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EVALUATION OF CAVE AND SURFACE RESOURCES

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The study of caves and their resources is a science which draws knowledge and expertise from many disciplines. No university offers a program by which a person may become a speleologist. Nearly every expert in the cave sciences has been drawn to that interest by work in related fields such as biology, archaeology, hydrology, geology, or paleontology. Many biologists, for example, specialize in the study of a single order of cave organism. Speleology is such a broad field, with so many different specialties within that it is hard to find an individual who is experienced in all. For this reason it is often difficult to accurately evaluate a cave and its resources.

It is not within the scope of this paper to pass on all the information necessary to evaluate a cave's resources. That would require several books to be written. The object of this paper therefore is to acquaint the reader with some of the important aspects of cave disciplines so that unique caves can be recognized and drawn to the attention of appropriate experts. An accurate evaluation of a specific cave resource must be deferred to an experienced researcher. For a person just learning about caves, understanding the resource can be considered a challenge.

Whenever a cave is discovered, the land manager should consider it to be unique until a thorough evaluation can be made. Recently on the Gifford Pinchot National Forest a new road was constructed past a previously unknown or forgotten cave. The road was built in conjunction with a timber sale, to remove timber from around the cave. Many people passed by the cave during the timber sale planning, road engineering, and road construction. Outwardly the cave seemed short full of broken rock, and of little significance. No one thought to have an evaluation made. By accident the cave was found by local speleologists who immediately recognized the cave as an archaeologic site, something unknown in other southern Washington lava caves. Subsequent evaluation by University of Washington archaeologists indicates the deposits may be 11,000 or more years old, and may predate other known Indian use of the area. Until further evaluation can be made, the Forest Service has felt compelled to place a 24-hour-a-day guard on the cave. This may be an unprecedented action by the U. S. Forest Service.

Deadhorse Cave, which is known nationally for its unique insect life, is located in the same area. Studies in southern Washington and in Hawaiian lava caves have shown that tree roots penetrating into the caves through ceiling cracks provide a major energy input into certain lava cave ecosystems. A timber sale was proposed to remove timber from the surface above this cave. The probable result of logging would have been a severe reduction in the food source of the cave organisms. The cave, and the surface above it, are now being considered for special designation as a Research Natural Area.

These stories help to illustrate the need for early evaluation of cave resources. Two potential disasters, archaeological and biological, were narrowly averted. In the past, many important caves have not escaped and their value was lost, even with well-meaning managers in charge.

BIOLOGIC EVALUATION

The biologic resources of caves are the poorest studied and least understood of the subjects to be discussed. From the beginning, it is important to understand that the relatively stable, isolated environment of caves creates very unusual conditions for the evolution of organisms. Energy input is usually restricted to organic matter brought into the caves by mammals or washed in through entrances. The low energy levels in most caves limit the variety and numbers of organisms found, especially if compared to the surface environment. The food chain within a cave is generally simple and offers biologists an opportunity to study interrelationships which would be difficult to study elsewhere.

When looking at a cave's biota, it is important to determine the major sources of energy input. In the case of Deadhorse Cave, energy was coming from tree roots. Woodrats, bats, raccoons, and other mammals leave their scat, carry in organic matter, or leave their bodies as food for cave organisms. In some areas, crickets, moths, gnats, and other insects from the surface provide food. Surface water entering caves may carry with it large quantities of organic debris which can nourish a large number of organisms. Even quantities of debris left by humans can form food sources; this should be considered whenever a cave is to be "cleaned" of litter. Any contemplated surface management should be evaluated against its effect on the underground food chain.

Logging in many areas would have an obvious impact on the food chain if carried out near a cave entrance. The removal of protection around an entrance could change its micro-environment. An alteration in the percolation of groundwater due to surface management must be considered. Road construction or land clearing can change the pattern of water movement which can potentially impact a cave's biota. Grazing in some areas has removed ground cover causing an increase in peak runoff which finds its way into caves. Herbicides and insecticides have an unknown effect on cave ecosystems, and should be used with extreme caution around caves.

Caves, especially in arid regions, contain fern and moss gardens. Moisture-requiring plants are found most often beneath skylight entrances. These small micro-environments can support relic communities of vegetation from past periods of more heavy moisture. In central Oregon are found plants which have their closest counterparts hundreds of miles away in the higher mountains. These significant and fragile gardens will not tolerate much foot traffic.

Of all the cave organisms, bats probably receive more attention than any other. Several species of bats have found their way onto the endangered species list, and several more are apt to be placed there soon. It is important to understand a little about bats' yearly cycle in order to evaluate their use of a cave.

The greatest concern is with caves used for hibernation or rearing of young. Bats generally go into hibernation in late October and come out in March. The timing depends on local temperatures and the availability of food. Some researchers believe bats may even come out of hibernation during warm periods to find food, or to move to different parts of the cave, seeking more favorable micro-environments, as winter conditions change.

Some bat species mate in the fall, and the female holds the sperm until spring when actual fertilization takes place. One or two young are born in the spring. Females normally group together in warm caves, in what many experts call maternity colonies. Generally, they choose locations that are warm to begin with – usually domes or high places in caves where warm air will collect. Larger colonies can sometimes use marginal locations if their combined body heat is sufficient to alter existing temperatures by warming the air. The summer months are critical for the rearing of young, the actual dates depending upon the species and the location.

Experts can determine use of caves by bats' direct evidence. Cave walls are frequently stained dark by urine at roosting sites, and with a little practice these are easily recognized. Guano deposits are another form of evidence which is readily seen. Hibernation sites, however, frequently have only thin deposits of guano. Bats do not defecate while in hibernation. Large quantities of guano can be found associated with maternity colonies or in summer roost sites used by the males.

Indirect evidence such as temperature can be used to predict areas where bats are likely to be found at certain tines of year. We know that during the summer bats prefer warmer portions of caves for roosting or rearing young. The temperature of roosting sites varies with species and sex. During the winter bats are likely to be found deeper in the caves, or where cold air collects and conditions are suitable for hibernation. Some bat experts can tell where in a cave bats are likely to be found simply by looking at a profile map of the cave.

When cave protection is talked about, the first thing to come into most people's minds is cave gating. Before a gate is placed in a cave entrance, the cave needs to be carefully evaluated biologically. Many important bat caves have been made inaccessible to bats by poor gate design. Different bats require different-sized openings to pass through. Restriction of air flow and the passage of other mammals can alter the cave environment or interrupt the food chain. Tuttle (1977) is an excellent reference.

Special training is required to accurately evaluate the biologic resources of a cave. For an untrained observer it is easy to assume that a cave is barren of significant biota. Management should be based on the premise that unique endemic species may inhabit a cave, even though none have been seen during cursory examination.

An excellent introduction to cave biology is by Mohr and Poulsen (1966). This book should be in the library of anyone anticipating biological studies or examination of caves. Another helpful publication for the identification of cave species, is by Cooper and Poulsen (1979), published as a part of the Caving Information Series by the National Speleological Society. This publication contains an important list of experts willing to identify biological specimens.

CULTURAL RESOURCES

Caves and archaeology remain almost synonymous in the mind of the public. The first scientists to study caves were archaeologists. Caves have provided protection, sources of water, storage space, and burial sites since the earliest times of man's prehistory. Some people used caves for religious purposes, and even today caves are looked upon as having mystic or religious qualities.

Cultural remains in caves are a non-renewable resource, which if disturbed lose their scientific value. On federal and state owned lands, laws are in effect to protect cultural resources. The earliest law was the Antiquities Act of 1906 which prohibits the appropriation, excavation, injury, or destruction of any historic or prehistoric ruin or monument, or object of antiquity, situated on lands owned or controlled by the Government of the United States. Excavation can be made only by qualified persons; generally people associated with reputable universities, colleges, or institutions. The act is quite specific and is still in full effect.

Many of the most important archaeological sites in the United States are found in caves. This is due to the protection caves offered early inhabitants and also to the protection the caves provided to the archaeological deposits. On the surface, erosion frequently has a degrading effect upon deposits of cultural materials. On the other hand, most caves work under a principle of deposition. Silt from the surface is washed in and covers cave floors. Flakefall and breakdown from the ceiling further protect and preserve the deposits. Caves which are very dry or in which the fill is permanently saturated with water tend to preserve organic and vegetative matter for extremely long periods of time. Caves offer the archaeologist an opportunity to examine remains which would have disintegrated on the surface long ago.

Dry caves offer the best opportunity for archaeologists, and are the ones which usually best preserve artifacts. When investigating any cave, it is important to look for any features out of the ordinary which might indicate human use. Specific items to look for are smoke blackened ceilings and any obvious artifacts such as flakes, tools, bones, etc. In the Northwest many Indians used heated rocks dropped into baskets full of water for cooking. The immersion of the rocks frequently cracked them, creating distinctive artifacts. Fire-cracked stream cobbles are frequently found in cave entrances. Some caves have obvious pictographs or petroglyphs on their walls. Fallen Arches Cave in Washington has sleeping platforms constructed of hand placed stones covered by sand. These contrast with an otherwise rubble-covered floor.

Many ‘caves’ described by archaeologists are better termed rock shelters by speleologists. They are frequently shallow and well-lighted by the sun. The favorite caves are those which are dry and face south or west so the sun warms them. When investigating a cave it is sometimes helpful to ask yourself if you would camp or live in it. A cold, wet, miserable cave would probably be a poor place for habitation but, in an arid land, could provide an important source of water.

In undisturbed caves it is sometimes possible to find tracks left by early visitors. If you believe you are in passages unused by modern man, be alert for foot prints and take care not to disturb them.

The lava plateaus of the western United States and the recent volcanic areas in Hawaii provide little surface water. The porous lava quickly absorbs precipitation and nearly no runoff occurs. Caves in these areas collect snow and ice which early inhabitants used as a water source. Where the caves were too warm for ice to form, early people learned they could collect dripping water. Many western caves have large archaeologic sites situated around their entrances. In both Hawaii and the West accumulations of charcoal scattered along passage floors tell of early man’s passing.

When considering a cultural resource site in a cave, you should also be examining the aboriginal use of the surface around the cave. Many times large quantities of flakes are found on the surface around cave entrances. Both surface and cavernous areas may constitute the site and for management purposes must be considered at the same time.

Protection of the site will depend upon the specific case and should be done with the consultation of a professional archaeologist. Under no circumstances should anyone be allowed to dig into or disturb the site. All artifacts should be left in exactly the position they are discovered. If an archaeologic site is suspected, it is important to find expert help for evaluation.

While discussing cultural resources, it is necessary to take a look at historic artifacts found in caves. During prohibition days many caves were used to hide stills. Others were used for cold storage or as root cellars. Onyx was mined from some caves and saltpeter from others. The guano mining industry flourished before the advent of modern fertilizers. Everyone has heard tales of money hidden in caves by bandits. Some caves have been found which were used as houses by early settlers. All of these uses leave certain artifacts which are of value to historians. It is a little vague where recent litter becomes of historic value. The Forest Service considers a site to be of historic interest if over 50 years old. If some significant event happens in a cave it might become important even sooner.

PALEONTOLOGY

Paleontology is the study of organisms of times past. Any direct information about such organisms is a candidate for study. Frequently these deposits are found in association with archaeologic materials. Sometimes the remains of the organisms help date the deposits.

Caves are important as fossil sites due to their relative rarity and uniqueness. Harris (1976) states that “in terms of caves per square mile, caves are extremely rare in North America and elsewhere. In terms of caves per million-year period of past time, things are even grimmer.”

Very dry caves, or ones in which the fill is saturated with moisture, tend to preserve remains for long periods. Caves offer the advantage of preserving bones of even very small animals which are difficult to find elsewhere. Most of the same principles which control the formation of archaeological sites apply to the deposition of paleontological deposits. A few special features should be looked for, however. Trap-like entrances into which animals can fall produce especially productive sites. Former entrances should be looked for, or areas where the fill changes character. Bones are the obvious sign of a site even if they are of fairly recent origin, along with signs of organic matter. Look for areas where gravity or drainage could carry remains from the entrance area.

In many caves air-carried pollen or plant spores are preserved in distinct layers and record changes in local vegetation. In some dry caves animal dung is preserved – sloth dung has been dated to 40,000 years b.p. Caves offer an opportunity to collect data obtainable from no other place.

Taphonomy is the science which concerns itself with all aspects of the transition from living to buried assemblages of organisms. Surface features of archaeological and paleontological sites give evidence of the processes by which the deposits form. Animal tracks, scat, bones, organic matter, nests, and ephemeral physical features are all important indicators of agents which alter the depositional record. An understanding of the processes by which the deposits form is important to the understanding of the paleontological and archaeological record and interpretation of the sites. Since these deposits are superficial in nature, care should be taken in their preservation. Heavy traffic through a zone containing these deposits can destroy the resource or severely limit its value.

Nearly all caves contain fossil material and with a little practice can be recognized. Even sterile-appearing fill commonly contains fossils which an expert can recognize. Cave fills should be examined by a paleontologist before any activity is undertaken which might disturb them.

GEOLOGICAL FEATURES

When most people think of cave conservation they are thinking of preserving the geological features in caves. A cave with beautiful formations is easy even for the uninformed to identify. No one would dispute the value of preserving this visually pleasing resource.

Some caves are important to geologist or mineralogists for the types of minerals or deposits found in them. Some mineral deposits are extremely fragile and easily destroyed. In some lava caves there are miniature badlands created by the rearrangement of fill by dripping water. These 'sand castles' are extremely rare and easily damaged by uninformed visitors. For identification of individual minerals a good reference is Hill (1976). Some lava caves also contain unusual drip formations which formed while the cave was still hot. These can be considered completely non-renewable features since the conditions under which they form cease at the end of volcanic eruption.

Less glamorous features include layers of fill in caves which can record past sequences of geologic events. In some instances organic matter in the fill can be used to make age determinations through C^{14} dating. A collapsed wall section in Lake Cave, Washington, exposed the charred remains of a tree stump below the lava flow. Dating of the charcoal showed an age of 2,250± years. Considerable research has been devoted to the dating of cave deposits through uranium-thorium analysis. Past climatic conditions can be determined through oxygen-isotope analysis of calcite speleothems. Both of these types of analysis can be used to determine age of cave deposits and to help in unraveling surface geomorphology.

As with the other cave sciences, expert advice is often necessary to accurately evaluate the geologic significance of caves. From the standpoint of identifying the more obvious formations there is usually little difficulty in determining their presence.

HAZARDS TO THE PUBLIC

In examining caves it is important to evaluate the potential hazards to the public. Many caves contain abrupt drops, pits, loose rock, slippery footing, dangerous gases, confusing passages, or may at times flood. In some arid caves the breathing of cave dust can cause a lung disorder called histoplasmosis. Any dry, dusty cave is suspect and it is a good idea to not create undue clouds of dust without wearing some sort of respiratory protection.

Air in most caves contain rather high concentrations of radon (Rn-222) and its breakdown daughters. Any person breathing this atmosphere containing Rn-222 and its daughters will retain a portion of the mixture in their lungs. The daughters retained in the lungs continue the break down process and give off a considerable amount of alpha energy to the lung tissue. Significantly long exposure can cause an increase in the lung cancer rate. This needs to be considered in the case of persons who may spend very long periods underground on a regular basis, such as cave guides. Cigarette smoking seems to have an enhancing effect on the damage caused from alpha radiation by radon daughters. Occasional cave visitors have little to worry about from this hazard.

FIELD INVENTORY AND CLASSIFICATION

Most people would agree that inventory is the very first step which must be taken in any sort of management. How to inventory caves has been a question asked by many managers, and has probably been approached in many different ways. This paper has discussed some of the important points a field investigation must consider. Each cave presents a special set of circumstances and may contain values not discussed here, or ones not realized by the present state-of-the-art.

The Forest Service, National Park Service at Carlsbad Caverns and Guadalupe Mountains National Park, and the Bureau of Land Management have developed an inventory and classification system for caves. This system is in use in New Mexico and parts of Arizona and has been meeting with success.

The system has provisions for inventory, classification, identification, record keeping, and management direction. A discussion of the classification system may be found in Trout (1978). The system is a good working tool for anyone anticipating a cave inventory.

In recent years it has become increasingly obvious that caves contain scientific resources of great importance. Land managers are learning of this value and the necessity for protection and wise management.

EXPERT HELP

When should 'expert help' be contacted? Consider your degree of knowledge, ability, and experience. You should be aware that uniqueness is a relative concept. What is unique in one geographical area may not be so in another. For instance, a 'well-decorated' limestone cave in the Pacific Northwest is unique simply due to the scarcity of limestone caves with decorations, unlike in the eastern United States. As you become more experienced in evaluation the need for outside help will decrease. Time pressure can require immediate expert assistance. If you expect an impact may occur shortly, or is presently occurring, you may want to consult a specialist at an early time. This is especially applicable within the fields of biology, paleontology, and perhaps even geology. Archaeologic resources should always be drawn to the attention of an expert as soon as they are suspected. Many government agencies have staff archaeologists who can be called. It is wise to remember that all Federal and most State agencies are under mandate by law to protect archaeologic sites under their jurisdiction.

If expert help is needed it can be found through local universities. Most states have a Historic Preservation Officer who catalogues and helps co-ordinate aspects of archaeology within their respective state. This is an excellent contact and a place where advice can be found. Cave biologists are more thinly spread than experts in other fields. Only a few universities are able to deal with cavernicolous species. If local help is unavailable it would be wise to contact the National Speleological Society, Cave Avenue, Huntsville, Alabama 35810. Ask for a referral in your area. The NSS Biology Section has within its membership most cave biologists within the United States.

REFERENCES

Ahlstrand, G. M., and P. L. Fry. 1978. Alpha radiation project at Carlsbad Caverns: two years and still counting. Pp. 133–137, *in* 1977 National Cave Management Symposium Proceedings (R. Zuber, J. Chester, S. Gilbert, and D. Rhodes, eds.). Adobe Press, Albuquerque, New Mexico. 140 pp.

Allen, G. M. 1962. Bats. Dover Publications, Inc. New York. 386 pp.

Barr, T. C., Jr. 1966. Evolution of cave biology in the United States, 1822–1965. National Speleological Society Bulletin 28(1):15-21.

Beckman, R. T. 1978. Cave radiation health seminar. P. 125, *in* 1977 National Cave Management Symposium Proceedings (R. Zuber, J. Chester, S. Gilbert, and D. Rhodes, eds.). Adobe Press, Albuquerque, New Mexico. 140 pp.

Campbell, N., and J. Chester. 1977. Wilderness caves of the Northwest: a method of inventory. Pp.

11–12, *in* 1977 National Cave Management Symposium Proceedings (R. Zuber, J. Chester, S. Gilbert, and D. Rhodes, eds.). Adobe Press, Albuquerque, New Mexico. 140 pp.

Cooper, J. E., and T. L. Poulsen. 1979. A guide to biological collecting in caves. Caving Information Series, #_______. National Speleological Society, Huntsville, Alabama. XX pp.

Cressman, L. S. 1960. The sandal and the cave: the Indians of Oregon. Beaver Books, Portland, Oregon. 81 pp.

Davies, W. E. 1966. The earth sciences and speleology. National Speleological Society Bulletin 28(1):1–14.

Gilkey, G. 1969. The environment of a nursery colony of little brown bats (*Myotis lucifugus*). National Speleological Society Bulletin 31(2):45.

Halliday, W. R. 1959. Adventure is underground. Harper and Brothers, New York. 206 pp.

Halliday, W. R. 1963. Caves of Washington. Information Circular No. 40. Washington Department of Conservation, Division of Mines and Geology. 132 pp.

Harris, A. H. 1976. Paleontology. Pp. 19–21, *in* 1975 National Cave Management Symposium Proceedings. Speleobooks, Albuquerque, New Mexico. 146 pp.

Hill, C. A. 1976. Cave minerals. National Speleological Society, Huntsville, Alabama. 137pp.

Jermann, J. V., and R. Mason. 1976. A cultural resource overview of the Gifford Pinchot National Forest, south-central Washington. Unpublished report to University of Washington, Office of Public Archaeology and the United States Forest Service. 217 pp.

Jones, R. F. 1972. Wappato Indians: their history and prehistory. Privately printed. 237pp.

Loose, A. 1976. Cultural resources. Pp. 22–23, *in* 1975 National Cave Management Symposium Proceedings. Speleobooks, Albuquerque, New Mexico. 146 pp.

McEachern, J. M., and M. A. Grady. 1978. An inventory of the cave resources to be impacted by the New Melones Reservoir Project, Calaveras and Toulumne counties, California. Unpublished report to U. S. Army Corps of Engineers, Contract DACWO5–77–C00038. 102 pp.

McReynolds, H. E. 1976. Rare and endangered cave animals. Pp. 38–42, *in* 1975 National Cave Management Symposium Proceedings. Speleobooks, Albuquerque, New Mexico. 146 pp.

Mohr, C. E., and T. L. Poulsen. 1966. The life of the cave. McGraw Hill, New York. ____ pp.

Moore G. W., and G. N. Nicholas. 1964. Speleology, the study of caves. Heath and Company, Boston. 120 pp.

Nieland, J., L. Nieland, and E. Benedict. 1978. Special management considerations of lava caves. Pp. 85–91, *in* 1977 National Cave Management Symposium Proceedings (R. Zuber, J. Chester, S. Gilbert, and D. Rhodes, eds.). Adobe Press, Albuquerque, New Mexico. 140 pp.

Poulson, T. L. 1976. Management of biological resources in caves. Pp. 46–52, *in* 1975 National Cave Management Symposium Proceedings. Speleobooks, Albuquerque, New Mexico. 146 pp.

Schmidt, V. A. 1969. Paleomagnetism of primordial cave sediments: a promising new technique for the dating of caves. National Speleological Society Bulletin. 31(2):41.

Trout, J. 1978. A cave classification system. Pp. 19–23, *in* 1977 National Cave Management Symposium Proceedings (R. Zuber, J. Chester, S. Gilbert, and D. Rhodes, eds.). Adobe Press, Albuquerque, New Mexico. 140 pp.

Wildensen, L. E. 1977. Cultural resource management: a guidebook of procedures and techniques for managing historical and archaeological resources. United States Forest Service, Region 6. Portland, Oregon. 222 pp.

Yarborough, K. A. 1978. Airborne alpha radiation in natural caves administered by the National Park Service. Pp. 125–132, *in* 1977 National Cave Management Symposium Proceedings (R. Zuber, J. Chester, S. Gilbert, and D. Rhodes, eds.). Adobe Press, Albuquerque, New Mexico. 140 pp

Yarden, D. W., and P. A. Morris. 1975. The lives of bats. New York Times Book Company, New York. 247 pp.

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