of the Great Mountain, through Little Caves to the crossroads in the Old Caves; here they could take the train again to get out of the cave.

In the year 1911-12 the railway was extended to the very cave entrance. In 1914 the first petrol-powered engine started to drive; as the traffic was increasing, the cave began to be filled with soot. The entrance platform was in the place where administration cave building has been erected. In 1922 a more powerful engine was put in action ("Orenstein") that could drive 25 small coaches carrying 150 visitors. In 1928 administration building was erected in the wall close to the entrance, behind it entering railway station was cut into the wall.

As the number of visitors was permanently inreasing, the Cave Administration was forced to put an end to every person walking to the Great Mountain in 1903 and let visitors go by train. In this way 338 visitors could be conveyed by 3 engines at a time. Increasing numbers of people in the cave has caused growing pollution of the dripstone formations. Dripstone formations in the Old Caves have been getting covered with soot, bad smell of petrol and misty vapor have alarmed visitors. Because of all these things the biospeleological station in entry parts of the cave - the first biospeleological institution of this kind in the world - had stopped working. Unfortunately a great deal of cave fauna had become extinct and have preserved solely in the lower parts on the underground river Pivka and in the Black Cave (Pratner E., 1968, 74). Recently even in underground Pivka Cave a strong decline of typical cave animals has been noticed - among them is human fish (Proteum anguinus) which only lives in some side crevices. In 1959 electric battery-powered engine was established in the Cave. For over half a million visitors a year it was indispensable to construct a double track cave railway by making an artificial tunnel on the entry platform in 1964. Next in 1967 a 422 meters long tunnel (sacrificial tunnel) under the Great Mountain came into existence behind the circular clover leaf section and an entry station under the Concert Hall. With those additional arrangements the present traffic system in the cave came finally to an end. The daily capacity has risen to the rate of 1500 visitors. These arrangements were urgent, for in the last years the capacity of the visitors has risen to 900,000 a

year, 80% of them being foreigners. The main tourist trade is concentrated in summer, from May to September. With so many visitors in the cave it often comes about breaking stalagmites and stalactites in spite of the great care. After the second world war over 200 attempts of stealing the dripstone formations have been registered, chiefly in the Beautiful Caves, which were discovered in 1891 and opened to visitors in 1925. In this very cave dripstone formations have had to be secured (protected) by iron fence coated with plastic substance.

The last improvement (interfering) in the cave hase been made in entrance part of the cave in the Great Hall; here the visitors will be able to use a special deepened passage to get out of the cave.

In 1926 the Postojna Cave was linked up with the Black Cave by an artificial tunnel 500 meters long. Material things from the tunnel were put down in the Great Hall of the Black Cave, so that stalagmites which were formerly up to 12 meters high now are jutting out solely a few meters from the levelled rubble floor. In the same way the Black Cave was linked up with the Pivka Cave by a hundred meters long artificial tunnel.

Very unusual interfering in the cave area was its illumination. Originally the Cave was lit by torches and candles, thick layers of soot were depositd on the dripstone area. That was why in 1825 the Cave Administration forbade to lighten the cave with torches (Hohenwart, 1830, I/8). Electric lighting, brought into use in 1884, was inconvenienceing the visitors because the electric conduit was simploy drawn on gallery walls. Not earlier than in the 30 years of the 20th century the electric wires were inlaid into walls in the way that they were invisible and didn't inconvenience anyone. Interests of making use of the cave and protecting the environment have sharply been confronted within the Postojna Cave. Todays state of affairs in the cave is very good example of compromise between the economical use of the cave and the need to protect its beauty and the cave itself. From the very beginning of the cave we have had to deal with the tendency to make better use of the cave on one hand, and to protect it on the other hand. Immediately after the cave's interior parts had been discovered, the cave was closed inorder to be kept safe from the danger that its dripstone formations might be broken off. Happy cooperation between the biologist Hohenwart and practicioner Schaffenrath has positively resulted in both, protecting the environment and arranging the cave as well. The Institute for protecting natural monuments SRS that did the planning, speleologists and Cave Administration collectively published a unique publication among the tourist caves of the world in 1978: "Full equipment of the Postojna Cave " ("Celostna oprema Postojnske jame") offering a large document of text and pictures. In the book there are: geomorphological and biospeleological outline of the cave, history of tourism, interferences in the cave, description of urban arrangements in the cave, analysis of the cave places (rooms) and regulation of the cave appliances. These chapters are followed by an interesting item about the cave concerning its protection and a proposal for its common verification. In the end the book is completed by a photocatalog of interferences (improvements) that have been performed in the cave.

The book may serve as an excellent example of how the caves

should be prepared for tourist traffic (visits) and how it should be protected; chiefly because it contains much useful advice for tourist cave arrangement.

CAVE CLOSING AS A CONSERVATION METHOD

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Abstract

Cave closing may be necessary in certain circumstances. These include: 1) preservation of nature; 2) scientific purposes; 2.1) speleological research; 2.2) use of the cave environment; 2.3) use of the cave situation; 3) utilization; 3.1) show caves; 3.2) medicinal caves; 3.3) economic uses; 3.3.1) water; 3.3.2) other economic uses; 4) protection of human life.

Cave closing may be total or partial, and/or permanent or temporary. Cave closing may serve several goals at once. Cave closing must be carefully planned and designed. It is important not to disturb the natural environment, ventilation, and air flow. The closing should not interfere with animal migration, or the flow of water into or out of the cave. The entrance should remain as natural as possible. The material used to close the cave should blend with the natural surroundings. The gate should be difficult to destroy or breach. Cave closing in Hungary is briefly reviewed.

Introduction

Cave closing is an intervention into the nature and natural conditions of caves. It is a necessary evil in certain situations. This paper will discuss some of the conditions under which cave closing may be useful or justified.

Preservation of Nature

Well-decorated caves may be closed in order to preserve their original condition. Such cave preserves may be visited only at certain intervals for scientific purposes. In Hungary, one such cave is the Hideout Hole which was described by Dr. Attila Kosa in the September 1975 NSS News. The Hideout Hole is made up of shafts whose walls are covered with exceedingly beautiful, but very fragile pisolites. It is impossible to descend the shafts without destroying some of the formations. Hideout Hole was documented thoroughly, and then closed. The public can enjoy the cave through written and photographic accounts.

In some inhabited areas, caves may be closed in order to indirectly protect nature. Caves that are left open, especially vertical caves, may be used to dispose of dead animals or rubbish. Such disposal endangers any underlying caves, and may affect the entire karst groundwater system.

Scientific Purposes

Caves may be closed for a variety of scientific purposes. In such cases,

the only people who may visit the cave would be qualified scientists. Such research caves are closed to protect their natural conditions, and to protect experiments and instruments from deliberate or accidental damage. There are several categories of caves closed for scientific purposes.

Speleological research. A closed cave may be used for speleological research. This would include research on cave geology, biology, hydrology, meteorology, and paleontology.

Use of the cave environment. A cave may be closed in order to use some of its special qualities like total darkness, constant temperature, and constant humidity. The simplicity and constancy of the cave environment make caves into unique natural laboratories. In Budapest, the Hungarian Water Research Institute (VITUKI) used the St. Ivan Cave as a laboratory for many years. At the biological laboratory in Hungary's Baradla Cave, most of the research is done on plants and animals that are not cave-adapted.

Use of the cave situation. A closed cave may be used for research that is not at all cave-related. Researchers can use a cave as an isolated place to observe trace elements, or to measure the transmission of radiation through stone.

Utilization

Show Caves. Show caves offer everyone an opportunity to see the wonders of the underground world. Show caves are usually well-decorated and well-known, so they must be closed to protect the formations from vandals.

Ice caves deserve a special mention. In some cases, ice caves may only be visited during certain seasons or during certain parts of the day. The number of visitors may be limited, because body heat from large numbers of people could warm the air of the cave, and cause the ice to melt.

Show caves also have various technical installations and safety appliances such as lights and elevators. If these are used in an unworkmanlike manner, damage or an accident may result. Therefore, show caves must also be closed to protect man-made features.

Medicinal Caves. Some caves are used for medicinal purposes. These caves have to be closed to prevent damage to the cave's curative effects. Often only a limited number of people may use the cave for some restricted period of time. Too many people may warm or otherwise affect the cave air enough to damage the curative powers of the cave. Medicinal caves must be closely monitored to maintain them in a clean condition with unvarying temperature and humidity.

Economic uses. Some closed caves are used for economic purposes. The only people who are allowed to visit these caves are people who perform work or services in the caves.

Water Supplies. Some caves are closed to protect drinking water supplies. In some cases, water is obtained at the cave entrance or at a cave stream resurgence. Water may also be obtained at a spring that is fed by cave streams and sinkholes. The caves and sinkholes that form part of the underground watershed may be closed to protect water supplies.

Other Economic Uses. Caves have other economic uses that range from mushroom-growing and cheese-aging to the use of cave air for air conditioning. The microclimate of

caves may be useful in storing and preserving agricultural products (vegetables, fruits, saplings). The cave may also be used for storage simply because it is enclosed and protected from the elements.

Protection of Human Life

Non-cavers may venture into caves, lose their way, extinguish their lights, and suffer accidents. Accidents are most common in larger caves and maze caves. One way to prevent such accidents is to close frequently-visited caves. In Hungary, cavers closed all of the caves in and around Budapest where such accidents were likely to happen. Organized cavers can request keys to the caves for tourist and training trips.

It is common for cavers to find the carcasses of animals that have fallen into potholes, sinkholes, and vertical caves. Careless adults and children may also fall into such holes, especially when the entrances are obscured by brush. In some cases, cavers have to close vertical caves by building a cover or fence.

Some caves contain poisonous gas, most commonly carbon dioxide. Visitors who do not expect such gas may get a headache, giddiness, or retching that can result in an accident or death. Such caves may have to be closed to prevent such accidents.

Cave closing may be total or partial. A partially closed cave is a cave that remains open to qualified, competent visitors. Show caves are partially closed at or near their entrances at all times. If the closing is for scientific or conservation purposes, it may be adequate to close only parts of the cave. If the cave is situated on an international boundary, with entrances in two countires, it may be necessary to have a gate on the international boundary in the cave. The Baradla-Domica Cave on the boundary between Hungary and Czechoslovakia has just such a gate.

Cave closing may be permanent or temporary. If the necessary research or excavations have been completed, a closed cave may be reopened to the public. A cave may be closed so that it can be reopened easily or with great difficulty. After exploration and documentation have been completed, a cave may be closed permanently. Perhaps this cave will not be visited for decades, until cave sciences have advanced, and new research can be performed.

Cave closing may serve several goals at once. Closing a show cave may also serve a goal of preservation. The purpose of a cave closing may change with time. The Matyas Cave in Budapest was originally closed to prevent cave accidents. Later, a geophysical laboratory was established in the cave, and an area in the cave was separately closed off.

Cave closing has to be carefully thought out and designed. The closing should not badly alter the natural environment of the cave. The closing should not change the natural ventilation or air flow within the cave. This could be especially important in caves with poison gas. The closing should not restrict the movements of animals (such as bats) that live in the cave. The closing should also not interfere with the movement of water into and out of the cave.

If possible, the cave entrance should not be importantly altered. It is desirable to build any physical barriers inside the cave rather than at the entrance or surface. This is not always possible, of course. The gate should be of a design and

construction that conforms as much as possible with the cave environment. Finally, the gate or barrier should be built so that it is difficult to breach or destroy.

This discussion will conclude with a brief review of cave closing in Hungary. There are about 1300 known caves in Hungary. Of these, 34 are closed to protect natural features. There are 8 caves closed for scientific reasons. The research caves include 5 used for speleological research, 2 used for the constant cave environment, and 1 used for its isolated environment. There are 10 show caves in Hungary, and four caves that are used for medicinal purposes. Three caves are closed to protect sources of drinking water. One cave (20 m long) is used for another economic purpose; to store saplings. A total of 12 caves have been closed to protect casual visitors from accidents. The total number of closed caves in Hungary is 53 out of 1300 or about 4%.

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FRASER CAVE: TASMANIA'S ARCHEOLOGICAL LIBRARY OF CONGRESS

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ABSTRACT

The inland region of south west Tasmania was considered, in ethnographic evidence, to have been unoccupied until two artifact discoveries were made early in 1981. One of these, Fraser Cave, has been shown to be among the most significant archaeological sites in Australia and the richest in Tasmania. Despite recent inclusion in a national park, the future of the cave is uncertain because of plans for a hydro-electric development.

BACKGROUND

1. EXPLORATION HISTORY

In the 1.4 million hectares of the Southwest Conservation Area, which occupies about one fifth of Australia's island state (see Figure 1) there is only one permanent town - the hydro-electric construction village of Strathgordon. Road access is only possible via the Strathgordon Road and the Lyell Highway - apart from these corridors and two hydro-electric impoundments the region is a temperate wilderness of international significance. The inaccessibility of the area and the relative abundance of caves and karst in Tasmania (Jennings, 1975) has meant that the South West has only recently received any serious attention from speleologists. Proposals to build a second hydro-electric scheme on the Gordon River focused attention on the area and in 1974 the Sydney Speleological Society conducted the first of a series of expeditions to the Gordon and Franklin Rivers (Hawkins, Kiernan and Middleton. 1974). This trip demonstrated the extent of the limestone and confirmed its speleological potential, leading to further trips in 1974/75, 1976, 1977 and 1978 (Middleton, 1979b). On the 1977 trip Kevin Kiernan discovered F34, a significant cave which was named Fraser Cave after the Australian Prime Minister (Middleton, 1979b). The larger caves were named after leading politicians to focus attention on the caves, the area and the threats to them from proposed hydro-electric impoundments.

2. ARCHEOLOGY

Numerous shell middens on the south-west Tasmanian coastline indicate Aboriginal man frequented the area and the very limited ethnographic records (notably G.A. Robinson's diaries - Plomley 1966) show that the coastal strip was populated, albeit sparsely, until 1834 when Robinson induced the last of those remaining to leave. Such work as has been done in the coastal

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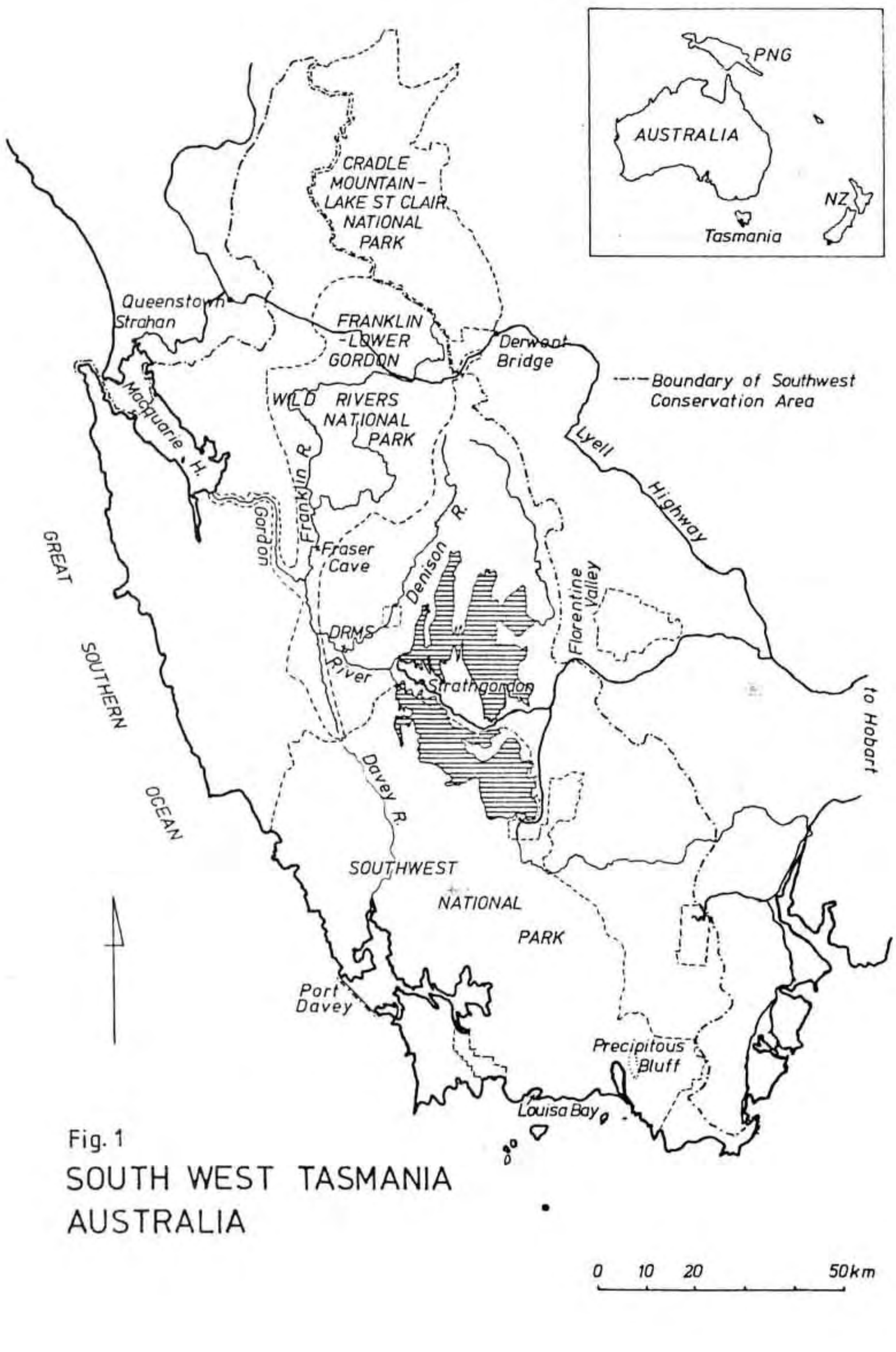

Fig. 1
SOUTH WEST TASMANIA
AUSTRALIA

middens (e.g. Vanderwal 1978) indicates they are relatively recent (hundreds to 3,000 years old) and until the present finds there was no archaeological evidence of Aboriginal man having occupied any part of the inland south-west. This was assumed to be because of the dense rainforest and its relative lack of edible plants and animals. There are, however, brief historical references, such as surveyor James Calder's note of "two natives' huts, very recently abandoned" (Calder 1849) near a tributary of the upper Franklin River.

Although not strictly in the "South West", two recently-located archeological sites in south central Tasmania indicate ancient occupation of the inland. In 1975 Murray and Goede found artifacts in a cave in the Florentine Valley (a tributary of the easterly-flowing Derwent River) dated at 20,000+ years BP (Murray, Goede & Bada 1980). The Pleistocene date suggested that the pre-Holocene vegetation may have been more amenable to human occupation than had previously been supposed.

Subsequently Corbett reported finding stone tools on a hill above Queenstown (Corbett 1980) and Keirnan (1980) found others in a moraine near Queenstown. Presumably these were deposited before the establishment of the rainforest which copper smelting removed from this vicinity in the last century.

In 1979 the Tasmanian Hydro-electric Commission released its 'Environmental Statement' on its proposed hydro-electric development of the Lower Gordon - Franklin Rivers (HEC 1979). While the Commission's statement therein, that: "There are no known archaeological sites in the project area" was not strictly a falsehood, it failed to acknowledge that no one has looked for them. While the Commission spent perhaps 1 million on scientific studies of the area, it failed to schedule one cent for archeology! Largely as a result, the National Parks and Wildlife Service organized an expedition into the area in January 1981 which resulted in the dramatic discovery near the mouth of the Denison River, by Rhys Jones and Don Ranson, of a stone core and a number of flakes (Harris, 1981; Middleton, in press). This was convincing evidence of human habitation of the inland rivers region, though there is some doubt as to whether this site fits the pre-rainforest (last glacial) hypothesis (Kiernan, 1981b). Charcoal associated with these artifacts is yet to be dated.

Kiernan's subsequent discoveries in Fraser Cave (Kiernan, 1981a,b,c) yielded an occupation site so rich that National Parks and Wildlife Service archeologist, Don Ranson, described it as "an archeological library of Congress" (Ranson, 1981).

FRASER CAVE, F34 - A TWO STAGE DISCOVERY

F34 was discovered (or re-discovered, since it proved to have long been frequented by Aboriginal people) by Kevin Kiernan on January 13, 1977 (Middleton, 1979b) by following a minor dry valley back about 30 m from the Franklin River. He subsequently briefly described it as "consisting of a number of impressive interconnected entrances leading to a sizeable passage, containing good stalactites, rimstone pools and a thick deposit of bones in a bank of cave earth" (Kiernan, 1977) (see Figure 2). While it occurred to the original survey party that the deposit was large and rich in bones, an anthropological origin was not seriously contemplated at the time (and no examimation for stone tools was made). Kiernan and the author

visited the cave again in February 1978 on a further cave-locating trip (Middleton, 1980) but again made no detailed examination of the bone deposit. However, when visiting the cave in February 1981, Kiernan realized that because of its location neither stream transport, natural pitfall nor marsupial carnivore den could satisfactorily explain the bone accumulation (Keirnan, 1981a). This time he probed the clay with a pocket knife and found a piece of stone unmistakably worked by an ancient hand. Almost immediately many more became obvious and he noticed that most of the large bones were split and some were burnt. It's amazing how the hidden may become obvious once the eye becomes attuned to it - a subsequent brief examination showed that the floor of the cave was liberally scattered with stone tools. The "large bone deposit" which was recorded in 1977 as covering less than four square meters was now seen to extend to about 100 square meters and to be perhaps two meters thick (Kiernan, 1981c).

Coming so soon after the revolutionary Denison River discovery, the Fraser Cave find broke like a bombshell on the Tasmanian community and newspaper headlines such as "Find Hailed as Tutankhaman of Tasmanian Cave Archaeology" (Sydney Morning Herald 17.2.81) echoed around the country. Supporters of the hydro-electric proposal which would flood the site and most of the rest of the limestone area called for an "independent expert assessment".

THE FRASER CAVE SITE

The extent of the cave and general area of the occupation deposit are shown in Figure 2. The bone deposit lies mainly on the western side of the chamber but stone tools are present throughout the daylight area. An excavation carried out within the main deposit during an 8-day National Parks and Wildife Service expedition in March 1981 (Harris, 1981, Kiernan, 1981a, Middleton, in prep.) under the supervision of Don Ranson and Rhys Jones yielded results which staggered these veterans of Tasmanian archeological field work. About a cubic meter of material yielded a conservatively estimated 100,000 bone and stone finds and indicated a phenomenal 150 million items for the whole deposit - undoubtedly Australia's archaeologically richest limestone cave, and probably ranking in the world's "top ten" (Ranson 1981).

The excavation itself, preliminary by nature, was confined to a meter square pit which was dug approximately 1 meter to bedrock. The material was excavated in 5 cm spits, following the gross stratigraphy, and was wet sieved through 3 mm mesh. All finds were kept.

The section showed, in the lower third, hearths mixed with clay. The lowest level with artifacts had been dated at 19,000 1,100 years BP(ANU 2785). The middle third was composed of small, angular, limestone blocks with occasional hearths. The upper third was a complex of interleaving hearths sealed by calcite deposits.

The full range of C dates have not yet been reported nor has a pollen sequence been constructed. A working hypothesis would suggest that the layer of limestone blocks represents frost fracturing during the height of the last glaciation. The basal deposits were formed during slightly wetter preglacial conditions, whilst the upper deposits show increased occupation post-glacially which was probably brought to a halt by the invasion of the rainforest about 8000 years ago.

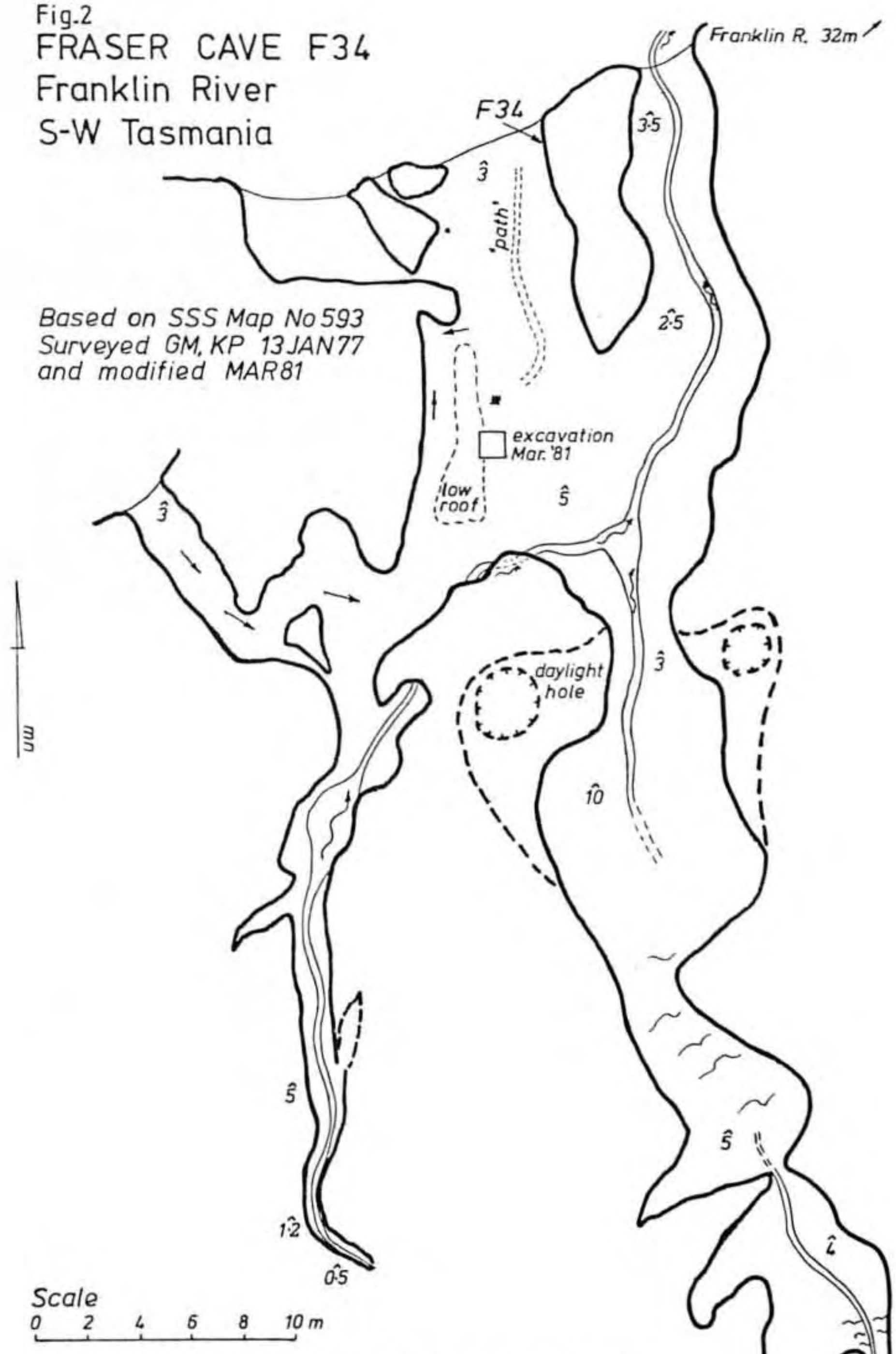

Fig.2
FRASER CAVE F34
Franklin River
S-W Tasmania

Stone tool material and bones cover much of the floor of the entrance chamber

An initial analysis of the finds reveals:

(1) Bone - Bones of Macropus rufogrisius predominate (c.95%) with the lower maxillae and limb bones making up the major component. Most of the limb bones show characteristic spiral fractures, indicating they were broken open for marrow.

Other animals present were wombat (4%), thylacine, echidna and an as yet unidentified mouse.
The faunal remains suggests an extremely tight targetting strategy with the cave being used as a base camp for the hunting of wallaby.

(2) Stone - Preliminary study suggests that the stone component represents a typical Tasmanian industry composed of pebble cores steep edged and concave scrapers, retouched flakes and flakes exhibiting "nibbling" through use.
The flake-to-tool ratio suggests a high level of on site manufacturing and maintenance of stone tools.

Of interest are the varied mineral types used, suggesting a comprehensive knowledge of the local geology by the inhabitants. Of particular interest is the collection of "Darwin glass", an impactite associated with a meteorite crater some 40 km to the northwest.

IMPLICATIONS

The presence of artifacts clearly indicates prehistoric occupation of this region. Presumably it was then more hospitable than in very recent times when it appears not to have been inhabited.

The richness of the deposit indicates a continuity or frequency of occupation, or an intensity of use, greater than any previously recorded from an Australian cave.

The fact that the bones are nearly all of one species indicates a highly specialized and consistent hunting strategy over a remarkably long period. Likewise, there appears to have been very little variation in toolmaking technology (although a variety of rock types were employed) during the entire period represented by the deposit.

The date of 19,000 BP indicates that man was living in this region before the last glacial maximum (determined by Kiernan as 18,800 500 BP (ANU 2533) Kiernan, 1980), though the standard deviation of 1,100 years means the occupation could have post-dated the actual maximum. Nevertheless, the site is certainly among the three oldest known occupation sites in Tasmania.

FUTURE PROSPECTS

Undoubtedly the Fraser Cave deposit is one of the most important archeological sites in Australia and demands further intensive research. It can also be assumed there will be other caves with occupational debris in the region and these must be located and studied.

Although the State Government has resolved to spare the Franklin River, and has resolved to build an alternative hydro-electric scheme, the Gordon above Olga, (which would

still flood the Denison River mouth site and other archeologically prospective valleys) and has created a 195,000 hectare Wild Rivers National Park over almost the entire Franklin catchment, the site remains under threat of hydro-electric development. The very powerful Hydro-electric Commission has never previously had one of its propoosals modified and has not accepted the Government's refusal to agree to the proposed Gordon-below-Franklin dam. The Commission has the full support of the (conservative) opposition and of the Upper House (Legislative Council). In fact, the Council has now twice rejected the Government's bill for the Gordon above Olga scheme and the State is suffering a continuing parliamentary crisis as there is no formal way of resolving the deadlock.

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MANAGEMENT OF A BIOLOGICAL RESOURCE - WAITOMO GLOWWORM CAVE, NEW ZEALAND

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Abstract

In 1975 the Waitomo Caves Research Program, a multidisciplinary study, was initiated. This action resulted from the recognition that after more than eighty years of tourist traffic the Glowworm Cave was showing signs of a deteriorating natural environment. As part of the program a study of the ecology of the glowworm population was carried out, the aim being to establish management procedures to ensure their long term survival. It was concluded that climate and food were the key factors for the maintenance of a large, healthy glowworm colony. A fungal pathogen Tolypocladium inflatum (Moniliales) thrived in the warm, humid conditions found in the cave in summer, and caused a significant reduction in the number of glowworm larvae. Reasons for the closure of the cave for three months in 1979 are discussed. It was recommended that the almost continous air flow through the cave be reduced by sealing the top entrance, except when ventilation was vital during times of peak tourist traffic.

Introduction

Waitomo Caves has been a popular international tourist attraction since the turn of the century. The key to it's success is the silent boat ride across the Glowworm Grotto, beneath the star-like display of glowworm lights.

The New Zealand glowworm (Arachnocampa luminosa (Diptera: Mycetophilidae)) is the larvae of a delicate gnat, its blue/green bioluminescence being produced by an organ at the posterior end. The larva suspends itself from the cave roof in a transparent mucus tube from which it hangs threads, adorned with droplets of sticky fluid. Some larvae produce over 100 of these "fishing lines" which are used to catch the flying insects on which it feeds (Richards 1960).

The New Zealand Tourist Hotel Corporation (THC) is responsible for the management of the Glowworm Cave (Fig. 1) and surrounding scenic reserves. In 1975 it became clear to many interested groups that the natural environment of the cave was showing definite signs of deterioration. This resulted in the formation, and funding by the THC, of a multidisciplinary research group, consisting of scientists from universities and government research departments. The terms of reference were "to provide from scientifically

sound data, practical advice to the Minister of Tourism on procedures that would ensure the long term conservation of the Waitomo tourist caves".

Based on the results of a preliminary report, problems requiring research were identified. In most cases the THC sponsored postgraduate students at universities who were supervised by members of the research study group. Meetings to discuss progress, management recommendations and future plans were held twice a year.

Of prime importance to the successful management of the cave, was to learn more about the ecology of the glowworm, the long term survival of which was crucial to the whole tourist operation at Waitomo. Other topics included in the research program were: cave cleaning, cave visitors and calcite corrosion, control of the lampenflora, cave lighting practices and plant growth, Waitomo Stream catchment management, hydrological and sedimentological process in the cave, cave microclimate and glowworm fungal disease.

The aim of this paper is to summerize the main findings from the study of glowworm ecology, and to emphasize management problems and recommendations made to reverse the recent decline in glowworm numbers.

Methods

Fortnightly field visits to Waitomo were made during 1978 and 1979. Cave climate was monitored using maximum/minimum thermometers, thermohygrographs and evaporation pans, placed at sites throughout the cave. Food supply was monitored in several ways. Sticky traps, made from stainless steel sheets coated with an adhesive grease "Tangle-trap" were suspended at various points in the cave roof. On the Glowworm Grotto lake (Fig. 1), emergence traps were used to quantify insects emerging from aquatic larvae from the lake bottom.

To follow the glowworms' life cycle, 0.1 m quadrats were marked out at random on the Grotto roof and walls, and observations made of the enclosed areas. The total number of glowworm lights counted in different areas of the cave was used to follow

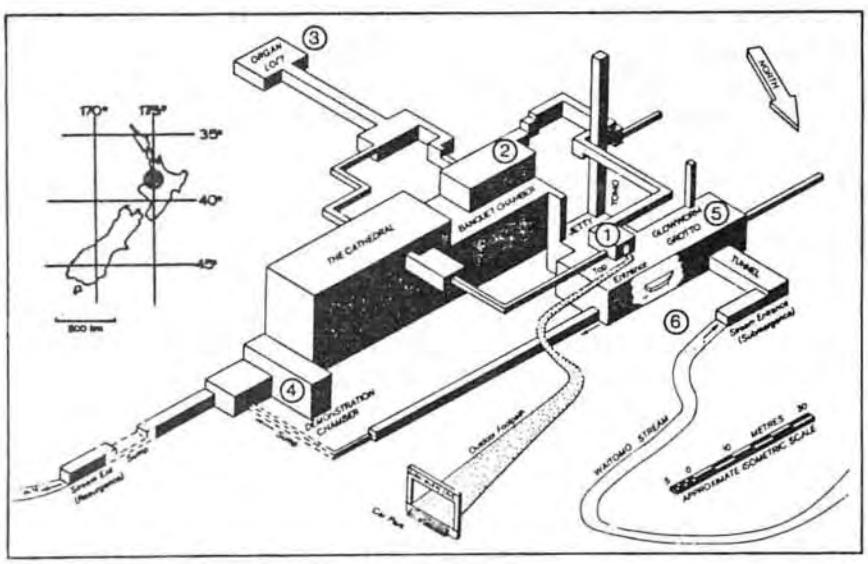

Figure 1. Location map and isometric diagram of the Glowworm Cave showing tourist route (nos. 1-6).

overall population changes.

Results

Climate:

The climate in the Glowworm cave shows much greater variability than would normally be expected in a typical cave environment. Two main factors are responsible: heat generated by the electric lighting and tourists; and the ease with which the cave atmosphere mixes with the surface air.

Typically in winter, when the cave is warmer than the surface, cold air flows into the lower entrance and is warmed and moistened by its passage through the cave. Warm air therefore blows out of the upper entrance (Fig. 2b). Besides lowering temperatures, this "winter" air current causes the drying out of the cave walls, i.e. the rate of evaporation increases. In summer the air flow reverses (Fig. 2a).

Comparison with Richards' (1956, 1960) climatic data, shows that the climate was much more uniform then, than it has been in recent years. At that time, and until 1975, a solid door prevented the free flow of air between the two entrances (Figs. 2c,d).

Glowworm life cycle and mortality:

An annual life cycle occurs in the cave (Fig. 3). Peak glowworm numbers occur in spring, dropping rapidly through summer to a low in

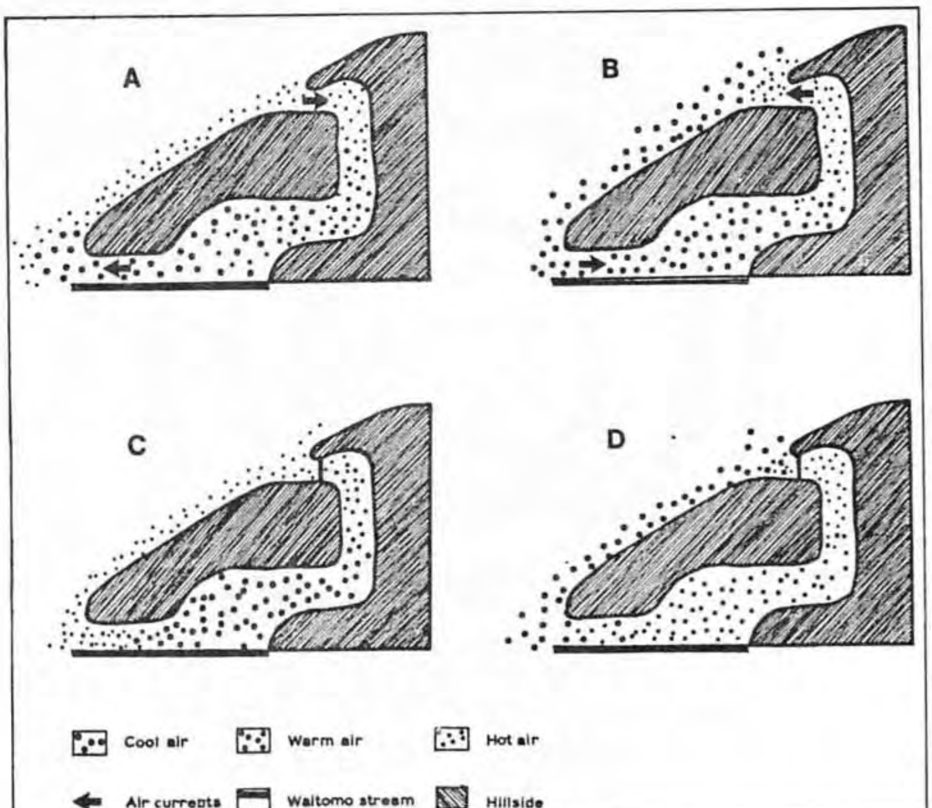

Figure 2. Diagrams to illustrate typical climatic conditions in the Glowworm cave with and without top entrance open. a. 'Summer' conditions 1977-80, b. 'Winter' conditions 1977-80, c. 'Summer' conditions predicted if top entrance sealed, d. 'Winter' conditions predicted if top entrance sealed.

autumn and winter.

During the study the number of glowworms in the Grotto fell (fig. 4). One of the main causes of mortality amongst larvae and pupae is a fungal disease Tolypocladium sp. (Moniliales), which in summer results in the appearance of white cadavers on the cave walls. Preliminary experiments show that the growth rate of this fungus increases rapidly over the range of temperatures reached in the Grotto in summer. Other causes of mortality include cannibalism, practiced mainly by early larval stages, and predation by opiliones (harvestmen).

Food

The majority of the food supply consists of freshwater insects (mainly chironomid midges), which emerge from aquatic larvae on the muddy bottom of the stream (Fig. 5). Few insects enter the cave from outside, most enter as larvae carried into the cave by the stream. The fact that glowworms usually flourish in the cave is almost certainly related to the abundance of food provided by the cave lakes, which act as traps for aquatic insects drifting downstream. Very few glowworms occur away from the stream passages, those that do must rely on insects flying from these

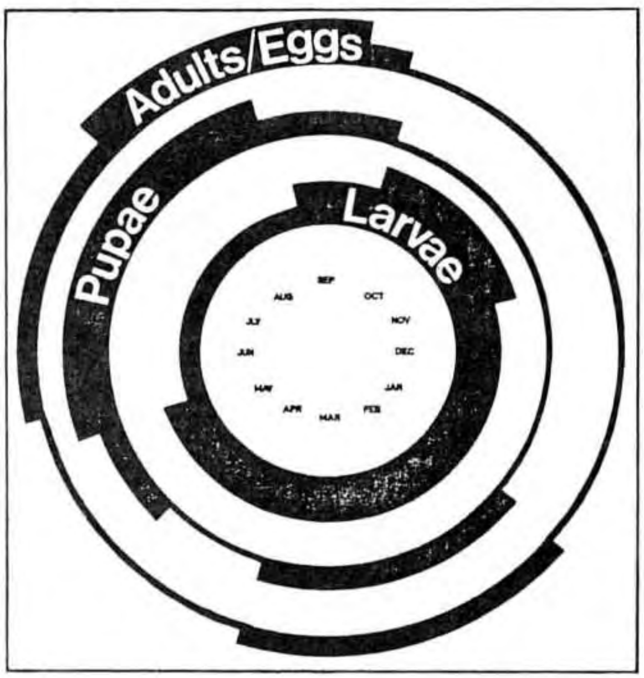

Figure 3. Life cycle of the New Zealand Glowworm Archnocampa luminosa (Skuse) (Diptera: Mycetophilidae) in the Waitomo Glowworm Cave 1977-1980.

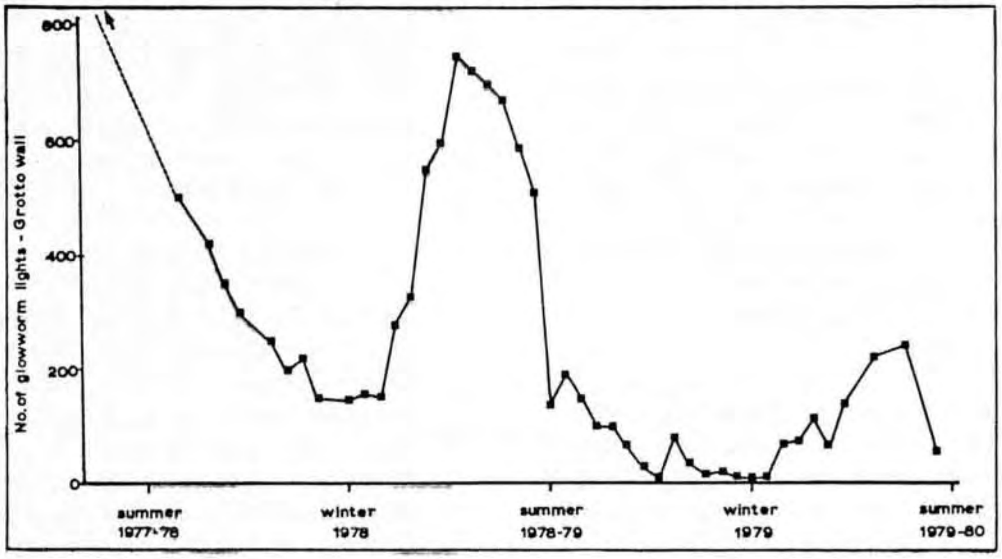

Figure 4. Decline in the glowworm population on a section of the Glowworm Grotto wall 1977-80.

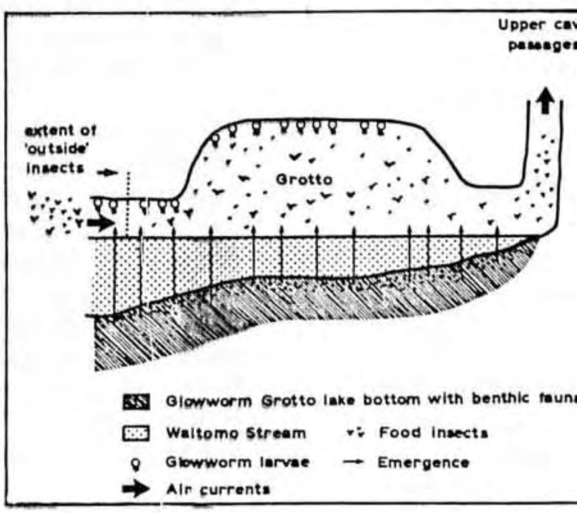

Figure 5. Diagram to illustrate the ecological relationships in the Glowworm Grotto.

areas. Air currents may well play an important role in distributing food in the cave.

Discussion

During the winter of 1979 the cave was closed for three months when the glowworm display was inadequate as a tourist attraction. The excellent, but inaccesible display in the Demonstration Chamber (Fig. 1) downstream of the Grotto, indicated that other parts of the cave were unaffected. Although the glowworm population in the Grotto is usually low in winter, this was not the main problem. It was that the few glowworms that were present in the Grotto roof had stopped glowing. The only explanation for this unusual behaviour was that it coincided with very dry conditions in the cave.

Cave glowworms, unlike those that live in the bush, have no defense against desiccation, in that they cannot retreat from dry air by retreating into "burrows". There is a possibility that larvae may turn off their lights in response to high evaporation rates. However, this hypothesis still awaits experimental verification.

The cause of the general decline in the glowworm display in recent years is because of a number of complex interacting factors, some of which are discussed below.

An adequate food supply is provided by the Waitomo Stream, but future planning should ensure that any changes in the catchment do not jeopardize the glowworms' food source. The effects of air currents, and periodic desilting operations to keep the Grotto navigable, may however upset the distribution, quantity and seasonal availability of the glowworms' food supply.

The fungal disease is present in other caves in the Waitomo district, but cadavers are rare. What little is known of the ecology of the fungi suggests that in the Grotto, a combination of draughts, to carry the airborne spores, high summer temperatures and relative humidity, make for ideal conditions in which it can flourish.

Many of the current problems can be linked to the change in climate, caused in part by the opening of the top entrance in 1975. The installation of the open grill was done to relieve an earlier problem, that of the build up of carbon dioxide and stale air in the cave when tourist traffic was high. The increased ventilation and the re-routing of tour parties away from the Organ Loft (Fig. 1), the main problem area, has been successful. However, the decision to erect the grill was made before the full consequences of its affect on cave climate and the glowworm population were realized. This exemplifies the importance of researching the effects of any manipulation of the cave environment, before and after, it is put into action.

To resolve the cave ventilation problem, a research program was started to study cave meteorology. Until the results of this work are known, plans for further modification of the top entrance have been held in abeyance. It was recommended that the top entrance be kept sealed unless tourist traffic was high enough to warrant ventilating the cave.

The Waitomo Caves research program has now been running for six years. The liaison between the THC management and researchers has been excellent. The caves are already recovering from the problems of the early 1970's, as results and recommendations from the study group have been put into practice. The

interest in, and help given to research work, by THC staff and local people, has resulted in an increased awareness of the problems facing cave management. This knowledge based in the Waitomo community, may well be the most effective defense against future decline in the glowworm population, or deterioration in the cave environment.

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CAVE CONSERVATION IN THE UNITED STATES OF AMERICA AN OVERVIEW IN 1981

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Abstract

Growing out of a rising environmental awareness in America in the 1960's, cave conservation activists have worked hard to obtain protection for caves during the 1970's. Efforts have concentrated in several areas: education of cavers, cooperation with government land management agencies, identification of and fighting against environmentally unsound projects affecting caves and karst, inclusion of caves in the National Wilderness Preservation System, ownership and management of caves by cavers, obtaining passage of state cave preservation laws, and in one case an official State Cave Commission, and protection of endangered species of cave life. American speleologists have chosen a low-profile path, avoiding that public media and shunning contact with the general public. This ostrich-style approach may have reduced the effectiveness of cave protection attempts, but has certainly prevented caving from becoming a widely popular sport which might result in the destructon of many, if not most, caves. Organizations most active in cave conservation efforts have been the National Speleological Society and its many local chapters, and the Cave Reserach Foundation with its close relationships with Federal agencies. The efforts of thousands of individual cavers, working on the local level, are probably responsible for the successes that have resulted, in spite of a lack of strong direction from the national level after 1975.

In 1966, Victor A. Schmidt, who was at that time Chairman of the Committee on Conservation of the National Speleologicl Society, outlined the status of American efforts at cave conservation in an article in Studies in Speleology (Schmidt, 1965). In that article, Schmidt listed several problems of importance: both professional and casual vandalism, the over collection of biota, pollution of groundwater, and unexplained decreases in bat populations. He noted a trend towards increasing destruction of caves by public works projects, such as dams and highways, and finally he predicted that the major problems of protecting caves were yet to be faced.

When Schmidt wrote in 1966, the National Speleological Society (NSS) had about 2500 members, representing, it was supposed, about half the cavers in the U.S. The world's longest cave was still in bits and pieces awaiting connection. In spite of 25 years of attempts to convince the American public that caves were important and deserved protection -- the message still hadn't gotten across.

Into this world of 1966 emerged the American and worldwide environmental movement. Laws were passed to protect the environment. Conservation activists within the NSS began pushing for more action. Cavers started putting their efforts into fighting conservation battles and attempting to save caves from the outside world. Up until this time, American cavers had probably been most concerned and occupied with saving caves from themselves. The adoption of the NSS Conservation Policy, in 1960, presented a strong conservation ethic as the accepted mode of caving. But putting into

practice what the Conservation Committee preached was a slow process, almost depending on a complete turnover of the membership and constant exposure to the message. But by the beginning of the 1970's, the battle had been won -- at least within the NSS. Almost all NSS cavers accepted and practiced the high standards of the NSS Conservation Policy. In those instances where the policy was broken or misinterpreted, peer group pressure led to acceptance of the attitudes.

In the late 1960's, however, cave conservationists began to realize that too many people caving would eventually lead to destruction of many, if not most, caves. With the growing self-awareness of conservation came a growing sense that if the public didn't know about caves, it would limit the potential for damage from groups outside organized caving. So in the early 1970's it became official NSS policy to seek no new members -- and especially to do nothing to encourage the general public to go caving. The result of this policy was that the general public did not recognize caves as being valuable, and thus the problem of obtaining protection for them became that much harder. As many people pointed out the problem did not go away, it just went underground.

Coupled with the environmental movement in the U.S. was an increasing awareness of outdoor recreational activities, and an increasing participation in such sports as mountain climbing, hiking, and in spite of the efforts of organized cavers to keep it under cover -- caving. Especially in areas containing many caves, hordes of young people -- ranging from Boy Scouts to school groups -- ventured under the ground. Caves that they knew about were vandalized extensively.

A growing awareness of this problem has led the NSS in the last few years to modify its membership recruitment policies, but not without some controversy. In spite of the protestations of the radical secrecy advocates, the NSS now is attempting the recruit all "existing cavers" into the organization -- not only to gain their support for cave protection -- but to expose them to high standards and ideals of caving and cave protection.

While lowering their public profile, cave conservationists raised their private one. Since, in the western part of the country in particular, the majority of caves are owned by various government agencies, cave conservationists began to work closely with public agencies to influence policy and encourage good cave management practices -- include limitation of access, gating of significant caves, and in some cases commercialization. The efforts of many local groups led to progressive policies on the local level, and it was soon recognized that there was a need for communication among cave managers and the caving public. This led to the first National Cave Management Symposium at Albuquerque, NM in 1975 -- since followed by annual symposia throughout the nation. These symposia have produced much communication and the publication of several volumes of proceedings (Speleobooks, 1976, 1977; Zuber et al. 1978, Wilson & Lewis, 1982). The dialogue has finally moved from considering whether we should save caves to how to go about it.

Although the bulk of the work on the Interstate Highway System was completed in the 1960's (at least in rural areas), continuing efforts at control of the nation's waterways by various federal agencies have continued. Cave conservationists have met these projects with varying responses.

In the case of New Melones Dam and reservoir in California, cavers decided to attempt the path of cooperation. By working with the U.S. Army Corps of Engineers to identify caves which would be adversely affected by the reservoir, and helping to mitigate the potential loss of caves and endangered species, members of the New Melones Conservation Task Force were able to obtain the creation of several cave preserves and the relocation of an endemic species of spider to another locale. Thus the loss of some caves will be offset, hopefully, by the preservation of others which might not have ever been protected without the presence of the dam.

At the other end of the spectrum the Meramec Conservation Task Force fought successfully to stop the Meramec Dam project in Missouri, which would have inundated over 100 caves. Other conservation battles have involved strip mines, uranium mines, and the continuing battle for wilderness protection.

With the passage of the Wilderness Act in 1964 (see references), the American Congress committed federal land management agencies to a review, within ten years, of all existing wilderness to determine if it should be preserved by statute permanently. Cavers had worked hard for passage of the Wilderness Act and now were faced with the monumental task of identifying which potential wilderness areas contained caves and which should be supported for inclusion in the National Wilderness Preservation System (NWPS). Efforts were in particular concentrated on the two most important cave National Parks -- Mammoth in Kentucky and Carlsbad in New Mexico.

Although the Wilderness Act does not specifically mention caves, it was soon concluded (by conservationists at least) that it did not exclude them. And a new concept was developed -- underground wilderness. The idea was first proposed formally at a preliminary wilderness planning meeting at Mammoth Cave National Park in 1967 by the NSS. Although the surface lands in Mammoth Cave National Park are not considered suitable for inclusion in the NWPS because they have been recently farmed, the underground portions of the park are still of wilderness quality. Why not include just the underground part of the park in the NWPS? This would provide additional protection for the caves, raise the standards of care, and assure that the world's longest cave (as it became five years later) was adequately protected and managed. Unfortunately the federal agencies have fought against this concept at every opportunity. Although they have been forced to acknowledge the legality and practicality of the idea, they have not yet created any underground wilderness areas. Thus the battle still goes on. At Carlsbad Caverns National Park, however, where the surface areas are of wilderness quality, large portions of the Park have been included in the NWPS, and thus many of the caves have been protected as wilderness.

In the Eastern part of the country most of the land is in private ownership, and cavers have worked with private landowners to assure continued access and in some cases have actually taken over management of caves, installing gates and attempting to limit access by peer-group pressure. But this has not been completely effective. Thus many cavers and organizations have acquired caves which they are managing themselves as cave preserves. The NSS owns two caves -- Shelta Cave in Alabama and McFails Cave in New York. The Butler Cave Conservation Society was

formed in the 1960's to own and manage the longest cave in Virginia (Hess, 1977). The Northeastern Cave Conservancy has recently acquired Knox Cave in New York. Many other groups of caves have pooled their resources to purchase and manage other caves and cave systems.

There are no specific Federal cave protection laws, although caves and cave features are protected under statutes aimed at other problems, such as the Water Pollution, Endangered Species, and Antiquities Acts. However, many states have enacted cave protection legislation since the late 19th Century, when Wyoming and Colorado enacted laws to protect caves. Until the 1960's such laws were usually appled specifically to show caves. Beginning in the 1960's cavers, speleologists, and cave conservationists became more active in seeking cave protection laws, and by the end of the 1970's almost all of the important cave states have adequate laws -- Kentucky being the major exception. These laws usually go beyond merely prohibiting vandalism and also protect caves from pollution and protect cave life. Whether they are truly effective, of course, is another question, since there is little public pressure for their enforcement and unless a vandal is caught in the act it is difficult to obtain a conviction in the courts. The passage of adequate protection legislation remains high on the list of priorities for cave conservationists in the U.S., however (Fiack, 1980).

Cavers in the state of Virginia have accomplished the most. The Virginia cave protection law passed in the early 1960's was the first of the more comprehensive laws and became the model for many others. In the late 1970's, cavers worked hard for the establishment of a State Cave Commission to review this law, and this Commission eventually recommended, and the legislature passed, a more comprehensive law. Although there has been little funding by the State, the life of the Commission has been extended and it continues to monitor the status of caves in Virginia and work for their protection (State of Virginia, 1979).

Many states have laws protecting endangered species, but the most important means of protection is through the Federal act. Several species of bats and cave invertebrates and fish are currently so protected, and others are in the process of designation. Speleologists have continued to work with the office of Endangered Species to identify and obtain designation for endangered and threatened species of cave life. Currently, efforts are continuing to obtain listing for the Kentucky Cave Shrimp, Palaemonias ganteri, which is found in limited numbers only in Mammoth Cave National Park, and is threatened by pollution from the nearby sinkhole plain.

In spite of the efforts of Jim Quinlan at Mammoth Cave National Park, Tom Aley at the Ozark underground laboratory, and many others, the public still has little knowledge of the complexities of karst environmental problems. Land planners in karst areas still overlook what seems to speleologists to be most elementary -- that just putting something underground will not necessarily get rid of it. Changing public attitudes by education has been a slow and frustrating process. But when the U.S. Environmental Protection Agency, in 1981, treats karst terrain and its special and difficult problems as a trivial case in developing its Proposed Ground Water Protection Strategy, one wonders just how much progress has been made in informing the very

people who should be educating the public.

In working for protection of caves and related features cave conservationists have always faced the misconception on the part of the public that caves are dark places harboring evil and undeserving of public protection. In fact, the caving establishment has promoted this image, because it has been legitimately feared that if the public greatly appreciated caves they would wish to visit them and thus inadvertantly cause their destruction. Because the U.S. has been a relatively affluent country, with a large number of caves, there has been a relatively large number of show caves that have provided some opportunity for public visits. With the exception of a few government-owned show caves which have accented environmental education, until recently the show cave experience has usually been more of an entertainment experience and has lacked an education orientation.

Published cave books have tended to be the "Guide" type, which has made them controversial in the eyes of the caving community and has usually caused them to be of high circulation but limited value in promoting cave conservation. Most high-quality "cave appreciation" books that have circulated in the U.S.A. have originated in Europe.

Organizations active in cave conservation efforts have included the NSS, with its many local chapters, the Cave Research Foundation, principally involved in research and education but also concerned about conservation, and a variety of general conservation organizations including the Sierra Club, the Audubon Society, the Friends of the Earth, the National Parks and the Conservation Association, and the Wilderness Society.

The NSS, with its over five thousand members and many local chapters, has probably contributed the most to the cause of cave conservation through its attempts to support and encourage local activists in their battles and via the communications afforded by its national publications and local chapter newsletters.

The Cave Research Foundation has worked hard to develop close ties with various Federal agencies in furtherance of its research goals, particularly at Mammoth Cave National Park in Kentucky. At the same time CRF leaders have realized that without preservation of the resource that they would be unable to study it. Although CRF took a relatively low profile until recently, within the last three years it has vocally spoken out with respect to important issues at Mammoth Cave and in other areas. Other conservation organizations have generally tended to give support to cave related conservation issues when requested, but have generally not taken the initiative. The Nature Conservancy, however, has purchased and preserved many caves. Most conservation successes that have occurred have been due to the hard-working efforts of local cavers who have become convinced that without their efforts to intervene in an issue that the caves would suffer.

Although the pronouncements of various cave conservationists (including myself) have tended to view the future with apprehension, I feel cautiously hopeful that an increasing number of caves will be preserved and protected. The trend in recent years for increasing caver control of caves through ownership is one hopeful sign. Increased awareness and activity on the part of Federal and State land managers

has resulted in a more enlightened management of government owned caves. And there is a large body of concerned cavers who will continue to be vigilant and to deal with issues as they come up. The combination of improved state laws, self regulation on the part of cavers and scientists, and an effort to halt public sales of speleothems via economic boycott and peer group pressure has succeeded to a certain extent in reducing the vandalism problems. A very conservative attitude towards collection prevails, especially with regard to bats. Although population declines continue, the increased awareness on the part of the cavers, scientists, and the Federal government have been hopeful signs.

Ultimately, however, the real conservation of American caves depends not only on continued vigilance on the part of cave conservationists, but an improvement of the public image of caves and cave related features, which will require increased public education about the need for cave conservation and protection.

As cavers are able to take management of caves into their own hands, they will be better able to control that management. Even though this control will represent only a few of the more than 20,000 caves in the U.S., at least some of them will be preserved. The rest of the caves may survive also, in varying degrees. Most of the traffic is to those caves which are well known, and although these caves will certainly be subject to destruction and degradation, others that are less well known will be relatively protected. But this puts the responsibility even more strongly on those who own and protect, and presumably manage well, those caves which cavers do control. Only by increased vigilance and efforts on the part of the conservation community will we assure that there are some relatively undamaged, wilderness caves existing in the next century.

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PHOTOMONITORING AS A MANAGEMENT TOOL

PETER J. UHL

Box 244, Larami, WY 82070

Abstract

Cave photomonitoring is a term used to describe precise photographs of selected points within the cave taken on a regular basis. These photographs can be used for inventory, as a record of change and as a basis of information for management decisions.

The system discussed has evolved from the work of others, from four years of use in Horsethief Cave, Wyoming plus two additional years of monitoring in the same cave by the author. Items to be considered are: types of equipment; location of photopoints; camera set up; film processing and analyses of photographs to give objective; permanent and repeatable results. Some examples of the reslts are obvious at a casual glance, while others require a thorough knowledge of the system and the subject matter in order to be discerned.

As a management tool, photomonitoring seems to have found favor with cavers and both private and government cave managers due to its objectivity, permanence, repeatability and low cost.

Definition and Objectives

Cave photomonitoring can be defined as a series of precise photographs of selected points within the cave which are taken on a regular basis. These photographs can be used for inventory, as a record of change and as a basis of information for management decisions.

A cave inventory in written form, or even combined with an accurate map is often inadequate. Written descriptions can be long, ambiguous and often incorrect. A photograph, if well taken, is compact, to the point and accurate. However, a photograph without written commentary is subject to the interpretation of the viewer and his experience with the subject. Also, photographs used for inventory purposes are almost useless unless they can be related to a map of the cave so that precise locations can be established. For inventory, a combination of photographs and written commentary related to an accurate map should cover the needs of the cave manager.

As a record of change within the cave, photographs cannot be excelled. Written descriptions can vary depending on the author and cannot approach the detailed accuracy of photos. On a precise photograph, measurements can be made which may be undetected by the human eye. Also, changes can be shown graphically by a comparison with previous photos.

Photographs, written reports and an accurate map are important cave management tools. The photos are a

permanent record of the cave when management personnel are changed and can be duplicated precisely by anyone, regardless of their interests or training. The same series of photos, taken at intervals over a period of time, can provide an objective view of the cave which is virtually impossible with written records. After the initial photographs are taken and analyzed, an update on the conditions in the cave can be obtained by repeating the same series of photos at any later date. The use of photographs can be an inexpensive method of obtaining consistent data without extensive training of unfamiliar individuals in methods of cave inventory.

The system described has been used by the Worland, Wyoming District of the Bureau of Land Management and was developed over a four year period. All of the methods discussed have been tried, and, when necessary, modified to give usable results.

Equipment

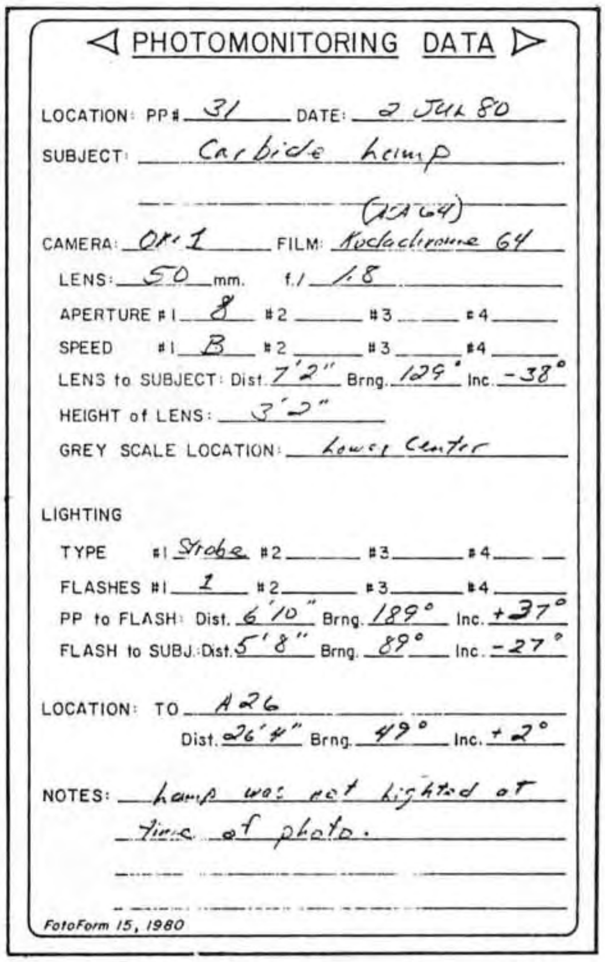
Camera - A single lens reflex 35 mm camera is used due to its availability, compactness, reliability, and simplicity. Lens - A standard lens for the 35 mm SLR camers (i.e.; 50 mm) was found to work best for most of the monitoring photos. A wide angle (28-35 mm) lens may be useful in certain situations. Tripod - The tripod is essential for properly locating and orienting the camera. It must be sturdy and compact to withstand the abuse of travel through the cave. Film - For monitoring photos a color print film seems to be the best choice. Color prints show changes in size and shape as well as color changes in the cave. Prints are also easily compared and direct measurements can be made from them. Black and white prints are less expensive but subtle changes in the cave environment may be harder to detect. Changes such as accumulation of dust on formations and the presence of moisture on the walls or floor of a passage show up much better in color. Transparencies are not recommended because of the difficulty of viewing them and the problem of making measurements on them. Plumb bob - used to locate the camera directly over the photopoint marker.

Tape - A 50 or 100 foot steel tape or equivalent is necessary to measure distances. Care must be taken to record the units of measurement or confusion will result such as mistaking inches for tenths of a foot or meters for feet. If it becomes necessary to convert from one unit to another, it should be done beforehand, not while setting up the photo in the cave. Brunton Compass - A brunton compass or other method of ascertaining bearing and inclination is necessary to orient the camera and strobe. As with the tape, be sure units of measurement are consistent and the compass is calibrated the same as for previous photographs. Grey Card - A standard photographic grey card and/or color scale should be included in each photo as reference for film processing. In addition there should be space for a scale and photo identification informatin. Data Forms - All data for each photo should be included on a standardized form (Figure 1) and a notebook should be included for additional written commentary. Copies of previous data and photos - It was found useful to have copies of the previus photos as well as the data for each photopoint when setting up the camera for subsequent photos.

Strobe - A strobe has been found to be the most reliable and most economical source of illumination. The strobe should have an open flash provision and can be either manual or automatic. An automatic strobe

seemed to provide more consistent results than a manual one in most situations. Cable release - A cable release which can be locked open is necessary for best results.

Carrying Box - All of the equipment with the possible exception of the tripod will fit in a surplus .50 caliber ammunition box, which is readily available and provides excellent protection for the equipment. More or less protection may be required depending on the cave being photographed. Miscellaneous - Items used in general photography such as spare batteries for the camera and strobe, lens cleaning equipment and other items should be included as necessary.



◁ PHOTOMONITORING DATA ▷

LOCATION: PP# 31 DATE: 2 JUL 80

SUBJECT: Carbide Lamp

(KA 64)

CAMERA: OM-1 FILM: Kodachrome 64

LENS: 50 mm. f./ 1.8

APERTURE #1 8 #2 #3 #4

SPEED #1 B #2 #3 #4

LENS to SUBJECT: Dist. 7'2" Brng. 129° Inc. -38°

HEIGHT of LENS: 3'2"

GREY SCALE LOCATION: Lower Center

LIGHTING

TYPE #1 Strobe #2 #3 #4

FLASHES #1 1 #2 #3 #4

PP to FLASH: Dist. 6'10" Brng. 189° Inc. +37°

FLASH to SUBJ. Dist. 5'8" Brng. 89° Inc. -27°

LOCATION: TO A26

Dist. 26'4" Brng. 49° Inc. +2°

NOTES: Lamp was not lighted at time of photo.

FotoForm 15, 1980

Figure 1.

Additional Equipment for Setting Photopoints

Brass Markers - The material used to mark photopoints is a 3/8 inch diameter brass rod 1/2 to 1 inch long. Other markers could be used as long as they are permanent and can be relocated over a period of several years. Hammer and Drill - A hammer and a 3/8 inch starr drill are used to drill a hole deep enough to place the markers almost flush with the surface. Adhesive - Aluminum solder was used to fix the brass markers in the holes.

Methods

Photopoints can be selected to monitor most aspects of cave use. Trails can be monitored for deterioration, formations can be checked for deterioration or damage and environmental conditions such as water levels or bat populations can be monitored.

When the subject is determined, the camera is set up on the tripod and oriented for the best view, the plumb bob is used to locate the photopoint on the floor and a brass marker is installed (Figure 2). The elevation of the lens above the marker is noted. A point is selected for the strobe to give the optimum illumination and this point is also recorded using distance, bearing and inclinations from the marker. It is also useful to have distances from the photopoint and from the strobe to the subject. If the cave is surveyed, the photopoint marker is connected to a convenient survey station with compass and tape to aid in the relocation of the marker. If the cave is unsurveyed, distance and bearing from the marker to at least two distinct landmarks should be recorded. The photograph is then taken and information on camera settings in recorded. For the first series of monitoring

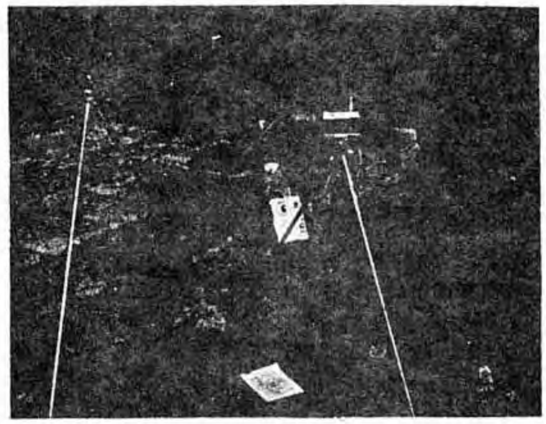


Figure 2.

Figure 3.

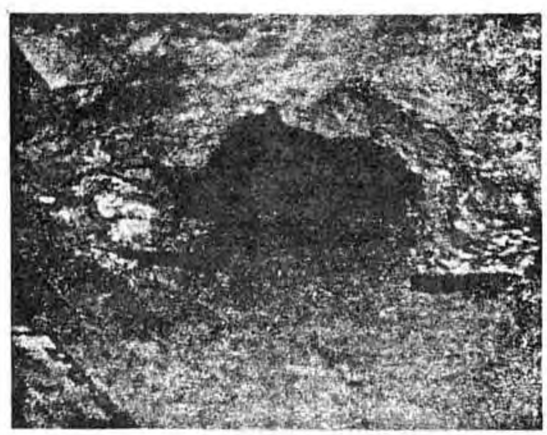


Figure 4.

photographs it may be necessary to bracket the exposures to determine the best one. A subsequent series of photos can be taken from the same set of photopoints by using the recorded data to re-establish the camera and strobe in an identical position.

All photographs should be processed and printed by a competent photo lab. The grey card and/or color scale can be used as a check to determine that all prints are processed to the same standards.

All photographs should be analyzed as soon as possible and a written report on each photopoint prepared. The report should include any information discerned from the photograph plus any information included in the written field notes.

Examples

The first example is from a Wyoming cave. Figure 3 was taken in 1970 before the photomonitoring system was begun, but was taken from nearly the same location as the photopoint which was established in 1975. Figure 4 was taken from the photopoint in 1979 and shows considerable enlargement of the passage opening. In the color prints a large amount of dust accumulation on the walls can also be detected.

The second example was to have shown traffic across the pool. Figure 5 was taken in 1977 while Figure 6 was taken in 1978 and shows that little traffic has crossed the pool as there are no marks or dirt on the wall. However, the water level in the pool has risen several inches. In subsequent years, the water has receded to its former level and, as yet, no signs of traffic have appeared.

There are numerous other examples of monitoring photos

Figure 5.

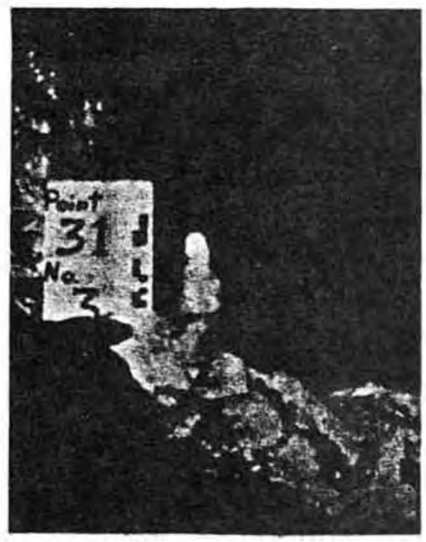


Figure 6.

showing increased use of areas of the cave as determined by trail width and depth. In another example, an area of flowstone has been observed, by the use of monitoring photos, to have become more active over a period of several years. Other photos show the breakage of formations from one year to the next.

Summary and Conclusions

The use of precise, repeatable monitoring photographs, along with other management tools, has helped managers make critical decisions affecting the cave environment. This system has been used by the Bureau of Land Management in Wyoming and a similar system has been used in the past by private cave owners. The expanded use of cave photomonitoring should be encouaged to aid managers in making decisions involving cave use and will provide a valuable record of caves which may be viewed by future cave users and managers alike.

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THE EVOLUTION OF THE VIRGINIA CAVE COMMISSION

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Abstract

The Virginia Commission on the Conservation and Use of Caves was established by the Virginia General Assembly in 1978. It published a report to the Governor and the General Assembly in less than a year with no direct appropriation and then ceased to exist.

This Study Commission recommended that a permanent Cave Commission be established and this came about in a two-step process. After much negotiating with the leadership of the General Assembly, that body approved a one year Commission with 8,000.00 in funds. This budget made it possible for accomplishing many things on a scale never before done in the Cave community.

One recommendation, The Cave Protection Act, contained several major improvements over the old law, including the banning of Speleothem sales and limitation of cave owner liability. Some of the recommendations of this Commission are described in this paper. The Cave Protection Act was approved overwhelmingly by the General Assembly in 1980 with little opposition, but several amendments, that protect the right of the cave owner to use his or her cave as he or she sees fit, were added.

In 1980 the Cave Commission was made a permanent State Agency as part of the Department of Conservation and Economic Development. However, no additional fundng was provided. Since no operating funds are now available for the Commission, interested cavers formed the Virginia Cave Conservancy to provide a means of funding, not only for the Commission but also for encouraging the ownership and management of caves. This Cave Conservancy will seek to raise funds from public solicitation and fund-raising projects such as bingo and dues. The funds will go to support cave acquisition and management as well as to assist organizations such as the Virginia Cave Commission.

The idea of a cave commission was first suggested in 1970 to a caver in Richmond. He did not agree that getting the state involved with caves and caving would be a good idea. However, within several years, a few cavers were found who agreed that a cave commission would be a desirable thing and by 1975, the wheels had been set in motion through Virginia State Delegate Bill Axselle. Together we set up a committee to study the problems of cave conservation and the role of the state in dealing with cave conservation.

The new committee was composed of cavers, a legislator, representatives of several appropriate state agencies and representatives of commercial caves in Virginia. After two meetings, it became apparent that the state agencies were not in favor of adding additional duties to their agencies. This, apparently because they felt that the General Assembly would not fund anything of this nature, and they did not wish to have any additional work without additional fundings.

So, the cavers were told by the representative of the agency that before their agency could support any on-going state activity to protect caves, we would have to thoroughly document almost everything about caves in Virginia. This request was beyond our resources to accomplish in any reasonable length of time. They were informed of our limitations but said they could not hlep, other than to supply us with a copy of John Holsinger's book, Descriptions of Caves in Virginia. Up to that point, the commercial cave representatives had not, in any significant way, opposed what the cavers were trying to do.

Since the current route appeared to be unproductive, the decision was made to go straight to the General Assembly with our ideas. Delegate Axselle was asked to draft a preliminary resolution, Joint House Resolution 10. A draft copy was sent to everyone on this committee: commercial cave owners, agency heads, etc., plus all the NSS chapters in Virginia, and asked for their support and suggestions. No suggestions came in. As a result, Axselle set up a public meeting with the Rules Committee prior to the start of the 1977 session of the General Assembly in order to get any input from the Rules Committee and other interested people. Several changes were suggested at this meeting including the deletion of the word "overcommercialization" from the whereas. We agreed to that, and after that hearing, representatives of commercial caves never again spoke publicly against any of our resolutions at any hearing over the next three years.

The one commercial cave representative who spoke against the resolution at that hearing in 1975 opposed the concept of commissions in general. He was opposed to any cave commission because he believed that it would lead to government regulation of commercial cave operations, even though the resolution prohibited this. This individual continued to oppose the commission to the end and tried unsuccessfully to get the Virginia Chamber of Commerce to oppose the resolution. We do not think that early opposition of the one commercial cave representative had any eventual effect on how long it took to get the resolution passed.

In Virginia, many legislators believe that bad laws and bad resolutions are worse than no laws at all. So, when there is a new concept proposed, the General Assembly tends to take its time while considering all aspects of the proposed law. Three or four years is typical for bills and resolutions of this type to be passed in Virginia. This was particularly true for this commission since it was not only a new concept for Virginia, but to the best of our knowledge, it is the first commission ever established in the United States to study overall use and conservation of caves.

The cave resolution was carried over in 1977 and then passed in 1978. The vote in the House was 76 to 7. It was amended by the Senate (funds deleted) and passed 40 to 0; the House then passed the Senate version. Resolutions do not require the governor's signature so the committee was approved as of the final day of the General Assembly in March, 1978.

We found that many cavers did not understand the concept of commissions in general, even though the vast majority of laws in Virginia go the route of either Legislative Study Committee or Commissions. We had to convince cavers that ultimately the goal of protecting caves would be better served not solely by cave protection

laws, but by an ongoing structure of commissions and agencies whose purpose is to protect caves, educate people, and even manage some caves. It is unlikely that punitive laws alone can adequately protect caves.

It is desirable to have people within state government who will come up with positive solutions to problems and be able to react quickly when threats to caves become apparent. This process of working for the support of cavers began to get results in late 1977, when numerous cavers began to contact their delegates. But, ultimately the commission was passed because Delegate Axselle was able to convince John Warren Cook, Speaker of the House and chairman of the Rules Committee to give the commission a try. I believe that 1978 was the first year that the commission could have been established under the circumstances.

Work and Recommendations of the Virginia Commission on the Use and Conservation of Caves

The Virginia Commission on the Conservation and Use of Caves was to make a report to the governor and the General Assembly; do this in less than a year with no direct appropriation and then cease to exist. That is what happened; its 43 page report was published and went to the Governor and the General Assembly with three major recommendations and extensive background material.

The Cave Protection Act contained several major improvements over the old law, including the banning of speleothem sales and limitation of cave owner liability. Some of the recommendations of this commission are described on the next few pages.

Sale of Speleothems

A major recommendation of the commission was that Virginia join West Virginia and Maryland in banning the sale of speleothems or their export from the Commonwealth for sale elsewhere (see proposed Virginia Cave Protection Act, Appendix III). By elimating this incentive for removing these mineral formations from caves, much vandalism should be stopped. Information on the provisions of the State cave protection law should be widely disseminated, perhaps by signs posted in cave entrances, to warn vandals that their activities are unlawful.

Limitation of Cave Owner Liability

The Commission recommended that cave owners be absolved from liability in the event of an accident in their cave. Persons entering a cave would then have to do so at their own risk except at commercial caves where an admission fee is paid. The provisions of the proposed Cave Protection Act (See appendix III) will permit the use of caves for recreational and scientific purposes without imposing unwarranted liabilities upon the cave owner.

Proposed Permanent Cave Commission

The Commission recommended establishing a permanent Virginia Cave Commission composed of eleven members, serving three-year staggered terms (See proposed legislation creating the Commission). Most of the members should be persons active and knowledgeable in the management, exploration, study and conservation of caves. Expertise in the fields of cave biology, geology, archeology, paleontology, history, and recreation may be represented.

Virginia's caves represent a unique, limited, and non-renewable natural

resource of great scientific, historic, educational, economic and recreational value. Vandalism and pollution are rapidly destroying this resource. In order to prevent Virginia's spelean wilderness from being destroyed within our lifetime, immediate steps need to be taken to protect Virginia's significant caves. The Commission recommends that a permanent Cave Commission be created to assist State agencies in dealing with cave-related problems, that a new, more comprehensive Cave Protection Act be enacted, and that the Virginia Research Center for Archeology be granted a special appropriation for the 1980-82 biennium to conduct a two-year archeologic survey of Virginia caves.

Establishment of a Temporary Cave Commission and Passage of the Cave Protection Act

The Study Commission recommended that a permanent Cave Commission be established. This came about in a two step process. After much negotiating with the leadership of the Virginia General Assembly, that body approved a one year Commission with 8,000.00 in funds. This budget made it possible to accomplishing many things on a scale never before done in the community.

The Cave Protection Act was approved overwhelmingly by the General Assembly with little opposition but several amendments that protect the right of the cave owner to use his or her cave as he or she sees fit.

As public interest in outdoor recreation continues to grow and land development accelerates in the intermontane valleys west of the Blue Ridge, increased pressure will be put on Virginia's limited and fragile cave resources. In order to preserve the unique educational recreational, scientific, historic and economic value of Virginia's caves and karst areas, the Commonwealth needs to make a continuing commitment to safeguard this spelean wilderness. A permanent Cave Commission, composed of conerned citizens, working in conjunction with other agencies of the Commonwealth, appears to be the most effective vehicle for focusing the attention of both government and the public on this goal.

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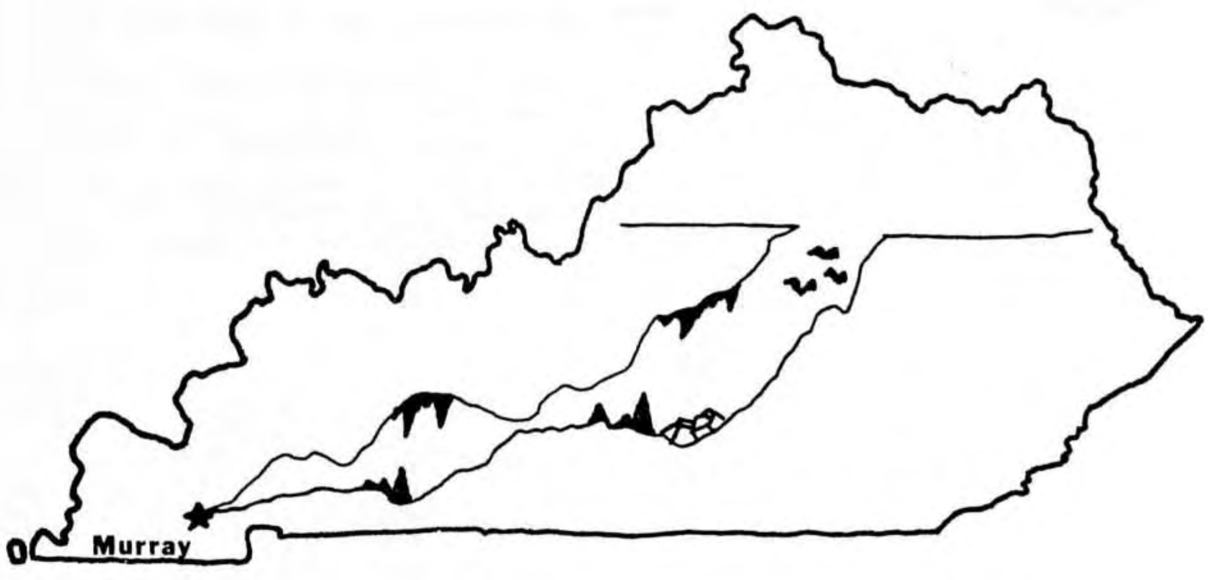
EIGHTH INTERNATIONAL
CONGRESS OF SPELEOLOGY

FIRST INTERNATIONAL CAVE MANAGEMENT SYMPOSIUM



PROGRAM

MURRAY STATE UNIVERSITY

JULY 15 - 18, 1981

TABLE OF CONTENTS

WELCOME

Welcome to the First International Cave Management Symposium. By gathering together interested individuals from across the world, this Symposium hopes to produce an exchange of ideas, concepts and methods that will lead to the improved management of caves. Caves are a resource, one that has many uses. As a resource, caves must be carefully managed, to maximize their utility, yet preserve them for future generations. Caves are variously a part of tourism, industry, scientific study, wilderness recreation and habitat preservation. The large variety of interactions between man and caves requires many different strategies. The First International Cave Management Symposium brings together representatives of the state, the public, commercial enterprise, conservation groups, scientists and sportsmen in the first meeting of its type involving world-wide participation. Representatives from every continent except Antarctica are present. Not only is there a large cross section of specific interests, but the vast diversity of backgrounds will add to the richness and cross-fertilization of the symposium.

Murray State University is honored to be host to this Symposium. The University has put part of its dormitory and Food Service at our disposal, as well as the new University Center, and the Hancock Biological Station. Please feel free to roam about the campus, and utilize its many resources, such as the library, swimming pool, Art Gallery and bookstore. If there are any questions, please ask anyone on the Symposium staff.

Sincerely,

John E. Mylroie
Symposium Director

EVENTS

The Symposium has been designed to provide the best possible conditions for the exchange of ideas. With this in mind, we have tried to provide a comfortable, relaxed atmosphere in a number of different settings. For a quick view of the events of the Symposium, see the condensed schedule of events which follows this discussion. The Symposium officially begins after dinner at 19:30 on July 15th, in the Banquet Room of Winslow Cafeteria (see campus map at the end of the program), where a wine and cheese social will be held. This will allow an informal atmosphere where the Symposium participants can get to know each other, and where University officials can make brief welcoming remarks. A keynote talk will be given by Rob Stitt, former Cave Conservation Committee Chairman of the National Speleological Society, and currently the President-elect of the Society. After his presentation, the social will continue, but since July 15th will have been a lengthy travel day for most participants we have not planned a very long event.

Thursday, July 16th initiates the presentation sessions, beginning at 8:30. Each speaker will have 30 minutes for the presentation and discussion. A long coffee break and a long lunch period are included to help us stay on schedule and provide ample time for informal talk. At 15:30, Dr. George Huppert of the University of Wisconsin-LaCrosse will moderate a panel discussion involving a wide cross section of cave management interests and backgrounds. For more details, check under "Huppert" in the Abstract list.

Following dinner, there will be three options for participants: 1) go on a field trip to a nearby cave; 2) go on a tour to the Mid-America Remote Sensing Center, a satellite imagery processing and research facility; 3) or relax on your own. Details of 1 and 2 above will be available during Thursday's sessions.

On Friday, July 17th, the sessions will continue, much as on Thursday. At approximately 16:00, we will transport the participants to the Hancock Biological Station on Kentucky Lake for a beer and barbecue picnic. This will include boating, swimming, volleyball, and a tour of the station. The picnic will continue until the last person gives up. People who have to leave early for Bowling Green will depart in early evening from the station. The remainder will return to Murray State University.

On Saturday morning, July 18th, we will arise early and be on the road to Bowling Green by 8:00, arriving there before opening ceremonies (arriving approximately 11:00 to 12:00, depending on actual departure time. Opening ceremonies start at 13:00.)

A Proceedings volume of this Symposium will be published after the end of the Congress. This is a completely separate Proceedings from that produced for the Congress itself. People making presentations should see Dr. Mylroie to obtain the details of manuscript submissions.

SCHEDULE

	Wednesday July 15	Thursday July 16		Friday July 17	Saturday July 18
8:00		Dorm Breakfast		Dorm Breakfast	Town Breakfast
8:30		Talk - Stebbings	8:30	Talk - Gamble III	Depart for Bowling Green
9:00	Arrivals	Talk - Brady	9:00	Talk - Wood (Benedict)	
9:30	Begin	Talk - Gamble I	9:30	Talk - Schultz II	
10:00	to	-----------Break-----------	10:00	-----------Break-----------	
10:30	Collect	Talk - Whitfield	10:30	Talk - Howarth	
11:00	in	Talk - Schultz I	11:00	Talk - Schultz III	
11:30	Nashville	Talk - Fink	11:30	Talk - Benedict	
12:00		Talk - Addis -----------Lunch-----------	12:00	Talk - Wilson -----------Lunch-----------	
13:30		Talk - Oedl	13:30	Talk - Stitt II	
14:00	Depart Nashville for Murray	Talk - Gamble II	14:00	Talk - Gardner	
14:30		Talk - Steiner & Waggoner	14:30	Talk - Goodbar	
15:00		-----------Break-----------	15:00	Talk - de Bellard-Pietri	
15:30	Dorm Check-in for participants	Panel Discussion (Huppert)	15:30	-----------Break-----------	
16:00			16:00	Social at Hancock Biological Station	
16:30			16:30		
17:00	-----Dinner-----	----------Dinner----------	17:00		
17:30			17:30		
18:00		Cave Field Trip -or- Tour of MARC	18:00		
18:30			18:30		
19:00			19:00		
19:30	Wine & Cheese Social Welcome & Introduction Talk by Rob Stitt		19:30	Early departure for Bowling Green	
20:00					

ABSTRACTS OF PRESENTATIONS

The abstracts of the presentations to be made are listed on the following pages by the author's name, in alphabetical order. Below each abstract is the author's name and the time of the talk's presentation. People presenting more than one talk have them numbered with a Roman numeral. All talks will be presented in the University Center Auditorium, on the top floor of the Center. Signs will be posted to assist you in locating the auditorium. There may be changes in the schedule that occur rather suddenly,as some people may not attend, or there may be late arrivals. Any changes will be announced as soon as they are known.

THE PETTIBONE FALLS KARST AREA
BIRTHPLACE OF THE NATIONAL SPELOLOGICAL SOCIETY

Robert Addis
Board of Directors, NSS
81 South Shore Road
Cuba, NY 14727

Pettibone Falls Cave is a small, 190 m long cave located in a small outcrop of marble in the Berkshire Hills of western Massachusetts. A major effort is being mounted by the NSS to acquire and preserve the cave and the surrounding karst area. The magnitude of the effort greatly exceeds the apparent worth of the cave, but reflects the importance of the cave to the origins of the Society. In addition, the acquisition effort represents the view that caves are a part of the environment, and this cave cannot be usefully protected without control of some of the surrounding area. The karst area is an isolated area, and contains on the surface a unique ecology, in itself valuable, independent of the cave.

A number of different strategies have been utilized during the acquisiton process, and a wide variety of organizations and individuals have become involved. The entire situation reveals the complexity of cave acquisition and management, even when dealing with an "insignificant" cave.

ADDIS
12:00 THURSDAY

THE GUACHARO CAVE

Dr. Eugenio de Bellard-Pietri

Apartado 80210 - Prados Del Este
Caracas, Venezuela 108

Guacharo Cave is Venezuela's largest cavern (10,200 meters explored). The tourist sector (about 1,200 meters) harbors the largest known colony of oil birds in the world (about 19,000) and has an interesting fauna (rodents, bats, spiders, centipedes, and myriads of insects). Due to the fact that the birds bring seeds in their crops and regurgitate them, the cavern's Humboldt Hall (759 m long) holds a number of seedling forests during the breeding season. The tourist sector can be divided in three successive sections: a) Humboldt's Hall, b) the Hall of Silence (240 m long), c) the Precious Hall (100 m long).

The beautiful cavern has been developed for tourism having in mind two parameters: (1) keep the cave as wild and as natural as possible, (2) give the visitors minimum adequate facilities. For this, a rock slab walkway 1,500 m long with four well spaced and ample areas and a number of natural rock bridges were constructed. All possible effort was put in camouflaging as best and as safely as possible the full walkway. No railings of any sort appear and steps only when necessary. Due to the birds, no electric light has been installed. The results have been rewarding: 65,471 visitors saw the cave during 1979. No accidents have been reported and wheelchairs for disabled can reach 400 m in Humboldt Hall. A visitor with two artificial legs managed with reasonable ease, the full tourist development. Guides with gasoline lanterns lead the tourists.

DE BELLARD-PIETRI

15:00 FRIDAY

CAVE MANAGEMENT FOR THE ENDANGERED INDIANA BAT (*MYOTIS SODALIS*) AND GRAY BAT (*MYOTIS GRISECENS*)

John T. Brady

Team Leader, Indiana/Gray Bat Recovery Team
U.S. Army Corps of Engineers
210 Tucker Boulevard, North
St. Louis, Missouri 63101

The Indiana bat and the gray bat are protected by the Endangered Species Act of 1973. Both species have experienced significant population declines in recent years primarily caused by human disturbance of Indiana bat hibernation caves and gray bat hibernation caves and nursery caves. Only a relatively few caves have the necessary microclimatic conditions that are acceptable to these two species.

Efforts have been made to protect these critical caves by the Recovery Team, the U.S. Fish and Wildlife Service, and numerous federal and state agencies. Management options include public acquisition of caves, posting of warning signs, and erection of fences and gates to exclude human entry. Specifications for constructing fences and gates that will not interfere with bat use of caves are presented.

BRADY
9:00 THURSDAY

TVA'S ROLE IN CAVE PROTECTION AND MANAGEMENT

Patricia A. Fink

Tennessee Valley Authority - Regional Natural Heritage Project
Division of Land and Forest Resources
Norris, TN 37828

The Tennessee Valley Authority (TVA), an independent corporate agency of the Federal government, is known primarily for its chain of lakes and its generation of inexpensive electricity, but is also charged with the responsibility of furthering the proper use, conservation, and development of the natural resources of the Tennessee Valley Region. The TVA Regional Natural Heritage Project is a data base of significant natural features, which includes caves. This data base is used to locate and prevent conflicts between sensitive natural resource features and proposed development projects. The Regional Heritage Project has also been involved in the protection of caves through cave gating, and the creation of protected Small Wild Areas, has supported cave-related research, and participated in cave management symposiums.

FINK
11:30 THURSDAY

PROBLEMS OF MANAGEMENT OF TRANSVAAL CAVES

Frances M. Gamble

Dept. of Geography and Environmental Studies
University of the Witwatersrand
1 Jan Smuts Avenue
Johannesburg 2001
South Africa

The management of karst caves is interpreted as the process which optimizes the resource potential of the cave. This process varies considerably between caves, from an undisturbed ecosystem to commercial development. The problems involved in such management are considerable. They vary from common problems of awareness of involved parties and exploitation of the resource to problems more specific to the Transvaal area. These latter include aspects such as culture, populaton distribution and mining practices. Contrary to these problems there are few current positive aspects to management. It is imperative that the most pressing of the problems, in the fields of awareness, distribution and administration, should be minimized as soon as possible. The problems of management are not seen as being insurmountable, but rather as long-term undertakings on the part of all concerned parties.

GAMBLE I

9:30 THURSDAY

THE RESOURCE POTENTIAL OF TRANSVAAL CAVES

Frances M. Gamble

Dept. of Geography and Environmental Studies
University of the Witwatersrand
1 Jan Smuts Avenue
Johannesburg 2001
South Africa

The resource potential of karst caves in the Transvaal is assessed in terms of both the positive and negative aspects of interaction between Man and the cave environment. Caves in the area have had uses varying from places of shelter, to sources of fertilizer and to tourist attractions. Superimposed on these positive aspects of the ecosystems are the hazards to Man, which are of varying significance in different caves. These negative features include the occurrence of Histoplasmin spores, and of high concentrations of both Carbon Dioxide and of Radon. With recognition of the balance between the positive and negative aspects of the resource, and with sound management practices, the potential of the individual cave ecosystems may be realized. This potential will increase over time as population pressures on wilderness areas increase and as cultures adapt to changes in lifestyle. It is imperative therefore that the total resource potential of the cave systems in the Transvaal should be acknowledged, and that thereby mismanagement of the resource should be avoided.

GAMBLE II
14:00 THURSDAY

KARST CAVE MANAGEMENT MODELLING IN THE TRANSVAAL

Frances M. Gamble

Dept. of Geography and Environmental Studies
University of the Witwatersrand
1 Jan Smuts Avenue
Johannesburg 2001
South Africa

The necessity for a management model for use in Transvaal karst cave areas is evident from the occurrence of both intentional and unintentional exploitation of cave resources. Such modelling is complex, depending on the specific region and the individual cave to which it is applied. The concern of the paper is with the general requirements, nature and feasibility of such modelling. Both physical and social environmental considerations are incorporated. The model is based on the most extreme conditions of susceptibility to disturbance of a cave system, that is on a static cave. Its nature varies from descriptive to mathematical. The success of the model as a management tool is dependent upon its flexibility permitting modification for individual applications and ease of interpretation. Many of the general principles are transferable to caves in other rock types and/or in other geographical regions.

GAMBLE III

8:30 FRIDAY

A DESIGN FOR CONSERVATION AND MANAGEMENT OF CAVE RESOURCES ON MISSOURI PUBLIC LANDS

James E. Gardner* and Treva L. Gardner**

*Wildlife Biologist, Natural History Section
Missouri Department of Conservation
P.O. Box 180
Jefferson City, Missouri 65102

**Project Assistant, Natural History Section
Missouri Department of Conservation
P.O. Box 180
Jefferson City, Missouri 65102

The Missouri Department of Conservation, Mark Twain National Forest, Division of Parks and Historic Preservation and North Central Forest Experiment Station-Columbia, Missouri, recognized the need for a comprehensive cave management program. The Department of Conservation's Design for Conservation plan provided the initiative for a cooperatively funded cave inventory project. Since the initiation of the cave inventory in October, 1978, valuable data on Missouri's cave resources have been gathered. Steps to provide protection to a number of caves have already been taken and management plans have been initiated for additional caves.

The Design plan was a major step toward management anu enhancement of cave resources on public lands in Missouri. Through Design directives, several caves have been purchased to provide protection for endangered species. Two caves have been designated natural areas so as to preserve cave ecosystems for study and future enjoyment. More caves are being considered for natural areas. Funding through Design has brought about inventories and research on non-game cave animals. Information programs and public awareness efforts have helped to elicit needed support for cave conservation and protection.

Completion of the cooperative cave inventory should bring about a better understanding of speleo-resources on Missouri public lands and hopefully provide successful solutions to management problems. Missouri has set a precedent for a quality cave management and conservation program. Through Design programs like the cave inventory, Missouri can better protect some of it's cave heritage as a quality resource.

GARDNER

14:00 THURSDAY

CAVE MANAGEMENT, A BUREAU OF LAND MANAGEMENT APPROACH

James Goodbar and J.B. Hummel

Bureau of Land Management
Roswell District Office
P.O. Box 1397
Roswell, New Mexico 88201

This paper deals with the Bureau of Land Management's philosophy and methods of managing cave resources on public lands in the United States.

Our approach is basically conservation/preservation oriented toward integrating unique cave resources with other natural resource programs into a combined comprehensive land use plan.

GOODBAR

14:30 FRIDAY

THE CONSERVATION OF CAVE INVERTEBRATES

by Francis G. Howarth

B.P. Bishop Museum, P.O. Box 19000-A, Honolulu, HI, USA, 96819

The sometimes bizarre adaptations that restrict obligate cave animals to a life in caves, coupled with their island-like habitat, have reinforced the assumption that cave animals are somehow fragile and therefore lead an endangered existence. Although many cave animals undoubtedly are endangered, the development of management recommendations for their conservation is hampered by the lack of good ecological data concerning the requirements of the species. For example, what factors limit cave animal distribution; what are the perturbations; and how do these cause rarity and endangerment? Indeed, experimental ecological studies in caves are difficult since in few other habitats is man so clearly an intruder than in the subterranean world. Caves are fragile windows through which man can visit and study the fauna that lives in the unique environment within cavernous rock. Furthermore, it has only been within the last decade that biologists have realized that highly specialized cave invertebrates also live in lava tubes and in tropical caves. Indeed, many caves threatened by land use changes have never been surveyed, and their biological resources remain unknown. The following are some of the major threats to the cave ecosystem: 1) mining activities, 2) land use changes such as deforestation and urbanization, 3) alteration of ground water flow patterns, 4) waste disposal and pollution, 5) local extirpation of trogloxenes (a food source), 6) the introduction of non-native species, and 7) direct human disturbance from visitation.

HOWARTH

10:30 FRIDAY

PANEL DISCUSSION ON CAVE MANAGEMENT

Moderated by

George Huppert

Department of Geography
The University of Wisconsin - La Crosse
La Crosse, Wisconsin 54601

A panel will be selected from the attendees, representing the greatest cross-section of interest and background. This should provide a very informative session. Some of the anticipated topics include:

1. What are the major problems of cave management in the different countries represented?

2. What existing cave laws are there in the various countries...do they work?

3. What is the role of commercial caves...are they a help or a hinderance to management?

4. What exactly is the definition of cave management, how far are we willing to go in order to reach those goals?

5. What does the future hold for cave management?

6. How can we best educate the public to the value of caves?

Any other topics related to cave management will also be discussed. This discussion is planned on an informal, full participation event.

HUPPERT

15:30 THURSDAY

SPECIAL MANAGEMENT CONSIDERATIONS OF LAVA CAVES

James Nieland,* Libby Nieland,** and Ellen Benedict, Ph.D.#

*Recreation Assistant, St. Helens Ranger District
Box 9, St. Helens R.S., Cougar, WA 98616

**NSS, Box 9, St. Helens R.S., Cougar, WA 98616

#Department of Biology, Pacific University, Forest Grove, OR 97116

Unique features of lavatube caves are only beginning to be recognized. For years they have been relegated to a "step-child" relationship to limestone caves. Even now few speleologists study lava caves; most regard them as sterile curiosities. Unique features of lava caves are little studied or remain unidentified. Like limestone caves they possess a wealth of valuable information to geologists, biologists, archeologists, paleontologists, and historians. Management problems arise primarily from a failure to recognize their significance. For years they have been left to manage themselves. As a result they have been dynamited, dug up, used as trash dumps, spray painted, and their formations removed by rock collectors. Fires have been set in guano deposits, cave animals trapped or killed, and delicate sand formations trampled into oblivion by careless visitors.

Lavatube caves occur mostly in the western United States; nearly all are found west of the continental divide, primarily on publicly owned land. The burden of management, therefore, falls mostly on government agencies.

In the past, management has mostly been undertaken without consideration of all potential effects upon the caves. This has often resulted in unnecessary damage. Two caves, Lava River Cave, Oregon, and Ape Cave, Washington, had at one time delicate sand castles. Both caves were developed so the public could easily view these features. It took only a few years to trample these sand castles into rounded sand humps. To effectively evaluate and manage cave resources, caves must be inventoried for their features and significance. Management decisions need to be made accordingly.

A number of management approaches and alternatives are available. Many lava caves are located far from human habitation and are thus protected by obscurity. These are best managed by being allowed to remain obscure with as little attention being drawn to them as possible. Caves with a history of use are the ones that warrant most management concern. These have been managed in a number of ways. They have been gated with access being granted to groups with an agency guide, and they have been commercialized, or developed for self-guided tours. Caves of special significance have been included in national monuments, in federal research natural areas, or placed under special use permits for scientific studies. The challenge is how to get away from the "band-aid" approach to lava cave management.

BENEDICT

11:30 FRIDAY

PROTECTION OF ICE CAVES

Dr. Friederich Oedl

Getreidegasse 21
A5020 Salzburg
Austria

In the Northern Alps there are numerous caves in which ice can be found the whole year over. Some of these are open to the public. The majority of them are so called dynamic ice caves having at least two entrances. With the example of the Eisriesenwelt (Salzburg, Austria) some special problems appearing in this ice cave are dealt with in this paper.

In general, protection of stalagmites and stalacites and other cave substances against wanton or careless destruction is the main task of cave protection, as such destructions cannot be repaired by nature during one or more human generations. In ice caves however, there is a continuous alternation of the ice not only according to the season but also from year to year. Ice cave protection should therefore cover all tasks to maintain the natural rhythm of ice in the cave. The term "dynamic ice cave" in contrast to the term "static ice cave" was originally chosen due to considerable natural cave ventilation being responsible for ice alteration within the cave.

Consequences and explorations resulting from human interference in ice alteration are discussed. Results of explorations over a period of more than 100 years in this cave, which was opened to the public more than 60 years ago, permit to give a report on experiences made there. In other concerns it is referred to future exploration. It is made clear that maintenance of cave temperature, cave ventilation and water flow are of decisive importance.

The paper further deals with questions of construction and maintenance of passages for the public and the effect of large scale visits on the life of ice and on the cleanliness within the cave. Finally questions of suitable cave illumination are discussed.

OEDL

13:30 THURSDAY

THE BLUE-GREEN ALGAE IN THE CANGO CAVES SYSTEM

Hans Oosthuizen

South Africa

During the past few years the growth of blue-green algae increased dramatically in the tourist part of the Cango Caves system.

The high humidity of 95% and the high temperature of 18 degrees C+, caused by body temperature and electrical lights has produced an ideal state for the growth of the blue-green algae was created.

Fluorescent lights are not practical for use in this cave, and consequently the more conventional type of lights are used, setting free more heat into the atmosphere to stimulate the growth of the algae.

The use of filters for all lights in the cave system was carried out with success, but caused a commercial and garish effect in the cave.

Use of a 4% formalin solution to be sprayed on the formations proved negative. Experiments with a solution of butyl-alcohol concentrate by means of a brush proved successful as the algae was removed quite easily, leaving the formations free of algae.

Experiments starting during February 1979 and up to date, have left the formations treated still clear of algae growth. An undiluted mixture of butyl-alcohol obtained the best results without damaging the formations themselves.

The destruction effected by the algae can be extensive.

Solutions of butyl-alcohol and epsom salts is producing positive results with the "rejuvenation" of the so-called "dead formations".

READ BY: M.C.T. SCHULTZ II

9:30 FRIDAY

EXPEDITION - CANGO 78

Reported by

Michael C.T. Schultz

Town Clerk/Director, Cango Caves
P.O. Box 225 Oudtshoorn
South Africa

The Cango Caves can be considered as three main points, Cango I, II, and III. The exploration of Cango III necessitated a detailed survey to relate features in Cango III with those in Cango I and II. The situation is complicated by a sump between Cango II and III that must be pumped out to allow access to Cango III.

Four cavers were established in a camp inside Cango III on August 30, 1978, and the sump was allowed to seal them in. They surveyed out of their base camp until September 3, 1978, when the sump was pumped out and they exited. A total of 1,900 m was surveyed (950 m out and 950 m back) by the team.

The expedition represents the unique difficulties of adequately inventorying a cave that is being used as a resource

SCHULTZ I

11:00 THURSDAY

REPORT OF THE CAVE INVERTEBRATE SPECIALIST GROUP SSC/IUCN 13-15 JULY, 1981

R.E. Stebblings, Chairman

Chiroptera Group, SSC/IUCN
The Institute of Terrestrial Ecology
Mouks Wood Experimental Station
Abbots Ripton, Huntingdon
England PE17 2LS

The International Union for Conservation of Nature and Natural Resources, headquartered in Gland, Switzerland, was founded in 1948 as an independent, international, non-governmental organization in order to promote scientifically-based action directed towards the sustainable use and conservation of natural resources. At present, IUCN has 444 voting members in 106 countries, these members being States (52), government agencies (114) and non-governmental organizations (278). The members meet triennially at a General Assembly to determine policies and broad elements of IUCN's program. A major proportion of the development and execution of IUCN programs is done by the six commissions which are composed of volunteer experts in their field.

The Species Survival Commission (SSC) is charged with the responsibility for conservation programs concerning threatened species of fauna and flora. The work of the SSC is largely done by specialist groups. These groups, now numbering approximately 60, have traditionally addressed endangered species problems by taxonomic groups, e.g., the Bear Group, the Chiroptera Group, and the Primate Group. The Cave Invertebrates Specialist Group is one of the first groups that concerns a habitat.

The Inaugral meeting of the Cave Invertebrates Specialist Group was held at Murray State University, July 13-15, 1981. A report on that meeting, and on the goals of the Specialist Group will be presented.

STEBBLINGS

8:30 THURSDAY

"SHOW CAVES - EDUCATIONAL ENTERTAINMENT FOR PROFIT THROUGH PROMOTION AND MANAGEMENT"

Jack Steiner
Lookout Mountain Caverns, Inc.
Lookout Mountain Scenic Highway
Chattanooga, TN 37409

Joe Waggoner
Lost Sea, Inc.
Route 2
Sweetwater, TN 37837

This seminar will be given by Joe Waggoner, Manager of Lost Sea, and Jack Steiner, President of Ruby Falls, both of which are privately owned show caves.

Jack Steiner will make a presentation on the promotional techniques of Ruby Falls and give some insight into various advertising medias used by them and other show caves.

Joe Waggoner will present the management and conservation techniques used by show cave operators and the daily responsibilities and problems that are incurred.

Jack Steiner will then end the Show Cave Presentation with "Why Profit?".

STEINER & WAGGONER

14:30 THURSDAY

HISTORY OF CAVE MANAGEMENT SYMPOSIA IN THE UNITED STATES OF AMERICA AN OVERVIEW

Robert R. Stitt

President-elect, National Speleological Scoiety
1417 9th Ave. West
Seattle, WA 98119

The term "cave management" in the United States of America includes the management of all caves, including wild caves and show caves by a variety of managers: cavers, private landowners, government agencies on both the Federal and State levels; for a variety of purposes, including preservation, recreation, tourism, and industrial uses.

Cave management in the U.S.A. undoubtedly began in the last century as private cave owners began exhibiting them to the public, but it was not until the middle of the twentieth century that cavers--active users of caves--and cave owners, primarily in the various state and federal agencies managing land containing caves, began to carry on a serious dialogue about cave management.

This dialogue led to the first National Cave Management Symposium in Albuquerque, New Mexico in the fall of 1975. The approximately one hundred attendees produced the first of many volumes of symposium proceedings and began a series which has culminated in this International Cave Management Symposium. Since Albuquerque in 1975, national symposia have been held in Mountain View, Arkansas in 1976; Big Sky, Montana in 1977; Carlsbad, New Mexico in 1978; and Mammoth Cave, Kentucky in 1980. In 1979, many regional symposia were held, and this tradition carried on into 1980 and 1981.

STITT: OPENING ADDRESS

20:00 WEDNESDAY

UNDERGROUND WILDERNESS
A CONSERVATION PRINCIPLES AND A MANAGEMENT TOOL

Robert R. Stitt
1417 9th Ave. West
Seattle, WA 98119 USA

With the passage of the Wilderness Act in 1964, the Congress of the United States of America established the National Wilderness Preservation System for the protection of natural lands in the U.S.A. Cave conservationists have argued for many years that caves, because of their unique nature, could and should be included in the National Wilderness Preservation System without further statutory authority. They have introduced the concept of "underground wilderness" to describe what many consider to be the world's last true wilderness—completely untouched, in many cases, by the hand of man. Although to date no caves have been included in the System on their own merits, some Federal agencies have accepted the validity of the concept, but have declined to ask Congress to implement it.

This paper presents a working and legal definition of underground wilderness, the application of the concept to cave preservation, and a discussion of the prospects for obtaining such application in the future.

STITT II

13:30 FRIDAY

ISOTOPE STUDIES ON A SELECTED STALAGMITE FROM CANGO II CAVE, OUDTSHOORN

J.C.Vogel

Natural Isotopes Division
NPRL
Pretoria

A slender stalagmite standing 273 cm high at the further end of the Cango II cave was selected for a detailed isotopic investigation. The aim of the study was to obtain a record of environmental temperature changes during the past 40,000 years by measuring the 0-18/0-16 ratios and C-14 contents of the successive growth levels of the stalagmite.

Four sections (0-50 cm, 50-99 cm, 165-195 cm, 195-225 cm measured from the top down) of the stalagmite have been analyzed.

Eight samples from the available sections were dated by means of C-14. The results reveal the following growth pattern: The base is approximately 34,200 years old, with a growth rate of 5 cm/1000 years, followed by a stagnation period, then growth to the present at 16 cm/1000 years.

We have located a confined groundwater aquifer in the southern Cape in which the age of the water increases regularly from the present back to nearly 30,000 years ago. Samples from this aquifer have provided us with a continuous record of the 0-18/0-16 content of precipitation since the middle of the Upper Pleistocene. By using this data and 0-18 measurements on the stalagmite the following tentative changes in temperature have been calculated:

5,800 yrs B.P.	+1.5 C
14,000 yrs B.P.	-6 C
30,000 yrs B.P.	-5 C

READ BY: SCHULTZ III

11:00 FRIDAY

CAVE MANAGEMENT IN BRITISH COLUMBIA, CANADA

Phil Whitfield

Vancouver Island
Cave of the Group
521 West Innes Street
Nelson, B.C.
CANADA V1L 3J2

British Columbia's 948,847 km area contains a wide variety of solution, volcanic, glacier, littoral and talus caves. Limestone karst is well distributed, but only portions of the more accessible southern areas have been explored to date. Reports of up to 700 limestone caves makes this category the most prevalent and significant cave type in the Province. Most known cave and karst features occur in areas of Crown (i.e. federal or provincial government) jurisdiction or forest company ownership. Prior to the 1960's, only the Nakimu Caves in Glacier National Park had received any management attention. However, with the advent of organized caving groups in the 1960's, new explorations and discoveries brought both a higher public profile for caves and pressure by cavers for government cave conservation measures.

In 1976, Parks Canada began a reassessment of its policies on the Nakimu Caves, which had been closed to the public since 1940. Three years later, the British Columbia Government began a process to produce broad policies on cave management. Though it received input from a wide range of cavers, interest groups, industries and government agencies, the process suffered initially from poor management and a decade old schism in the Provincial caving community. In spite of one prominent British Columbia caving organization's refusal to contribute to the process, a policy statement was eventually released in May 1981. Meanwhile, the Ministry of Forests, the Provinces major land management agency, had prepared a specific management plan for one important cave under its jurisdiction and has started work on a general management policy for all caves on Crown forest lands.

Although these governemnt initiatives are significant, one of the most immediate impediments to effective cave management in British Columbia remains the lack of adequate communication and coordination among cavers. This problem has reduced overall caver credibility and has weakened the educational effectiveness of the cave conservation lobby.

WHITFIELD
10:30 THURSDAY

THE AMERICAN CAVE CONSERVATION ASSOCIATION AND CAVE MANAGEMENT IN AMERICA

John M. Wilson

Richmond Area Speleological Society
P.O. Box 25594
Richmond, VA 23260

Recently the Richmond Area Speleological Society (RASS) took the initiative to help establish the American Cave Conservation Association (ACCA). This is to be a membership association for both individual and organizations interested in owning, managing and protecting caves. It is our hope that this organization can work in cooperation with all other organizations interested in cave conservation.

The ACCA is interested in identifying caves that are in need of protection, then locating the means by which this can be done, by private landowner, government agency, scientific organizations and caving societies. By working with existing cave management entities, and facilitating their work, the ACCA believes that a significant contribution can be made to the safeguarding and preservation of caves in the United States.

WILSON

12:00 FRIDAY

INTERPRETATION AS A PRIMARY TOOL IN CAVE CONSERVATION AND MANAGEMENT

Edward E. Wood, Jr.

Chief, Interpretation and Resource Management
Lehman Caves National Monument (NPS)
Baker, NV, USA

Effective interpretation can be a valuable tool to aid speleologists in the presentation and perpetuation of cave resources. Since a majority of people are only occasional visitors to caves and they confine their visits to commercial or show caves, the burden of demonstrating the value of the underground realm lies almost entirely with the interpretive presentations available at show caves. A concerted effort must be maintained by the managers of show caves to demonstrate a high level of concern for conservation of their resource as well as in caves in general. From the instant a visitor arrives at a cave, he is influenced by every aspect of the operation — the grounds, the facilities, the interpretive staff and the resource itself.

To be effective, interpretation must progress beyond the hypothesized speleogenesis of formations and include entertaining elements as well. Spontaneity, enthusiasm and expertise of interpreters becomes paramount. A review of some techniques in use at show caves in the United States demonstrates that creativity does not have to be sacrificed in achieving the conservation theme.

Only by fostering a genuine appreciation throughout the general population, of the complexity of the forces effecting caves, can speleologists expect to be able to rally support for cave conservation. When caves become important resources to everyone, the job of conserving them will become easier.

READ BY: E. BENEDICT

9:00 FRIDAY

A campus map has been provided (see following pages) to assist you in locating the various places on the University campus. Specifically marked are the location of the University Center, where the presentations will be made; Winslow Cafeteria, where the meals will be served and where the wine and cheese social at 19:30 on July 15th will be held; Hart Hall, the residence for Congress participants; and Lowry Center, where the MARC tour will be given at 19:30 on July 16th. If you have any problems locating features on the campus, ask one of the Symposium organizers, or any of the students, faculty or staff around you.

The University Center is the hub of the Symposium. It is open from 7:00 to 22:00 during the Symposium. It contains a bookstore with a large display of items, which is open from 7:30 to 15:30. There are three areas to get food in the center: the Sweet Shop on the second floor, open 10:00 to 14:00; or a lunchroom on the second floor open 7:00 to 14:00; and a dining room on the first floor open from 18:00 to 22:00. Please note there are no eating facilities in the University Center between 14:00 and 18:00.

A post office is available in the Center, open from 7:30 to 14:30, and the Center contains lounging areas, a well-equipped game room, and stereo headphones. A movie will be shown on Thursday evening in the auditorium.

All meals are covered in the registration fee, and are served at the dining hall at Winslow Cafeteria. Symposium participants may eat elsewhere if they choose, but cannot be reimbursed for meals missed at the cafeteria. Mealtimes are: breakfast, 6:30 to 8:30; lunch, 11:00 to 13:00; dinner 16:30 to 18:00.

KEY TO LOCATIONS ON THE CAMPUS MAP

Alphabetical listing

Agricultural engineering shop building624
Applied Science and Technology Building 17
Blackburn Science Building 19
Business North 4
Business South 5
Carman Pavilion 58
Carr Health Building 35
Central Heating and Cooling Plant 20
Ceramics Laboratory 22
Clark Hall 46
College Courts (married housing) 45
- A 700 unit
- B 800 unit
- C 800 unit
- D 500 unit
- E 900 unit
- F 400 unit
- G 200 unit
- H 100 unit
- I 300 unit
- J 1000 unit
- K 1100 unit
- L 1200 unit

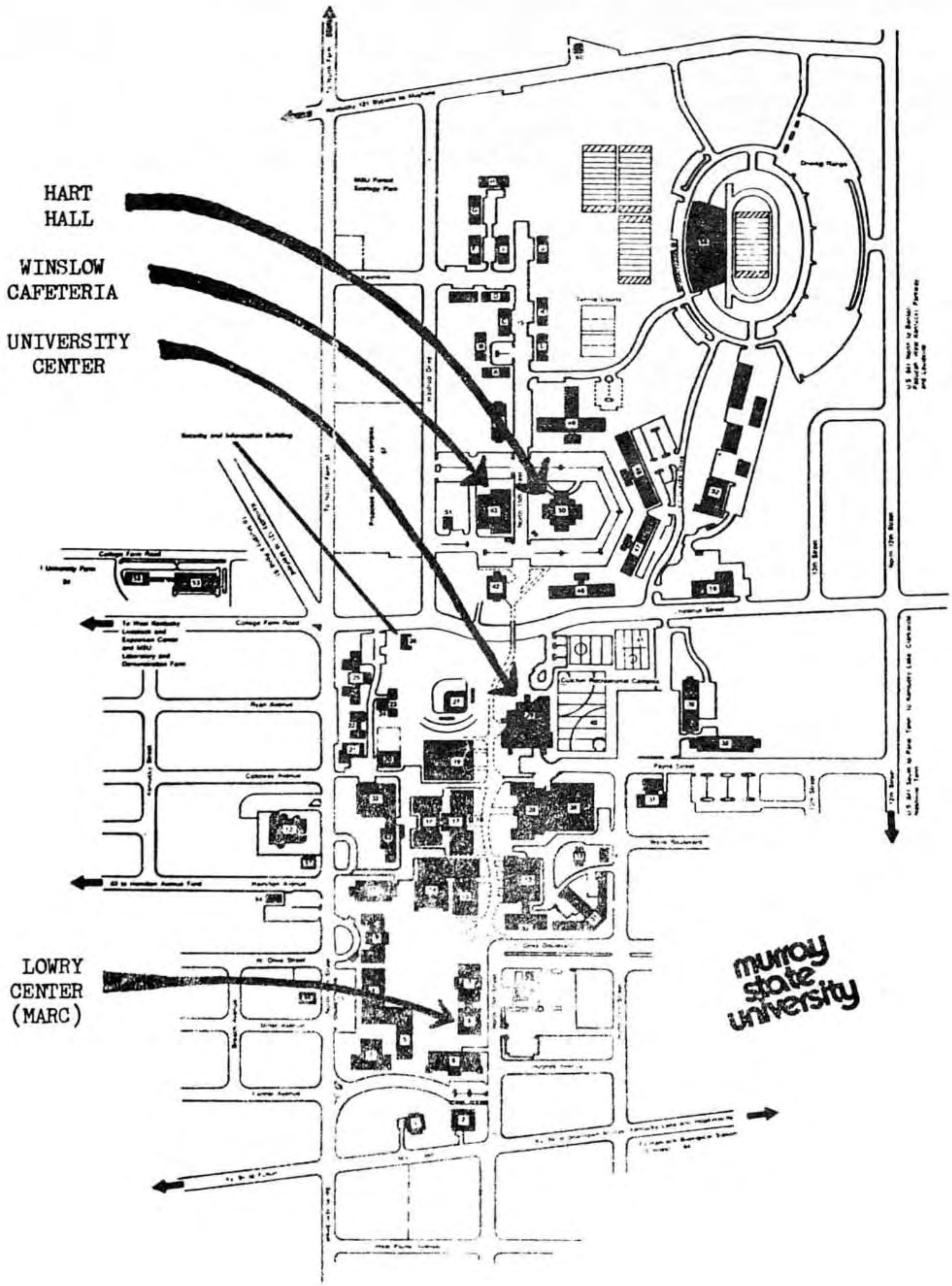
Curchin Recreational Complex 40
Doran House 68
Doyle Fine Arts Center 15
Early Childhood Center 62
Elizabeth Hall 42
Faculty Hall 10
Football Practice Field 57
Franklin Hall 48
Gatlin House 65
General Services Building 59
Greenhouse 23
Hamilton Avenue Field 63
Hancock Biological Station 64
• Hart Hall 50
Hester Hall 44
Home Management House 34
Housing Office 51
Howton Building 21
Industrial Education Building 16
Lovett Auditorium 14
• Lowry Center 8
Mason Hall 37
MSU Laboratory and Demonstration Farm 54
Murphy's Pond 61
Nash House 66
Proposed recreational complex 67
North Farm 55
North Tennis courts 69
Oakhurst (president's home) 1
Ordway Hall 30
Physical Plant Complex 52
Pogue Special Collections Library 7
Racer Arena 36
Reagan Baseball Field 27
Regents Hall 39
Richmond Hall 47
Security and Information Building 26
Simpson Child Development Center 33
South Tennis courts 41
Sparks Hall (administrative offices) 2
Special Education Building 12
Springer Hall 49
Stewart Stadium 56
Stubblefield Monument 11
Student Center 32
Swann Hall 25
University Bookstore 28
• University Center 29
University Power Station 60
Waterfield Library 13
Wells Hall 9
Wells Monument 18
West Kentucky Livestock and Exposition Center 53
White Hall 38
Wilson Hall 6
• Winslow Cafeteria 43
Woods Hall 31
Wrather Museum 3

Numerical listing

1 Oakhurst (president's home)
2 Sparks Hall (administrative offices)
3 Wrather Museum
4 Business North
5 Business South
6 Wilson Hall
7 Pogue Special Collections Library
• 8 Lowry Center
9 Wells Hall
10 Faculty Hall
11 Stubblefield Monument
12 Special Education Building
13 Waterfield Library
14 Lovett Auditorium
15 Doyle Fine Arts Center
16 Industrial Education Building
17 Applied Science and Technology Building
18 Wells Monument
19 Blackburn Science Building
20 Central Heating and Cooling Plant
21 Howton Building
22 Ceramics Laboratory
23 Greenhouse
24 Agricultural engineering shop building
25 Swann Hall
26 Security and Information Building
27 Reagan Baseball Field
28 University Bookstore
• 29 University Center
30 Ordway Hall
31 Woods Hall
32 Student Center
33 Simpson Child Development Center
34 Home Management House
35 Carr Health Building
36 Racer Arena
37 Mason Hall
38 White Hall
39 Regents Hall
40 Curchin Recreational Complex
41 South Tennis courts
42 Elizabeth Hall
• 43 Winslow Cafeteria
44 Hester Hall
45 College courts (married housing)
- A 700 unit
- B 800 unit
- C 800 unit
- D 500 unit
- E 900 unit
- F 400 unit
- G 200 unit
- H 200 unit
- I 300 unit
- J 1000 unit
- K 1100 unit
- L 1200 unit

46 Clark Hall
47 Richmond Hall
48 Franklin Hall
49 Springer Hall
• 50 Hart Hall
51 Housing Office
52 Physical Plant Complex
53 West Kentucky Livestock and Exposition Center
54 MSU Laboratory and Demonstration Farm
55 North Farm
56 Stewart Stadium
57 Football Practice Field
58 Carman Pavilion
59 General Services Building
60 University Power Station
61 Murphy's Pond
62 Early Childhood Center
63 Hamilton Avenue Field
64 Hancock Biological Station
65 Gatlin House
66 Nash House
67 Proposed recreational complex
68 Doran House
69 North Tennis courts

MURRAY STATE UNIVERSITY CAMPUS MAP



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INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE AND NATURAL RESOURCES: SPECIES SURVIVAL COMMISSION: CAVE INVERTEBRATES SPECIALIST GROUP

Inaugral Meeting, Murray State University, Murray, Kentucky, 12-13 July 1981

Provisional Agenda

Introduction

Note that under appropriate topics noted below (Action) a request is made to attendees indicating specific actions they should undertake prior to the meeting and be prepared to report on at the meeting.

1. Background on IUCN and SSC

2. Purpose of Group
   (a) Production of action program.

   (b) Scope of interest and relationship with other SSC groups and speleology organizations.

3. Membership
   (a) Size of group should remain manageable (10-15). Each member should enlist the support of a cadre of expert correspondents.

Action (b) Please bring to the meeting a list of names and addresses of possible new members and/or correspondents.

   (c) Terms of Reference (draft attached).

4. Communications
   Most of the work of the group will be of necessity by correspondence. The chairman will prepare and distribute a newsletter at least annually. Meetings may be called only under special circumstances.

5. Review of the Conservation Status of Cave Invertebrate Species throughout the World

Action Please come prepared to make a statement about the situation within your area of expertise, both geographically and taxonomically. Address conservation problems such as mining, land use practices, sensitivity of cave fauna to visitation, and the problem of publicizing cave locations.

6. Research Needs
   (a) Scope of the problem.

   (b) Reasons for endangerment and strategies for ameliorating their impacts.

   (c) Carrying capacity of caves.

   (d) Biological surveys of poorly known but threatened cave areas.

   (e) Ecological studies.

7. Selection of criteria for determining priorities for conservation action
   (a) Define terms -- endangered, threatened, rare, etc.

   (b) Methods of documentation of cave fauna distribution and assessment of possible threats.

   (c) Special conservation measures should be taken for:
      (1) Especially rich cave areas which are under major threat,

      (2) Threatened cave areas which have been poorly surveyed,

      (3) Extremely localized endemic species,

      (4) Unique species,

      (5) Caves which include other significant resources.

8. Develop Action Plan
   (a) The group should prepare a list of species to be included immediately in the IUCN Red Data Book.

   (b) The group should outline 5-10 projects and rank according to priority of funding.

Action (c) Please come prepared with a list of species which you think can be included in the Red Data Book without further study. Please include an outline of known threats to the existence of the species and any conservation measures in progress or proposed to protect it.

Action (d) You may submit one or more conservation proposals, including a preliminary budget, for discussion among the group.

9. Any Other Business

Francis G. Howarth

18 April 1981