Gray Bat Recovery Plan

This is the completed Gray Bat Recovery Plan. It has been approved by the U.S. Fish and Wildlife Service. It does not necessarily represent official positions or approvals of cooperating agencies and it does not necessarily represent the views of all recovery team members, who played the key role in preparing this plan. This plan is subject to modification as dictated by new findings and changes in species status and completion of tasks described in the plans. Goals and objectives will be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints.

The Gray Bat Recovery Plan, dated July 1, 1982 prepared by the U.S. Fish and Wildlife Service in cooperation with the Gray Bat Recovery Team:

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PREFACE

This plan has been prepared under the authority of the Endangered Species Act of 1973 and subsequent amendments of 1978. The plan is designed to provide decision makers with an orderly set of events which, if carried to a successful completion, would lead to the recovery of the species. The plan also establishes priorities for protection and management of caves, guidelines for protection of foraging habitat, public education, and monitoring procedures.

The plan is organized into three parts. The first part includes a description of the gray bat, its distribution, life history, reasons for decline, population status, recovery actions completed or planned, and needed recovery actions.

The second part is a step-down plan wherein all existing and needed research and management efforts are organized into an orderly set of events. The prime objective is to move the gray bat to threatened status. The minimum requirements for the attainment of this objective are documentation of protection of 90% of Priority 1 hibenacula and documentation of stable or increasing populations at 75% of Priority 1 maternity caves after a period of 5 years.

The third part identifies the priorities, biological significance, needs, and recommended management agencies for all known gray bat caves.

Portions of Parts I and II are quoted directly from Tuttle (1979a) with the expressed permission of the editors of the Journal of Wildlife Management.

PART I

Description

The gray bat is the largest member of its genus in the eastern United States. Its forearm measures 40-46 mm, and it weighs from 7-16 gms. (usually 8-11 gms.). It is easily distinguished from all other bats within its range by its unicolored dorsal fur. All other eastern bats have distinctly bi- or tri-colored fur on their backs. Following molt in July or August, gray bats are dark gray, but they often bleach to chestnut brown or russet between molts (especially apparent in reproductive females during May and June). The wing membrane connects to the foot at the ankle rather than at the base of the first toe, as in other species of *Myotis*.

Distribution

The gray bat is a monotypic species that occupies a limited geographic range in limestone karst areas of the southeastern United States (FIGURE 1). 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 (Barbour & Davis, 1969; Tuttle, 1979a). Distribution within the range was always patchy, but fragmentation and isolation of populations is increasing.

Life History

Prior to recent major declines, individual hibernating populations of gray bats contained from 100,000 to 1,500,000 or more bats. Approximately 95 percent of the entire known population hibernates in only nine caves each winter, with more than half in a single cave. Undisturbed summer colonies in Tennessee and Alabama contain from 5,000 to 250,000 or more bats each, with most numbering 10,000 to 50,000 (Tuttle, 1979a).

Most gray bats migrate seasonally between hibernating and maternity caves. The distance traveled by individual coloney varies depending on geographic location. Tuttle (1976a.) reports that one-way migration for a major maturnity colony segment varies from a non-migratory 17 km to 525 km.

On arrival at hibernating caves, adults copulate and females immediately begin hibernation. Some mate and enter hibernation as early as the first of September, and nearly all do so by early October. Following mating, males remain active for several weeks, during which time fat supplies depleted during breeding are replenished. Juveniles of both sexes and adult males tend to enter hibernation several weeks later than adult females, but most are in hibernation by early November. Stored fat reserves must last for at least six to seven months (Tuttle, 1976a; Tuttle, unpublished data; Tuttle & Stevenson, 1977).

Adult females emerge in late March or early April, followed by juveniles of both sexes and adult males. Most juveniles and adult males leave between mid-April and mid-May (Tuttle, 1976a). Migration is hazardous, especially in

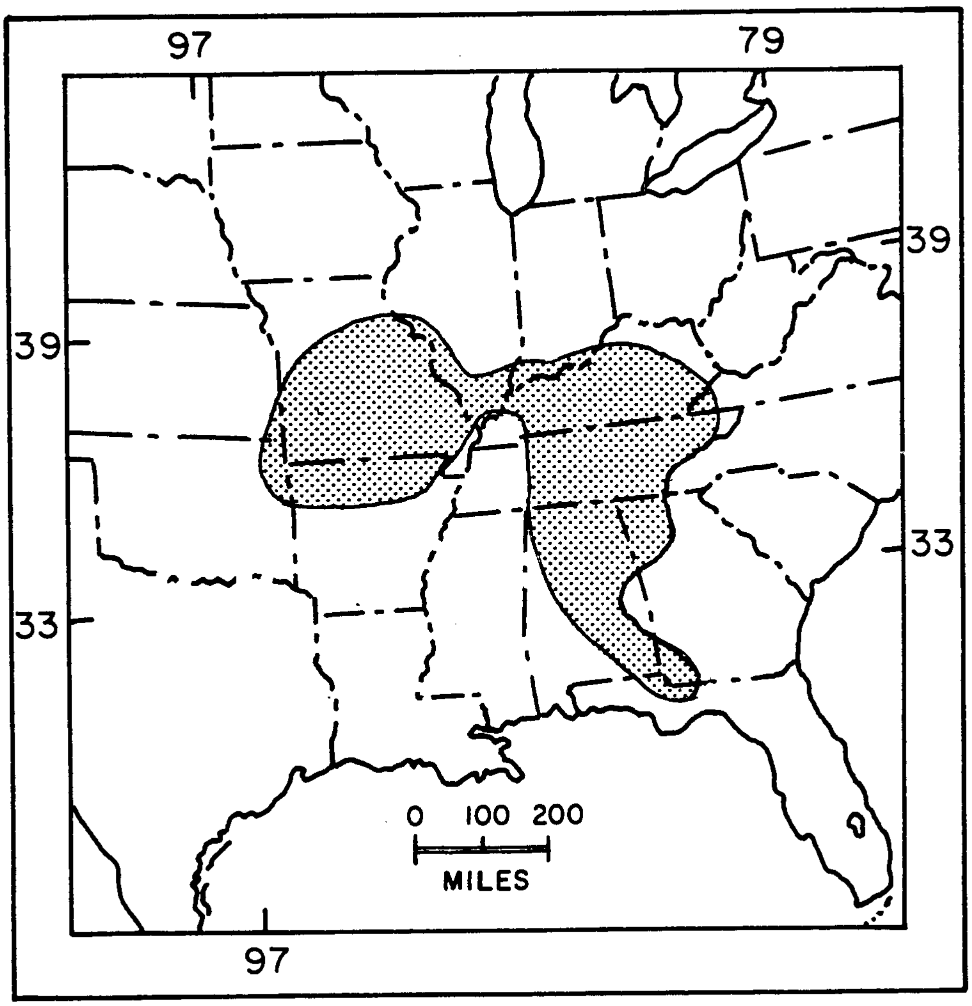

FIGURE 1. Distribution of _Myotis grisescens_.

spring when fat reserves and food supplies are low. Consequently, adult mortality is especially high in late March and in April (Tuttle & Stevenson, 1977).

Each summer colony occupies a traditional home range that often contains several roosting caves scattered along as much as 70 km of river or reservoir borders. Colony members are extremely loyal to their colony home range, but tend to disperse in groups among several different caves within that area (Tuttle, 1976a; LaVal, unpublished data).

Adult females store sperm through the winter and become pregnant soon after emergence from hibernation (Guthrie & Jeffers, 1938). They give birth to a single young in late May or early June. At that time, the reproductively active females congregate in a single, traditional maternity cave (usually the warmest one available), while males and non-reproductive females congregate in smaller groups in more peripheral caves within the colony home range (Tuttle, 1976a).

Growth rates of nonvolant young are positively correlated with colony size (Tuttle, 1975), because increasing numbers of bats clustering together reduce the themoregulatory cost per individual (Herreid, 1963; 1967). Growth rates are also affected positively by higher ambient cave temperatures and porous or domed ceilings at roosts. Though growth rates vary, most young begin to fly within 20-25 days after birth. Where colonies have been reduced in size as a result of roost disturbance this time may be increased to 30-35 days (Tuttle, 1975), and in severely reduced colonies, the young sometimes die before learning to fly (Tuttle, unpublished data).

For newly volant young, growth rates and survival are inversely proportional to the distance from their roost to the nearest over water foraging habitat (Tuttle, 1976b). Although mothers continue to nurse their young for a brief period after the young learn to fly, juveniles are apparently left to learn how and where to hunt on their own (Tuttle & Stevenson, in manuscript).

Especially during the period of lactation from late May to early July, reproductive females must maintain high body temperatures at their relatively cool roosts. This requires larger amounts of energy, and during the period of peak demand, when young are roughly 20-30 days old, individual females sometimes feed continuously for more than seven hours during a single night.

During peak insect abundance in early evening many gray bats feed in slowly traveling groups, but when insect numbers drop 1-1/2 to 2 hours after sundown, gray bats become territorial. Depending upon prey abundance, foraging territories may be occupied by from one to as many as 15 or more bats. Territories seem to be controlled by reproductive females and are located in the same places and used by the same individual bats, from one year to the next (Tuttle et al., in manuscript).

Habitat Requirements

The gray bat is, perhaps, the most restricted to cave habitats of any U. S. mammal (Hall & Wilson, 1966; Barbour & Davis, 1969; Tuttle, 1976a). With rare exception (Hays & Bingham, 1964) it roosts in caves year-round. Because of highly specific roost and habitat requirements, fewer than 5% of available caves are suitable for occupation by gray bats (Tuttle, 1979a). Colonies move seasonally between unusually warm (14-25°C) and cold (6-11°C) caves.

Most winter caves are deep and vertical; all provide 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 & Stevenson, 1978). At all seasons, males and yearling females seem less restricted to specific cave 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). Except for brief periods of inclement weather in early spring and possibly late fall, adult gray bats feed almost exclusively over water along river or reservoir edges (LaVal et al., 1977a; Tuttle & Stevenson, in manuscript). Detailed observations over an east Tennessee reservoir indicated that most foraging was restricted to within 5 m of the water surface near shore (Tuttle et al., in manuscript), but gray bats in Missouri have been seen foraging in forest canopy along river edges in addition to low over-water (LaVal, unpublished data).

At an east Tennessee reservoir, foraging territories were nearly always located over slabrock bottom along areas of the original river channel that were bordered by forest. Foraging territories were found up to 20.3 river-km from the roost, and a maternity colony of approximately 8,000 gray bats dispersed nightly along approximately 362 km of reservoir shoreline. Males and yearling females were excluded from foraging territories, and the colony may have been food limited (Tuttle & Stevenson, in manuscript; Tuttle et al., in manuscript).

LaVal et al. (1977a) studied a gray bat maternity colony in Missouri and also found colony members foraging up to 20 or more km from their roost. Though their study technique could not detect territorial behavior, they did note that individual bats fed in areas of patchy distribution.

At an east Tennessee reservoir, Tuttle et al. (in manuscript) compared insect faunas in foraging versus nonforaging areas and found significantly more mayflies (*Choroterpes* and *Stenacron*) in foraging areas. They found no gray bats foraging over a nearby reservoir where mayflies were rare. They concluded that their study colony was dependent upon mayflies for survival. Mayflies are believed to be especially susceptible to aquatic pollution from industrial effluents (Fremling, 1968), and the reservoir where gray bats were

not found is known to receive unusually large amounts of toxic industrial wastes (Anon. 1978).

Newly volent young gray bats often feed and take shelter in forest surrounding cave entrances. Also, whenever possible, gray bats of all ages fly in the protection of forest canopy between caves and feeding areas. Such behavior provides increased protection from predators such as screech owls. Forested areas surrounding caves and between caves and over-water feeding habitat clearly are advantageous to gray bat survival (Tuttle, 1979a). Additionally, gray bat feeding areas have not been found along sections of river or reservoir where adjacent forest has been cleared (LaVal *et al.*, 1977; Tuttle & Stevenson, in manuscript).

Reasons for Decline

Human Disturbance.-- In summer, gray bats select only a few caves, which must be located near rivers or reservoirs (Tuttle 1976b). They hibernate in deep, vertical caves that have unusually low (6° - 11° C) temperature. As a consequence of their combined thermoregulatory and other habitat requirements, gray bats congregate in larger numbers and in fewer hibernating caves than any other North American bat. "This concentration of such a large proportion of the known population into so few caves constitutes the real threat to their survival" (Mohr, 1972). In a brief plea for bat conservation, Manville (1962) noted the extreme vulnerability of the gray bat to human disturbance and vandalism, and Barbour and Davis (1969) pointed out that "in the last few years human disturbance has threatened the very existence of the species." They concluded that "...*M. grisescens* is destined to continue a rapid decline in numbers and probably faces extinction." Tuttle (1979) reported human disturbance in caves to be a primary cause of decline and demonstrated a close relationship between decline and frequency of disturbance.

Although any repeated disturbance of roosts is harmful, disturbance from late May through mid-July at maternity caves and from mid-August through April at hibernating caves is especially detrimental. In the first period, flightless young are on roosts, and thousands may die from a single disturbance. In the second, each human entry causes all gray bats within range of sound or light to arouse at least partially, and usually completely, from hibernation.

A limited number of arousals is natural and necessary, but each arousal from hibernation is energetically expensive, and energy reserves (in the form of fat) cannot be replaced before spring emergence. Calculations for similar sized species of the same genus indicated that each arousal causes a bat to expend 20-30 days of stored energy reserves (Daan, 1973). Similarly, Tuttle's unpublished observations on gray bats indicate normal rates of hibernating weight loss of less than 0.01 gms/day. In contrast, he found that gray bats sometime lose as much as 0.48 gms in the first hour of disturbance. The amount lost varies according to season, cave temperature and other factors, but Tuttle's data indicate that simple arousal and movement to a new roosting place probably costs an average gray bat as much

energy as it would normally expend in 10 to 30 days of undisturbed hibernation (Tuttle, unpublished observations).

An average human visit to a gray bat hibernating cave usually results in either multiple or prolonged disturbance to the bats. Clearly, repetition of visits within a single winter can exhaust the bats' limited energy reserve, resulting in high levels of mortality. Once a bat's energy stores are exhausted, it likely will leave the cave prematurely in search of food, dying outside where its fate will go unnoticed.

Environmental Disturbance.-- The very large proportion of gray bat decline that appears to be directly attributable to human disturbance renders detection of other potential problems extremely difficult. Nevertheless several factors involving environmental disturbance probably have affected gray bats adversely.

The possible influence of pesticides in causing decline of North American populations of insectivorous bats has been reported (Mohr, 1972; Reidinger, 1972, 1976; Clark and Prouty, 1976; Geluso et al., 1976), and a recent study has documented mortality and probable population decline in gray bats resulting from routine insecticide usage (Clark et al., 1978).

Clearly, further investigation is needed. Donald Clark (personal communication) analyzed samples of guano from 22 gray bat caves in Alabama and Tennessee and has found considerable variation among localities, with levels of PCB, DDD, DDE, heptachlor epoxide, or lead at potentially dangerous levels.

A further possible cause of decline may involve other chemical pollution or siltation of waterways over which gray bats forage. Although studies on prey preferences are not yet complete, gray bats are known to forage primarily over rivers, streams, and reservoirs (Tuttle, 1976a,b; LaVal et al., 1977) where they capture a variety of insects. Among these are large numbers of mayflies (Tuttle, 1976b; Tuttle et al., in manuscript), as well as stoneflies and caddisflies (Brack et al., in prep.). All three groups of insects are thought to be quite sensitive to aquatic pollution. Through broad areas of their former habitat, mayflies have been virtually eliminated, and they are now rare in other areas of former abundance (Fremling, 1968). Clearly, such declines could prove disastrous for predators that depend upon mayflies as a major food source.

Few observations are available on the potential effects of siltation. Carlander et al. (1967) suggested that at least some siltation benefited nymphs of the two species of mayflies. Other studies indicate some species apparently were unable to survive on mud or silt substrate, (Lyman, 1943; Minshall, 1967). In areas surrounding the Cumberland Plateau in Kentucky and Tennessee, recent increases in strip mining have produced levels of siltation that could have extreme and far reaching effects on aquatic biota and consequently on the future survival of gray bats living along affected waterways. In a recent census of gray bats in Alabama and Tennessee, all colonies along heavily silted waterways had declined (Tuttle, 1979a).

Problems involving the effects of both chemical and silt pollution on aquatic insects upon which gray bats depend need more investigation.

Additionally, deforestation of areas near cave entrances and between caves and rivers or reservoirs where gray bats feed may have affected them detrimentally. During exceptionally cold spring weather, Tuttle (1979a) has observed that gray bats sometimes forage in forested areas near their caves. Also, during evening emergence gray bats usually fly in the protection of forest canopy enroute to rivers or reservoirs where they feed (Tuttle, 1976b). Gray bats often travel considerably out of their way in order to take advantage of even scattered trees along fence rows. Screech owls capture emerging gray bats but are less successful when the bats are able to take cover in forest canopy (Tuttle, 1979a).

Since female gray bats produce their first young when 2 years old (Guthrie, 1933b; Tuttle, 1976a) and thereafter produce only one per year, even slight increases in predation could prove significant. Young gray bats are slow and clumsy fliers during their first week of flight, and at caves surrounded by forest, they often spend several nights foraging in the forest before venturing farther away. The trees provide convenient resting places for weak fliers and protection from predators and wind.

Impoundment of Waterways.-- Gray bat preference for caves near rivers has made their roosts particularly vulnerable to inundation by man-made impoundments. The initial effect of long-established impoundments, such as the Tennessee Valley Authority reservoir system, is difficult to evaluate due to a lack of pre-impoundment data. The little information available indicates that many important caves, and probably their bat populations, were extirpated. An account by McMurtrie (1874) describes a cave in Alabama, since flooded by a reservoir, which was "inhabited by countless thousands of bats" and had guano piles 4.5 m deep. Long-time residents have told of many other such caves now submerged. Timing of the initial flooding may be a critical factor in whether the flooded populations are destroyed immediately. The bat's strong site attachment and narrow ecological requirements, however, make survival of displaced populations questionable even if they escape initial destruction.

It was initially suspected that reservoirs might increase the amount and quality of foraging habitat for colonies that survived (Tuttle, 1976b). Recent studies of gray bat foraging habitat and prey preference requirements support an opposite conclusion (Tuttle et al., in manuscript). Furthermore, recreational activity associated with reservoirs has greatly increased the number of people visiting gray bat habitat, and many caves formerly long distances from population centers and roads are now within easy access by boat.

Cave Commercialization and Improper Gating. - Some of the largest gray bat colonies ever known have been extirpated as a result of cave commercialization. In fact, the largest remaining gray bat summer colony would have been destroyed by commercialization in 1977 if the U. S. Fish and Wildlife Service had not intervened (Tuttle, 1979a). Some responsible owners of commercial caves have protected sections of their caves that were critical to gray bats, and those bats may have benefited by commercial enterprises.

In several cases, entire gray bat colonies, especially at maternity caves, have been lost as a result of the well meaning efforts of poorly informed conservationists who built improperly designed gates for the bats' protection (Tuttle, 1977). Any modification of cave entrances that affects bat movements, cave microclimate or facilitates predation should be avoided (See Appendix II).

Natural Calamities.-- Cave flooding is by far the most important natural calamity faced by gray bats, and it is becoming increasingly important as they retreat farther back into inaccessible places to avoid human disturbance. Summer colonies often retreat to roosts over deep water in order to avoid disturbance by humans. In some caves, this is a successful avoidance strategy; but in others, such roosts become death traps during flooding (Tuttle, 1979a).

An additional problem involves cave entrance closure. On rare occasions cave-ins or gradual fill-in of sinkhole entrances render a cave entrance or an important passage too small for a large colony to pass through without greatly increasing the danger of predation.

Current Status of Population and Trends

As pointed out by Tuttle (1975, 1979a), estimation of gray bat population size is exceedingly difficult. For this reason, plus the fact that available estimates have been made by several different workers, we suspect that some population estimates presented here may differ from the actual numbers by as much as 25-50%.

TABLE 1. MAJOR GRAY BAT HIBERNACULA AND POPULATION BY STATE

State	Number of Major Hibernacula	Total Population
Alabama	1	700,000
Tennessee	3	300,000
Arkansas	1	250,000
Kentucky	1	25,000
Missouri	3	300,000
	Total	1,575,000

There are only two situations in which gray bats remain at a given site in a specific cave long enough to allow the entire population to be censused: (1) At hibernacula during December-February; (2) at maternity caves during late June, after all young are born but not yet flying. Hibernaculum counts are especially inaccurate, but to date provide our most convenient population estimates for wide geographic areas. All nine known major gray bat hibernacula have been censused within the last 5 years, and probably account for some 95% of the summer population of the states listed, as well as adjoining states:

Few of these caves have been censused at regular intervals, so no overall estimate of population decrease can be made. However, at least three major hibernacula in Alabama and Tennessee have been entirely, or almost entirely, abandoned in the past 50 years and a population occupying one Missouri cave has diminished from 100,000 to 3,000 in the last 15 years. Other hibernating populations have suffered declines of around 50% over that period, including one that accounts for half of all hibernating gray bats. Several populations have remained nearly stable. The overall estimate of decline, based on hibernating population censuses, is at least 50%.

Estimates of former populations, based on stained areas and guano accumulation at maternity sites, are the best indicator of the overall population decline suffered by this species.

Tuttle (1979) reported on a number of caves in Alabama and Tennessee that he had censused twice. The estimated maximum past population for the 22 caves was 1,199,000. By 1970 the numbers had diminished to 635,700, a 47% reduction, and just six years thereafter the combined population had fallen to 293,600, an additional 54% reduction.

In Missouri, 41 maternity caves had an estimated maximum past population of 1,247,700. Twenty of these caves are now abandoned. The remaining 21 had a population of 343,600 in 1978, a reduction of 72%. Twenty-seven maternity caves censused in the early 1960's by Myers (1964) had a population of 238,000. In 1978, 16 were abandoned, the remaining 11 having a population of only 46,500. This constitutes an alarming 80% reduction over the 15-year period.

Recent (1979) data from Kentucky indicate an even more serious situation there. Twenty caves had a maximum past population of 515,400. Today only 61,100 bats remain in the eight caves still occupied, an 88% decline.

In summary, it appears that, although the decline in gray bat populations probably began during the nineteenth century when the exploitation of caves first began on a large scale (mining of saltpeter, onyz, and other cave minerals), the rate of decline has accelerated drastically during the past two decades reflecting the soaring popularity of spelunking as a sport. If populations continued to decrease at the rate of 54% every six years, there would be as few as 100,000 gray bats left by the year 2000. Because gray bats require large colonies for successful rearing of young (Tuttle, 1975), a population of 100,000 scattered among many caves in six states might not be able to sustain itself, and thus the species might be doomed to extinction if the population is allowed to drop anywhere near that level.

Recovery Actions Already Accomplished, Underway, or Planned

Since the gray bat was listed as endangered (Federal Register, 28 April 1976), encouraging progress has been made. the U. S. Fish and Wildlife Service has purchased Sauta Cave, the most important known summer cave, and is considering other important acquisitions, including the only major gray bat hibanaculum in Kentucky. it also fenced and posted Cave Springs Cave, a major summer cave on the Wheeler National Wildlife Refuge in Alabama. During more than ten years of precipitous decline, the formerly large maternity

colony at this cave was destroyed, and only a transient bachelor remnant of approximately 9,000 bats remained. Following only 2 years of strict protection from human disturbance, this colony has returned to maternity status and increased to more than 19,000 bats.

Acquisitions and management actions have been undertaken by a number of Federal and state agencies. However, certain agencies have been especially active in the acquisition and protection of gray bat caves, and should be gratefully acknowledged for their services to date. These include the U. S. Fish and Wildlife Service-Region 4, Tennessee Valley Authority, National Park Service, U. S. Forest Service, U. S. Army Corps of Engineers, and Missouri Department of Conservation, and the Tennessee Widlife Resources Agency.

Needed Recovery Actions

Acquire and Protect Caves.-- Because gray bats roost almost exclusively in caves, a substantial measure of protection can be afforded the population if all or at least the more important of these caves are protected from adverse human disturbance or modification. In the majority of caves this means that various governmental agencies, and possibly private conservation organizations as well, must first acquire some degree of control over the cave. This may be by fee acquisition, lease, easement, cooperative agreement, or some other arrangement, the critical factor being that the agency can legally take whatever steps are required to reduce or eliminate disturbance of the bats.

Clearly, the immediate objective must be to reduce human disturbance in occupied caves. First, the locations of gray bat caves must be made known to appropriate Federal, state, and local agencies, and private organizations, along with recommended options for protection. Locations of most gray bat wintering caves and many summer caves are known to bat researchers. Even those not yet known to researchers are usually known locally to spelunkers. Access to such location lists, however, should be restricted to accomplish protection of the sites.

Certain caves that have been especially important to bats in the recent past, but are now abandoned due to heavy disturbance, probably will be recolonized if protected, and should be acquired so the required degree of protection can be achieved. Protecting caves may require signposting, gating, fencing, and surveillance by enforcement agents. No gating or other entrance alteration of gray bat caves should be attempted without careful consideration of the potential impact upon movement of both bats and air (Tuttle & Stevenson, 1977).

However, because gray bat usage of caves is seasonal, protection efforts should be concentrated during the periods of residence (see FIGURE 2). As a rule of thumb, all disturbance must be avoided at maternity caves between early April and the end of July. At hibernacula, it is best to avoid all disturbance between mid-August and mid-May. At these and other kinds of gray bat caves, the actual period of usage, which may differ somewhat from the above dates, must determine periods of intensified protection effort.

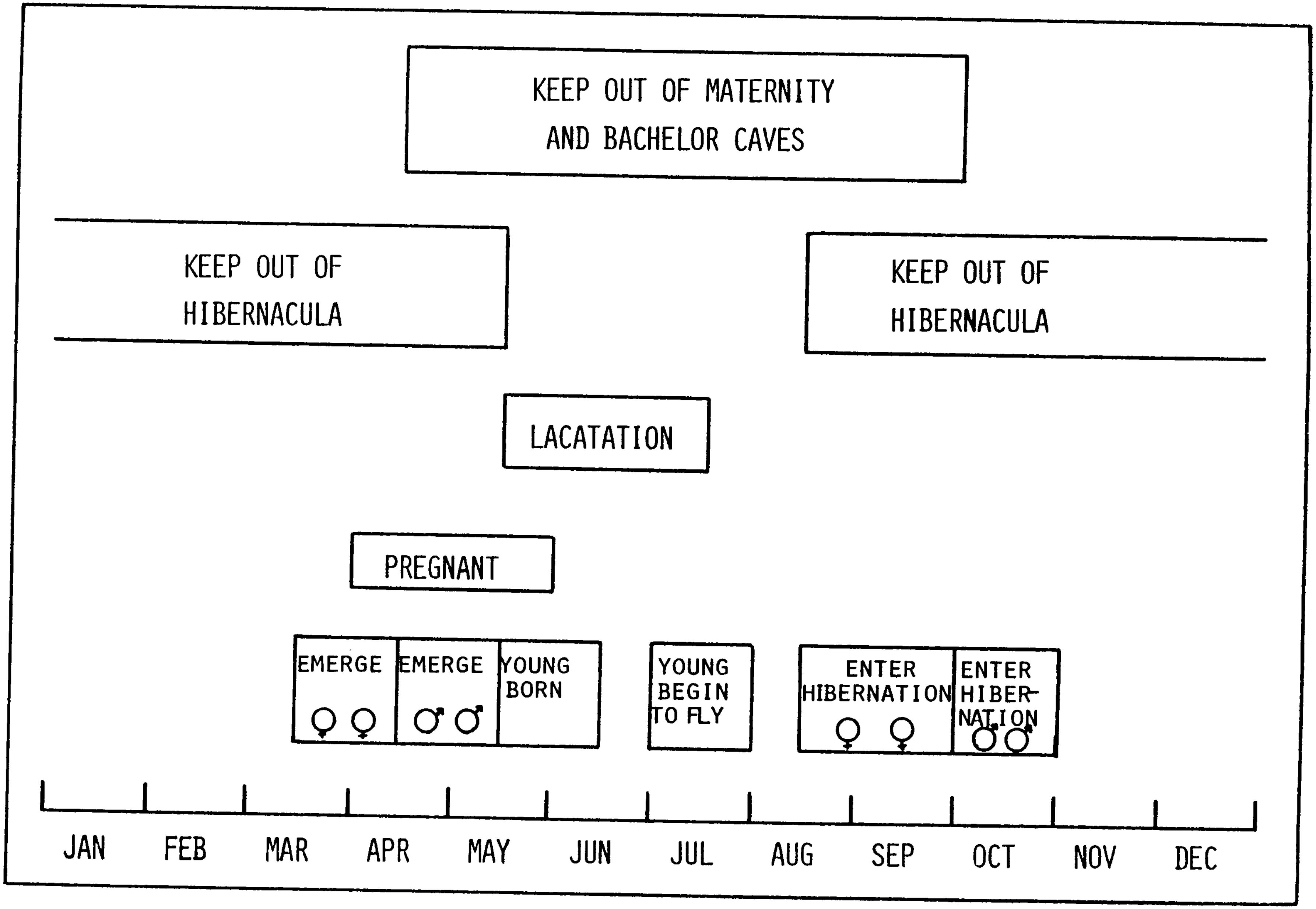

FIGURE 2. Annual chronology of the gray bat (*Myotis grisescens*), showing seasons when caves should not be visited. Some maternity and bachelor colonies naturally leave their caves as early as 1 August annually, and at such locations entry is permissable thereafter.

Control Habitat Destruction.-- Fortunately, much of the foraging habitat used by gray bats in their primary population centers (the Ozark and southern Appalachian regions) has not been seriously modified by man's activities except for the construction of reservoirs by the Tenneessee Valley Authority, the U. S. Army Corps of Engineers, and public utility companies. Much of this region remains forested, and the level of water quality necessary for production of the aquatic insects eaten by gray bats has been largely maintained in many rivers and streams. In some areas reservoirs provide foraging habitat for gray bats; however, recent studies indicate that the quantity and quality of prey species of insects produced are not as great as that produced by unimpounded rivers (Tuttle et al., in manuscript). Forested corridors, river edges, and reservoir shorelines should be left intact near major gray bat summer caves. Substantial areas of habitat have been destroyed or degraded by clearing, channelization, siltation, spraying of herbicides, pesticides, etc., and such destruction continues. Any activities that might adversely affect the foraging habitat within 25 km of major gray bat caves should be carefully examined and modified, if necessary, to protect the habitat. When unusual numbers of dead bats are found in caves, the carcasses should be examined for lethal concentration of pesticides or other toxic substances, and the source identified and controlled. In this and other cases where population decline is apparently due to destruction or degradation of foraging habitat, steps should be taken to restore and/or enhance existing habitat.

Public Education.-- Government officials at all levels should be educated regarding the ecological role of bats. Many officials, through exaggerated fear of bats as disease vectors, feel that the only good bat is a dead bat. Disease problems should be put in perspective and officials should be informed, for example, that the gray bats from a single cave in Alabama consume more than 900 pounds of insects nightly and 80 tons annually.

Major efforts should be made to educate and gain the cooperation of landowners. Many would cooperate if contacted by local wildlife officials or conservation groups. Cave owners should be provided with an official written statement outlining the basic problem, the potential value of having the bats, and Federal and state laws and penalties for disturbing them. Additionally, State wildlife agencies in coordination with the Fish and Wildlife Service should offer to post privately-owned gray bat caves, as well as posting their own, with signs briefly outlining reasons for protection and specific times during which entry is prohibited (see APPENDIX II). It is important also to inform landowners that a valuable and rare resource is involved, to generate a sense of pride and stewardship, making the protective posture a positive step. A plaque can be given cooperative landowners which has their name on it to be placed at the cave.

Such procedures should impress the landowner that protecting bats is important enough to warrant his participation and lets him "off the hook" with neighbors and others who might otherwise think of him as unfriendly. Also, informative signs often elicit cooperation even from would-be vandals, especially if a definite time period is stipulated.

A carefully-written brochure should be made available for distribution by state and Federal agencies throughout the range of the gray bat. The purpose of the brochure would be to convince the public that bats are worth protecting, and that the public's cooperation is essential if bats are to be protected successfully.

The need to avoid disturbance of gray bat caves should be emphasized. A sample brochure published by the state of Missouri is attached (APPENDIX V). A color slide presentation should be prepared for use in parks, nature centers, schools, etc., located within the distributional range of the gray bat. The National Speleological Society, Boy and Girl Scout troops, and other organizations whose members explore caves should receive special emphasis in these efforts.

Research Needs, Recommendations, and Cautions. - Gray bat seasonal habitat requirements (Tuttle, 1975, 1976a,b; LaVal et al., 1977) and movement patterns (Myers, 1964; Hall & Wilson, 1966; Tuttle, 1976a; Elder & Gunier, 1978) are relatively well understood, and available information is adequate to permit management initiatives. Nevertheless, several areas require further investigation.

Throughout the range of gray bats, investigations of the effects of environmental disturbance are essential. The most important areas of concern involve the potential effects of water pollution and siltation on aquatic insect life upon which gray bats depend, as well as those of pesticide contamination and local deforestation. Foraging habitat and prey preferences are necessary baseline data.

Plans for further studies raise the question of potential research-related disturbance. Gray bats are especially vulnerable to any disturbance during winter hibernation and immediately before and during their maternity period. Observation, netting, trapping, handling, banding, and other research-related activities should be restricted to the times and situations recommended by Tuttle (1979a:15-16).

If bats are banded, the recommended bands (called "rings" in England) can be obtained from Lambournes (Birmingham) Limited, 170-174 Great Hampton Row, Birmingham, 1319.3JF, England. Hibernacula should only be censused every 2 years.

PART II: RECOVERY

Abbreviated Step-Down Outline

PRIME OBJECTIVE: TO RECLASSIFY THE GRAY BAT FROM ENDANGERED TO THREATENED STATUS.

1. Prevent Disturbance to Important Roost Habitat.

1.1 Public Education.

1.1.1 Literature.

1.1.2 Interpretive Signs at Caves.

1.1.3 Ranger-Naturalist Talks.

1.1.4 Inform Cave Users.

1.1.5 Slide Program.

1.2 Prevent Unauthorized Entry.

1.2.1 Erect Warning Signs.

1.2.1.1 Design Proper Wording of Signs.

1.2.1.2 Select Caves Where Signs Alone Will be Effective.

1.2.2 Gate or Fence Cave.

1.2.2.1 Gain Control of Roost Site.

1.2.2.1.1 Roost Site Evaluation.

1.2.2.1.1.1 Identify Roost Sites to be Protected.

1.2.3 Monitor Roost Sites.

1.2.4 Monitor Caves by Law Enforcement Agencies.

1.3 Prevent Adverse Modifications to Roost Sites.

1.3.1 Prevent and Rehabilitate Adverse Modifications to the Subsurface, Including Entrances.

1.3.2 Prevent and Rehabilitate Adverse Modifications to the Surface Watersheds Surrounding Important Roost Sites.

1.3.3 Make Locations of Important Roost Sites Available to Appropriate Fish and Wildlife Service Offices and State Wildlife Agencies.

2. Maintain, Protect, and Restore Foraging Habitat.

2.1 Public Education.

2.1.1 Literature.

2.1.2 Ranger-Naturalist Talks.

2.1.3 Slide Program.

2.2 Prevent Adverse Modifications to Foraging Areas and Travel Corridors.

2.2.1 Determine Habitat Requirements.

2.2.2 Preserve Water Quality.

2.2.3 Preserve Forest Cover.

2.2.4 Monitor Habitat.

2.2.5 Include Foraging Areas and Travel Corridors in Section Seven Consultations.

3. Monitor Population Trends.

3.1 Monitor Status of Populations in Hibernacula.

3.2 Monitor Status of Populations in Maternity Colonies.

3.3 Monitor Residues of Toxic Chemicals.

3.3.1 Sample Insects.

3.3.2 Sample Guano.

3.3.3 Sample Bats.

Recovery Plan Narrative

OBJECTIVE: TO REMOVE THE GRAY BAT FROM ENDANGERED STATUS

It is the opinion of the Indiana/Gray Bat Recovery Team that the status of the gray bat can be changed from endangered to threatened if the following conditions are met. The criteria for the change to threatened status is documentation of permanent protection of 90% of Priority 1 hibernacula and documentation of stable or increasing populations at 75% of Priority 1 maternity caves (see Part III) during a period of 5 years. Once the status of the gray bat has been changed from "endangered" to "threatened," it will be possible to delist this species by the documentation of permanent protection as well as stable or increasing populations during five years of 25% of Priority 2 caves in each state. The most important feature of this plan is the protection of roosting habitat. This will require gaining

control of important hibernacula and maternity caves and protecting them from human disturbance. This can be done by either direct purchase, cooperative agreement, easement, etc. We also believe that as much as practicable, foraging habitat (which consists of bodies of water ranging from small streams to large reservoirs with accompanying riparian vegetation) must be maintained, protected, and restored. Finally, in order to insure the success of our efforts, a monitoring program should be established to insure that gray bat populations are responding positively.

1. Prevent Disturbance to Important Roost Habitat. There are a number of hibernation and maternity caves distributed throughout the range of the gray bat which must be preserved if the species is to survive. Disturbance, especially from human beings, has been documented as a major factor in decline of the species (Tuttle, 1979a). Because gray bats have such specialized requirements, only a small percentage of available caves are suitable.

1.1. Public Education. The public must be informed of the consequences if their actions disturb gray bat roosts. In addition, the beneficial qualities of gray bats should be promulgated.

1.1.1. Literature. The U. S. Fish and Wildlife Service should make available interpretive brochures to land management agencies, cave owners and organizations whose members explore caves within the known range of the gray bat.

1.1.2. Interpretive Signs At Caves. Signs erected at cave entrances should provide information on life history and consequences of disturbance.

1.1.3. Ranger-Naturalists Talks. These talks, given at places such as national parks and forests and Corps of Engineers and Tennessee Valley Authority reservoirs, should include appropriate information on the gray bat.

1.1.4. Inform Cave Users. Special emphasis should be made to educate cave users such as speleologists, boy and girl scouts, and cave owners.

1.1.5. Slide Program. A slide program should be prepared by the U.S. Fish and Wildlife Service on the gray bat with emphasis on the beneficial effects and need for protection.

1.2. Prevent Unauthorized Entry. Preventing unauthorized human access to gray bat caves is the best way to curtail disturbance.

1.2.1. Erect Warning Signs. Signs can be used at certain caves to discourage entry. Signs are also used in conjunction with gates to inform the public. Signs should not block bat movement or air flow (see APPENDIX II).

1.2.1.1. Design Proper Wording of Signs. FIGURE 3 shows a sign which the Team thinks is properly worded.

1.2.1.2. Select Caves Where Signs Alone Will be Effective. Criteria are presented in APPENDIX II.

1.2.2. Gate or Fence Cave. Place a structure such as a gate or fence at the roost cave entrance to prevent human access, but which will permit gray bats to come and go without danger. See APPENDIX II. All plans to gate or fence a cave should be submitted to the Regional Director for approval, because improper construction can destroy the colonies they are built to protect.

1.2.2.1. Gain Control of Roost Site. If the roost site is not on public land, control through fee purchase, easement, or other legal arrangement should be obtained.

1.2.2.1.1. Roost Site Evaluation. All important roost sites must be evaluated to determine if a structure is needed to prevent entry. An improperly designed gate can prevent gray bat use. APPENDIX II describes how a gate or fence should be constructed to prevent adverse impacts. The Recovery Team will evaluate which caves should be structurally protected and make recommendations in the Implementation (PART III).

1.2.2.1.1.1. Identify Roost Sites to be Protected. After all known gray bat roost sites are identified, the Recovery Team will recommend which sites should be protected based on the following categories in order of biological significance. Final priorities (PART III) will be based on management needs as well as biological significance. The Recovery Team will review all priority assignments, classification, and categories of biological significance of new or revised data.

Categories of Biological Significance*

(1) Primary hibernating caves (those occupied now or in the past by more than 50,000 gray bats in northern Alabama and Tennessee; 25,000 elsewhere).

(2) Primary maternity caves (those occupied now or in the past by 50,000 or more gray bats in northern Alabama and in Tennessee west of the Cumberland plateau; 40,000 in Kentucky; 10,000 elsewhere except for Florida, Oklahoma, Arkansas, Kansas, and southern Alabama where the number is 1,000).

(3) Primary bachelor caves (those used now or in the past by more than 50,000 male and nonreproductive female gray bats in northern Alabama and in Tennessee west of the Cumberland plateau; 10,000 elsewhere except for Florida, Oklahoma, Arkansas, Kansas, and southern Alabama where the number is 1,000).

* Caves that are not presently suitable for bat use have been excluded.

(4) Secondary maternity caves (those presently used now or in the past by more than 5,000 but fewer than 50,000 gray bats in northern Alabama, and in Tennessee west of the Cumberland plateau; by more than 1,000 but less than 10,000 elsewhere, except for Florida, Oklahoma, Arkansas, Kansas, and southern Alabama where they number more than 500 but less than 1,000).

(5) Secondary bachelor caves (those presently used now or in the past by more than 5,000 but fewer than 50,000 gray bats in northern Alabama and in Tennessee west of the Cumberland plateau; by more than 1,000 but less than 10,000 elsewhere, except for Florida, Oklahoma, Arkansas, Kansas, and southern Alabama where the number more than 500 but less than 1,000).

(6) Secondary hibernating caves (those used by more than 5,000 but less than 50,000 gray bats in Tennessee and Alabama; by more than 2,000 but less than 25,000 elsewhere).

(7) Gray bat caves not included in the previous categories, such as caves which receive only brief seasonal use by small numbers of gray bats, and abandoned caves which in the past housed only small colonies.

1.2.2.1.1.1.1. Identify All Gray Bat Roost Sites: The Recovery Team has sent a request to all persons known to have information on gray bats to determine the location, size, and type of roost sites (see PART III).

1.2.3. Monitor Roost Sites. After roost sites are protected, they must be monitored to determine if the method of protection is effective and to determine if repairs or changes in management are needed.

To make a population estimate, each important maternity cave should be visited once per year between late July and mid-August after young bats are volant. To minimize disturbance, entry into the cave should be made at night soon after the bats emerge. To obtain population estimates, the area on the floor of the cave covered by new guano deposits should be measured in square meters and multiplied by the mean clustering density of $1{,}828/m^2$ and rounded to the nearest hundred. Guano deposited during the current season is recognizable by a combination of factors such as kind and stage of growth of associated fungi, general moisture content, kinds and life stages of invertebrates present, stage of decay of dead bats, and amounts of guano removed by streams known to undergo seasonal fluctuation. Information gathered should be sent to the Recovery Team Leader. The Recovery Team will analyze the data and transmit its recommendations to the Regional Director.

1.2.4 Monitor Caves by Law Enforcement Agencies. The Law Enforcement Division of the U. S. Fish and Wildlife Service has requested funds to monitor gray bat caves and investigate violations. State agencies should also cooperate in this effort.

1.3. Prevent Adverse Modifications to Roost Sites. To preserve roost habitat for gray bat use, adverse modifications must be prevented.

1.3.1. Prevent and Rehabilitate Adverse Modifications to the Subsurface, Including Entrances. A number of caves that were formerly important roost sites have been adversely modified by such means as partially blocking an entrance or creating new entrances. Modifications such as these can greatly affect the air flow; and, as a result, the temperature and humidity regimes (Tuttle and Stevenson, 1978). Any roost sites that are identified for protection in item 1.2.2.1.1.1, and that have been adversely modified, should be restored. Reference to APPENDIX II and Tuttle and Stevenson (1977) should prevent additional adverse modification. In addition, any proposed modification to an important gray bat roost site should be approved by the appropriate Regional Director of the U. S. Fish and Wildlife Service on the recommendation of the Recovery Team.

1.3.2. Prevent and Rehabilitate Adverse Modifications to the Surface Watersheds Surrounding Important Roost Sites. Caves are vulnerable to changes made to the surface areas above, including areas which drain into caves. For example, deforestation can increase the amount of runoff and silt entering a cave.

1.3.3. Make Locations of Known Roost Sites Available to Appropriate Fish and Wildlife Service Offices and State Wildlife Agencies. Insure that appropriate U. S. Fish and Wildlife Service offices and state wildlife agencies are provided with the locations of known roost sites so they can be used to identify potential conflicts during Section 7 consultations and other planning activities.

2. Maintain, Protect, and Restore Foraging Habitat. Gray bats forage primarily over streams, rivers, and lakes where crepuscular and nocturnal insects are abundant. They usually disperse from caves to foraging areas through or beneath the protective forest canopy. Foraging areas may be 25 or more kilometers from the cave, although many are closer. Therefore, it is important to maintain forested corridors or dispersal routes to foraging habitat.

2.1. Public Education. Land owners in the vicinity of known gray bat roosts should be urged to leave natural forest corridors, especially along streams, ponds, and lakes. The beneficial effects of insectivorous bats should be emphasized.

2.1.1. Literature. Interpretive brochures should be made available to land management agencies, cave owners and organizations whose members explore caves by the U. S. Fish and Wildlife Service outlining the values and needs of the species (see item 1.1.1).

2.1.2. Ranger - Naturalist Talks. Agencies conducting interpretive programs within the range of the species should be urged to include information on the need for protection of the gray bat as well as other bats.

2.1.3. Slide Program. A slide program should be prepared by the U.S. Fish and Wildlife Service on the gray bat with emphasis on its beneficial effects and need for protection.

2.2. Prevent Adverse Modifications To Foraging Areas and Travel Corridors. Modification of foraging habitat may be detrimental to the survival of these bats.

2.2.1. Determine Habitat Requirements. Throughout the range of gray bats, investigations on the effects of environmental disturbance are essential. Most important areas of concern involve the potential effects of water pollution and siltation on aquatic insect life upon which gray bats depend, as well as those of pesticide contamination and local deforestation. Foraging habitat and prey preferences are necessary baseline data. Foraging areas for each maturnity cave should be identified, with emphasis given according to the priority list in Tables 4-7.

2.2.2. Preserve Water Quality. Insects that serve as food for this species are adversely impacted by water pollution. Water quality of streams and lakes near known roosts should be maintained at acceptable levels as defined by state and Federal regulations.

2.2.3. Preserve Forest Cover. Gray bats depend on the forest canopy for travel between caves and foraging areas. Forested corridors between caves and foraging habits should be maintained. Deforestation of riparian areas may also affect siltation rates and adversely impact food availability.

2.2.4. Monitor Habitat. Foraging areas amd travel lanes should be identified for each cave identified in item 1.2.2.1.1.1. Once delineated, the areas should be monitored periodically to identify potentially damaging changes.

2.2.5. Include Foraging Areas and Travel Lanes In Section 7 Consultations. U. S. Fish and Wildlife Service Section 7 Consultation teams should include foraging habitat for maturnity caves, as well as other cave roosts, in their consideration of projects affecting the habitat of these bats.

3. Monitor Population Trends. In order to measure the effectiveness of the actions taken as part of this recovery plan, it will be necessary to regularly monitor the status of selected populations. Population declines will signal the need for corrective action, and increasing populations should be used to measure progress towards the prime objective of removing the gray bat from the Endangered Species List.

3.1. Monitor Status Of Populations In Hibernacula. The Recovery Team in cooperation with the U. S. Fish and Wildlife Service will develop a monitoring system and implement a census of Priority 1 hibernacula every three years.

3.2. Monitor Status Of Populations In Maternity Colonies. Priority 1 maternity colonies of this species should be monitored annually as described in item 1.2.3.

3.3. Monitor Residues Of Toxic Chemicals. The possible influence of pesticides in causing the decline of insectivorous bats has been reported and a recent study has documented mortality and probable population decline in gray bats resulting from routine pesticide usage (Clark *et al*., 1978). The following parameters should be monitored if this is suspected.

3.3.1. Sample Insects. Where bat mortality has been demonstrated, insect samples from known gray bat foraging areas should be collected and analyzed for toxic chemical residues. Significant amounts should be traced to their source, and corrective action taken.

3.3.2. Sample Guano. Where bat mortality has been demonstrated, guano samples from summer cave roosts should be analyzed periodically for toxic residues and any significant amounts traced as in item 3.3.1.

3.3.3. Sample Bats. Any analyses of insect or guano samples containing significant amounts of toxic residues should be reported, and samples of gray bats from these areas should be analyzed directly for residues. Dead bats should be used whenever possible. Corrective action should be taken as in item 3.3.1.

PART III

IMPLEMENTATION

Priorities in column four of the following implementation schedule are assigned as follows:

1. Priority 1 - All actions that are absolutely essential to prevent extinction of the species.
2. Priority 2 - All actions necessary to maintain the species' current population status.
3. Priority 3 - All other actions necessary to provide for full recovery of the species.

IMPLEMENTATION SCHEDULE
GRAY BAT

GENERAL CATEGORY	PLAN TASK	TASK #	PRIORITY #	TASK DURATION	RESPONSIBLE AGENCY: FWS REGION	RESPONSIBLE AGENCY: FWS PROGRAM	RESPONSIBLE AGENCY: OTHER	FISCAL YEAR COSTS (EST.) FY 80	FY 81	FY 82	COMMENTS NOTES
A6	Acquire Fern Cave (AL)	1.2.2.1	1		4						See Appendix VI
A3	Protect Bonanza Cave (AR)	1.2.2	1		4		USFS				"
A6	Acquire Coffin Cave (MO)	1.2.2.1	1		3		MDC				"
A6	Acquire Hubbards Cave (TN)	1.2.2.1	1		4		NC				"
A6	Acquire Pearson Cave (TN)	1.2.2.1	1		4	SE Realty	TWRA				"
A?	Protect Jesse James (KY)	1.2.2	1		4	SE					"
A?	Protect Chimney Cave (MO)	1.2.2	1		3	SE	NPS				"
A3	Protect Marvel Cave (MO)	1.2.2	1		3		MDC SDC				"
A6	Acquire Tobacco-port Cave (TN) protect	1.2.2.1	1		4	SE Realty	TWRA				"
A?	Protect Old Indian Cave (IL)	1.2.2	1		4	SE	FL(DNR)				"
A6	Acquire Santa (AL)	1.2.2.1	1		4						"
A6	Acquire Saltpeter Cave (MO)	1.2.2.1	1		3	SE Realty	USFS				"
A6	Acquire Maves Cave (MO)	1.2.2.1	1		3	SE Realty	MDC				"

GENERAL CATEGORY	PLAN TASK	TASK #	PRIORITY #	TASK DURATION	RESPONSIBLE AGENCY FWS REGION	FWS PROGRAM	OTHER	FISCAL YEAR COSTS (EST.) FY 80	FY 81	FY 82	COMMENTS NOTES
A?	Protect White Buis Cave (TN)	1.2.2	1		4	SE	TWRA				See Appendix VI
A6	Acquire Overstreet Cave (KY)	1.2.2.1	1		4	SE Realty	KNPC				"
A6	Acquire Bat Cave (MO) Shannon	1.2.2.1	1		3	SE Realty	MDC				"
A3	Protect Tumbling Creek Cave (MO)	1.2.2	1		3		OUL				"
A3	Protect Bellamy Cave (TN)	1.2.2	1		4		TWRA				"
A6	Acquire Judges Cave (FL)	1.2.2.1	1		4	SE Realty	FL				"
A3	Protect Nicka-jack Cave (TN)	1.2.2	1		4		TWRA TVA				"
A6	Acquire Bone Cave (AK)	1.2.2.1	1		4	SE Realty	AGFC				"
A3	Protect Beck Cave (MO)	1.2.2	1		3		USACE				"
A6	Acquire Cripps Mill Cave (TN)	1.2.2.1	1		4	SE Realty	TWRA				"
A?	Protect Oaks Cave (TN)	1.2.2	1		4	SE	TWRA				"
A6	Acquire Chrisman's Cave (KY)	1.2.2.1	1		4	SE Realty	KNPC				"

GENERAL CATEGORY	PLAN TASK	TASK #	PRIORITY #	TASK DURATION	RESPONSIBLE AGENCY FWS REGION	PROGRAM	OTHER	FISCAL YEAR COSTS (EST.) FY 80	FY 81	FY 82	COMMENTS NOTES
A3	Protect Roaring Springs Cave (MO)	1.2.2	1		3		MDC				See Appendix VI
A3	Protect Geromes Cave (FL)	1.2.2	1		4		FL				"
A?	Protect Key Cave (AL)	1.2.2	1		4	SE	TWRA TVA				"
A6	Acquire Logan Cave (AK)	1.2.2.1	1		4	SE Realty	AGFC				"
A?	Protect Moles Cave (MO)	1.2.2	1		3	SE	MDC				"
A6	Acquire Indian Cave (TN)	1.2.2.1	1		4	SE Realty	TWRA				"
A6	Acquire Cool Springs Cave (KY)	1.2.2.1	1		4	Realty	KNPC				"
A?	Protect Girards Cave (FL)	1.2.2	1		4	SE	FL				"
A6	Acquire Cave Springs Cave (AL)	1.2.2.1	1		4						"
A6	Acquire Inca Cave (MO)	1.2.2.1	1		3		MDC				"
A6	Acquire Holland Cave (KY)	1.2.2.1	1		4	Realty	KNPC				"
A6	Acquire Cave Springs (IL)	1.2.2.1	1		3	Realty	IL USFS				"
A3	Protect Hambrick Cave (AL)	1.2.2	1		4		ALDOC				"

GENERAL CATEGORY	PLAN TASK	TASK #	PRIORITY #	TASK DURATION	RESPONSIBLE AGENCY			FISCAL YEAR COSTS (EST.)			COMMENTS NOTES
					FWS		OTHER				
					REGION	PROGRAM		FY 80	FY 81	FY 82	
A?	Protect Sanders Cave (AL)	1.2.2	1		4	SE					See Appendix VI
A3	✓ Protect Georgetown Cave (AL)	1.2.2	1		4		NPS				"
01	✓ Public Education	2.1	1	2 yrs	3	SE			$20,000	$10,000	
I1	✓ Monitor roost sites	1.2.3	2	Every 3 yrs	3,4,2	SE	States	$10,000	10,000	10,000	
02	Law Enforcement	1.2.4	1	Continuous	3,4,2	LE	States		20,000	20,000	
I1	✓ Monitor population trends	3	2	Continuous	2,3,4	SE	States	1,000	1,000	1,000	

APPENDIX I

TUTTLE, 1979a (From J. Wild. Mgmt)

STATUS, CAUSES OF DECLINE, AND MANAGEMENT OF ENDANGERED GRAY BATS

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Abstract: **Twenty-two** summer colonies of the endangered gray bat, Myotis grisescens, were censused in 1968-70 and 1976. A conservative estimate revealed a 54% decline in that time period and a 76% decline from known past maximum population levels. A strong association between decline and disturbance by people in caves was observed. Some major colonies disappeared entirely within the 6-year period. Gray bats are restricted to caves year around and, due to specific temperature and foraging habitat requirements, they aggregate in large colonies in fewer than 5% of available caves. Management requires that the 9 known hibernation caves receive immediate protection, followed by protection of the most important summer caves used by bats from each protected winter cave. Adequate protection may prove impossible unless accompanied by public education. Environmental disturbances such as pesticides contamination, water pollution and siltation, and deforestation may pose serious threats and require further investigation.

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Populations of some North American insectivorous bats are known to have declined markedly in many areas over the past 20 years or more (Mohr 1952, 1953, 1972, 1975, Cockrum 1970) (C. Jones 1971 and J. S. Findley 1973, in unpublished reports). The causes and rates or extent of decline rarely are well documented. Quantification of decline is hampered by the difficulty of accurately censusing large populations (Davis et al. 1962) and by the variation among techniques used by different investigators (Humphrey 1971), even for the same populations. The problem of determining causes is complicated by the fact that population trends and causes of declines may vary greatly among species, even within a single locality (Cockrum 1970, Mohr 1972). But the primary impediment to understanding cause and effect relationships is that local movement patterns, locations of alternate roosting sites, and seasonal behavior generally are poorly known.

In this paper, I present my observations on the decline of gray bats, discuss some of the problems encountered in evaluating the status of bat populations, point out immediate management needs, and suggest areas of concern that require additional investigation. Although gray bat populations have declined alarmingly in parts of their range (Barbour and Davis 1969), most reports of colony locations provide little more than vague estimates of numbers (Hall and Wilson 1966) and are of minimal value in estimating population trends. In the present analysis I restricted myself to a representative sample of my most intensively studied localities in Alabama and Tennessee. Local movement patterns, locations of alternate movement patterns, locations of alternate roosts, and seasonal behavior are unusually well documented at these localities (Tuttle 1975, 1976a,b, Tuttle and Stevenson 1977), and censusing techniques have been consistent throughout.

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Fieldwork from 1968 to 1971 was supported by grants from the Watkins Museum of Natural History Grants and Biomedical Sciences Support, administered through the University of Kansas, the Theodore Roosevelt Memorial Fund of the American Museum of Natural History, and the Ralph W. Stone Graduate Research Award of the National Speleological Society. Censusing and analysis of foraging habitat requirements in 1976 were supported by the Division of Forestry, Fisheries, and Wildlife Development, Tennessee Valley Authority.

METHODS

Bat Population Estimates

Estimates of past and present populations of gray bats were made in more than 100 caves in late July and early August from 1968 to 1970. During 3 weeks from 28 July to 17 August 1976, I resurveyed 22 of the summer colonies that in 1968-70 had shown the least decline from their prior peak population sizes.

Population estimates were based on the area of stained cave ceiling, area covered by the existing colony, and area covered by old versus new guano deposits. Length and width of each part of irregular shaped roosts or diameters of round roosts (or guano deposits) were measured with a 50-ft steel tape, and these measurements were used for calculation of the number of square meters covered by roosting bats. Only well-defined, clearly reddened areas of staining were included in measurements of roosts, and guano was measured only to the edge of accumulations that clearly were dropped by roosting bats. I carefully avoided measuring areas around old guano piles that appeared to be the result of outward spread of steeply conical-shaped deposits.

In all calculations of colony size I assumed the mean clustering density to be $1,828/m^2$ (Tuttle 1975), multiplied this density estimate times the number of square meters estimated to have been covered by roosting bats, and rounded to the nearest hundred. Although density of roosting bats varied among colonies, due to differences in roost texture and configuration, it appeared to vary only slightly within individual colonies, regardless of changes in colony size. Consequently, variation in clustering density is assumed to have had minimal effect in biasing estimates of population trends within colonies over time.

The largest past colony size achieved in a given cave was calculated from the area of staining on the roost surface or, in a few instances, from the area covered by old guano deposits. Roost staining on cave ceilings apparently re-

quires many years and may not occur at all in a few caves. In such caves I was forced to rely on measurement of old guano deposits. Because guano falls directly to the floor beneath clustered bats this measurement provided a good alternate estimate. For the same reason, the area covered by new guano provided a good indication of size of extant colonies in 1968-70 and again in 1976. Visual observations of clustered bats were often used to verify my conclusions regarding roosting configuration and density but only twice were they used as the basis for final estimates of population size.

The classification of guano as new or old was made as follows. Guano deposited during the current season is recognized by a combination of factors such as kind and stage of growth of associated fungi, general moisture content, appearance and odor of the guano, kinds and life stages of invertebrates present, stage of decay of dead young bats, and amounts of guano removed by streams known to undergo seasonal fluctuation.

Disturbances by Humans

Frequency of human disturbance was estimated for each roosting area based on a combination of landowner and local caver observations, and on my own verification through evidence seen near the roosts. I lumped numeric disturbance estimates into categories of rare (1 distrubance or less/2-month period), infrequent (1/month), moderate (2-4/month), and frequent (more than 5/month), and these were compared to calculated rates of decline in the period 1970-76.

The direct impact of distrubance is difficult to evaluate. Rare and frequent disturbance categories were easily assigned, but the moderate and infrequent categories were, at best, only approximations. Furthermore, even absolute knowledge of disturbance frequency is not necessarily an adequate indication of disturbance intensity. Important determinants of intensity include (1) seasonal and daily timing of disturbance, (2) height of roosts above cave floor or water, (3) nearness of roosts to the most heavily explored passages, (4) presence of alternate, less accessible roosts within the cave, (5) length of disturbance, and (6) kind of disturbance, i.e., accidental versus vandalistic.

I assumed that most disturbance occurred in the daytime when it would be most damaging. Since all caves censused were used by bats almost exclusively from April through October, human visitation in other months was considered to be of little or no consequence. Bat colonies that roosted high above cave floors or beyond deep water or muddy or dangerous passages were least disturbed by individual human visits. The average length of time of disturbances could not be determined, but evidence of vandalism in the form of sticks, rocks, fireworks fragments, spent shotgun and rifle cartridges on guano piles, smoke stains on ceilings, and dead bats often provided clues to the kinds of disturbance. My estimate of disturbance frequency represent disturbance at or near roosts rather than including every human visit to any part of a cave. Even so, I could not quantify the effect of vandalism or height above floor.

RESULTS

The estimated maximum past population for the 22 localities censused was 1,199,000. By 1970 numbers had diminished to 635,700, a 47% reduction, and just 6 years thereafter the combined population had fallen to 293,600, an additional 54% reduction (Table 1).

In 1970, 7 colonies were still as large as their all-time past maximums; however, by 1976 this number was reduced to 4. The largest maternity colony in the stable category in 1970 (population of 111,400 in cave 19) had declined by at least 95% by 1976. Whereas this cave housed the largest gray bat maternity colony known anywhere within the entire species range in 1970, and was used continuously from early April through October, in 1976 not more than 6,000 gray bats visited the cave at any time, and none used the cave for more than a few days in succession.

From 1970 to 1976 evidence of human disturbance, and especially vandalism, increased markedly. When estimates of disturbance are compared with those of percentage declines by locality (Table 1), it is clear that mean rates of disturbance and decline are related. Nevertheless, the unexpectedly small decline in cave 11 and the considerable reductions that occurred in caves 6, 7, 10, and 17, for example, may indicate the existence of fctors in addition to disturbance.

Colonies in caves 20 to 22 were exceptional because their marked declines may have been caused primarily by single events. Cave 20, according to the owner, had been visited by a group of teenage boys who shot large numbers of bats at their roosts and during evening emergence. Many spent cartridges in the cave verified the report. Caves 21 and 22 had been gated for protection of bats, but their colonies refused to return due to inadequate gate designs (Tuttle 1977) and are feared lost.

Reduction in the number of individuals in a colony can have an effect which brings about further decline in numbers. Thermoregulatory requirements may result in a baseline population size, varying among caves of different temperatures or ceiling configurations, below which a maternity colony cannot successfully rear young (Constantine 1967, Tuttle 1975). Colonies in 5 caves (Table 1) changed from maternity to bachelor status from 1970 to 1976. Four of those had undergone major population decline (43-95%) during those years. This prooblem is aggravated by the colder nature of the secondary roosts to which the bats retreated to escape disturbance. The implications of these effects are of great concern. Due to the long lifespan of adults, colonies may appear to be relatively stable for several years, even after young are no longer successfully reared. Extinction of such seemingly stable colonies could then occur rapidly when the adults reached the end of their life span.

DISCUSSION

Censusing Problems

Although a variety of different censusing techniques has been used by other investigators (Humphrey 1971), none is suitable for large-scale censusing of

Table 1. Census data from 22 summer gray bat colonies subject to different degrees of disturbance by humans during April through August.

Cave numbers by disturbance category	Number of gray bats			% population decrease		
	Maximum pre-1968	1968-70	1976	From max. to 1968-70	1968-70 to 1976	Total max.-1976
<1 per month						
1[a]	20,400	10,200	10,200	50	0	50
2[c]	7,800	6,100	6,200	22	0	21
3[c]	4,000	3,900	4,000	2	0	0
4[c]	12,200	12,200	12,200	0	0	0
5[a]	29,800	19,000	18,700	36	2	37
6[c]	17,700	10,000	8,000	44	20	55
7[a]	12,200	12,200	9,700	0	21	21
1 per month						
8[a]	25,500	10,200	6,500	60	36	74
9[a]	36,700	15,600	9,200	57	41	75
10[a]	46,200	46,200	18,900	0	59	59
2-4 per month						
11[c]	219,400	174,700	127,500	20	27	42
12[b]	121,200	32,500	18,500	73	43	85
13[c]	23,800	12,200	6,100	49	50	74
14[a]	19,100	19,100	8,700	0	55	55
15[b]	126,400	26,200	9,100	79	65	93
16[a]	31,100	31,100	9,000	0	71	71
17[c]	12,800	9,400	0	27	100	100
≥5 per month						
18[c]	127,500	28,600	4,100	78	86	97
19[b]	111,400	111,400	5,100	0	95	95
20[b]	15,600	13,600	1,900	13	86	88
Gated-1968						
21[a]	132,600	10,900	0	92	100	100
22[a]	45,600	20,400	0	55	100	100
Totals	1,199,000	635,000	293,600	47	54	76

[a]Maternity site.
[b]Maternity site in 1968, bachelor site in 1976.
[c]Bachelor site.

gray bats. Emergence counts, including those incorporating photography, are not feasible due to factors such as dense surrounding vegetation at some sites and multiple cave entrances at others, and are of no value in determining past population sizes. Techniques requiring direct observation of bats at their roosts must be restricted to daytime during the maternity period in order to find maximum or even constant numbers of bats in a single cave, thereby causing major disturbance and mortality of flightless young. A method whereby only the young were observed after the adults emerged to feed at night, combined with entrance trapping, was used by Tuttle (1975) and resulted in minimal disturbance. However, that method is time consuming, useful only during June, provides no means of comparing past versus present population sizes, and still causes more disturbance than the techniques used in the present study.

Timing of censuses is important. Most summer colonies of gray bats use several different caves in a home range area which may be as much as 50 km long, and they may occupy a succession of several caves through 1 season. This normal movement among caves makes censusing difficult and requires a prior familiarity with each colony's normal preferences and timing and patterns of movement. These movements have been documented in prior (Tuttle 1976a) and continuing studies of 40,182 banded gray bats from these and adjacent colonies.

Maximum concentration of a gray bat colony takes place during June when young are reared. A gradual breakup of colonies and movement among alternate caves often occurs by late July or early August (Tuttle 1975, 1976a). Censuses conducted in April or May usually include only a fraction of a given colony and might cause abandonment of preferred roosts. Those made in June or early July entail some level of disturbance of maternity groups. Although colony breakup often already had occurred or was in progress by late July and early August, sampling was done then to avoid needless disturbance during critical periods, while still sampling the peak population for the year. Use of areas of stained ceiling and of old versus new guano deposits minimized the problems posed by disturbance or colony breakup, because in most caves it was unnecessary to see the bats. Censusing later than mid-August is inadvisable due to potential loss of evidence such as new guano (through flooding) or fungal growth.

Because entire colonies of gray bats, including reproductive females and bachelor groups (adult males and nonreproductive females), often aggregate in a single cluster in maternity caves just before parturition or following fledging of young, my censuses of maternity caves often represent entire colonies. On the other hand, censuses in bachelor caves frequently do not. Nevertheless, caves chose for this analysis all appeared to be essential focal points of activity for their colonies, and fluctuations of numbers in these caves should indicated changes over time for their respective colonies.

An additional census variable is that colonies often move among several alternate roosts within a single cave at 10- to 14-day intervals within a season, except when flightless young are present. For this reason it is not accurate to measure and combine all areas of recent guano within even 1 cave. Instead, in a maternity cave I located and measured the maternity roost only, ignoring the smaller nonmaternity roosts. Maternity roosts were recognizable, almost without exception by the presence of at least a few dead young and unusually large numbers of mites

that result from long, continuous use of a single roost. In caves used only by bachelor segments of colonies, I simply measured either the largest stained area or guano deposit, or used the average of several that were of similar size but of varied shape.

Simultaneous use of 2 or more roosts in a single cave was uncommon but most likely to occur where colonies were large or where suitable roosting surface was limited in any 1 place. Such behavior was easily detectable through observation of guano decomposition and associated fungal and invertebrate faunal indications, and in these cases the different areas were combined. This problem had negligible effect on the estimates of 1970 or 1976 populations. For estimates of past populations it was impossible to detect simulataneous use of multiple roosts in a single cave. Bias of this kind undoubtedly led to underestimation of past population maxima.

Another source for underestimation of past population figures lies in the ease with which even sizeable guano piles are made unrecognizable. Two examples of the possible extent of past population underestimation due to this bias were observed.

Paul B. Robertson and I measured areas covered by old and new guano in cave 18 on 10 July 1968 and found a single deposit 12.2 m long by 10.7 m wide and 2.4 m deep, giving an estimate of past colony size of 238,600. However, due to the possibility that 2 adjacent roosts were used alternately to produce the large area of guano observed in 1968, I later averaged our 1968 measurements for 3 different roosts in this cave, arriving at a figure of 127,500. By July 1976 this deposit was virtually unrecognizable due to heavy traffic by spelunkers. The guano had been scattered, compacted, and covered with clay carried over the surface by muddy feet. For unknown reasons, ceilings where bats roosted were never stained clearly, so if I had not visited this cave in 1968 and earlier I would have suspected a past colony size of no more than 30,000. Nevertheless, careful recent observations at cave 19 indicate that even the figure of 238,600 for past size could be a considerable estimate.

In cave 19, from 1969 to 1970 measurement of recent guano and direct observation of the bats indicated that, during periods of maximum use, the cave housed 111,400 or more gray bats. Yet by 1976 this cave was used infrequently by small, transient bachelor groups, and much evidence of past use had been obliterated by flooding reservoir water and by the muddy feet of spelunkers. Additionally, in this cave there were 5 distinct roosting areas, and during its period of maximum use all 5 roosts, and much area between them, were being used simultaneously. Without prior knowledge, only 1 roost would have been counted, leading to an underestimate of roughly 80%.

A third source of past population underestimation results from the slowness of the roost staining process. In 5 other cases where colonies were stable or growing and roost staining was distinct enough to permit reliable comparisons between area of staining and area covered by bats or by new guano, the 1970 colony sizes averaged 11% (range 7 to 17%) larger than the maximum area of roost staining would have indicated.

In summary, the varied, unavoidable biases discussed above all tended to obsure rather than accentuate detection of decline over time. Other potential problems, such as inaccuracies involving estimation of areas covered by irregularly shaped roosts or of mean clustering density, could have biased my estimates equally in either direction in any given cave. Since these problems appeared to remain constant in most caves, I believe that they have caused negligible error in my conclusions.

Causes of Decline

The gray bat is, perhaps, the most narrowly restricted to cave habitats of any U. S. mammal (Hall and Wilson 1966, Barbour and Davis 1969, Tuttle 1976a). With rare exception (Hays and Bingham 1964, Gunier and Elder 1971) it lives in caves year-round. In summer, gray bats select only a few caves, which must be located near (rarely more than 2 km and usually less than 1 km from) rivers or reservoirs (Tuttle 1976b) and provide certain temperature or roost conditions (Tuttle 1975). They hibernate in deep, vertical caves of exceptionally low (6-11 C) temperature (Tuttle and Stevenson 1978), and often travel hundreds of kilometers in order to reach these scarce sites (Tuttle 1976a). As a consequence of their combined thermoregulatory and other habitat requirements, gray bats congregate in larger numbers and in fewer hibernating caves than any other North American vespertilionid. "This concentration of such a large proportion of the known population into so few caves constitutes the real threat to their survival" (Mohr 1972).

In the present analysis I completely ignored caves where the greatest reductions already had occurred or were clearly in progress in 1970, concentrating only on those colonies which appeared stable enough in 1968 to 1970 to warrant further attention. Consequently, it is important to note that this report is on the status of gray bats only in the "healthiest" summer colonies of gray bats that were known to me in 1970, in the area of gray bat distribution south of Kentucky and east of the Mississippi River. It is probably, therefore a gross underestimate of true population losses.

Disturbance and Vandalism.--In a brief plea for bat conservation, Manville (1962) noted the extreme vulnerability of the gray bat to human disturbance and vandalism, and Barbour and Davis (1969) pointed out that "in the last few years human disturbance has threatened the very existence of the species." They concluded that ". . .M. grisescens is destined to continue a rapid decline in numbers and probably faces extinction." In the course of my field studies of this species from 1960 to 1970, I noted numerous examples of local gray bat extirpation throughout the southeast both as a result of apparently innocent disturbance and of direct, intentional vandalism.

In 2 summer caves in Tennessee, for example, I estimated that approximately half a million gray bats already had been lost prior to 1960. In 1 case the owner of a commercialized cave personally described to me how he and his assistants had killed bats with torches. In the other cave, ceilings were too high to permit much direct destruction, but the bats apparently were driven out simply by the high frequency of human visitation. Already, in 1968, gray bats

were gone from many and possibly most of their previously occupied caves in Tennessee. The largest remaining summer colony in the state (cave 10) numbered only about 46,000 and was down to roughly 19,000 by 1976.

During the 1960's old-timers frequently enjoyed telling me that when they were children, bats emerged from local caves in great clouds and that they killed the emerging bats with switches, just for fun. Bats frequently were caught at roosts in caves, to be used in local pranks. Also, due to premature, erroneous claims from local health authorities (Fredrickson and Thomas 1965), some cave owners tried to exterminate entire colonies on their properties. An elderly man who had owned cave number 1 for many years told me that rabies researchers informed him that his bats were rabid and would transmit the disease to his cattle if he did not get rid of them. Consequently, he poured fuel oil into the cave where the bats roosted and lit it. Most of the colony apparently escaped, and since my first contact with this landowner in 1968, these bats have received strict protection and have remained stable in numbers.

As these accounts demonstrate, it was apparent prior to my 1976 investigations that human disturbance was often a primary cause of gray bat decline. Nevertheless, no one had attempted to quantify a cause and effect relationship, and other sources of stress were unknown. The relationship between frequency of disturbance and mean rates of decline found in this investigation is obvious. The 2 most heavily disturbed caves lost of 90% of their bats while 5 colonies in rarely disturbed caves remained stable or nearly stable. Nevertheless, considerable variation existed within some classes of disturbance.

The most extreme variation (caves 11 and 17) appears explainable based on cave size and contours and location of roosts. In cave 11, bats roosted approximately 15 m above the floor over an area of large guano-covered boulders that appeared to keep most spelunkers from getting close to the bats. Aproaching cavers did not startle the bats and usually kept at least 50 m away from them. The disturbances, while of moderate frequency, were not intense.

Cave 17 illustrates the opposite extreme, where nearly every disturbance was intense. The bats roosted only 100 m inside that cave, and 2 m above the floor where anyone exploring the cave passed by closely. Bats could not detect intruders until the intruders rounded a nearby corner. The roost was located over water deep enough to drown fallen young and possibly some adults, but not enough to deter cavers. Furthermore, such a roost was especially vulnerable to intentional vandalism.

Much of the remaning variation within disturbance categories (Table 1) could have resulted from failure to quantify intensity of disturbance. Single acts of destruction could greatly alter average trends. Also, I probably erred occasionally, especially in the 2 intermediate categories, in estimating frequency of disturbances.

Emigration to Other Caves.--Cavers and others often have speculated that when bats abandon one cave, they move to another previously unoccupied cave. However, this rarely occurs. Gray bat colonies are extremely loyal to single caves or groups of caves (Tuttle 1976a) and usually have environmentally limited

ability to move to alternate caves for the rearing of young, even within their own home range. They require caves of specific roost and temperature conditions and maternity colonies are found only in caves that are near a river or reservoir.

Any cave that is used only as an alternate, transitory roosting place undoubtedly receives such limited use for a good reason. Some essential condition is not continuously met, or the cave is too heavily disturbed. Consequently, only a small proportion of the caves in any area are or can be used regularly. In Alabama, for example, although 1,635 caves had been mapped by 1975 (Varnedoe 1973, 1975), only 39 (2.4%) were known to have sheltered even small summer colonies of gray bats. Two more (0.1%) were used for winter hibernation. These figures are the result of my own surveys combined with assistance from members of the Huntsville and other Alablama grottos of the National Speleological Society. Even if these figures were doubled, 95% of Alabama's caves would not have been used by gray bats.

This species probably occupied all suitable caves within its range long before the arrival of modern man. In suppport of this belief, I have not observed the establishment of a single new colony in a previously unused cave in 17 years of work in more than 200 southeastern caves. Gray bats readily colonize newly available sites such as storm sewers and abandoned mines when these sites provide required conditions (Hays and Bingham 1964, Tuttle, unpublished data). Any cave not already used by gray bats, however, should be assumed to be unsuitable for future use. Such caves probably do not provide essential temperature or roosting conditions, are too distant from acceptable foraging or hiberernating sites, or are too vulnerable to predation or flooding. Others that have been used but that are now abandoned may be recolonized. Prior to any reuse, however, these caves would have to receive strict protection from human disturbance or other environmental perturbations which caused their abandonment.

Although approximately 23,000 banded gray bats have been recaptured during my studies, I have found no evidence of successful emigration by members of declining colonies to previously unoccupied caves or to caves outside the colony's originally occupied home range (Tuttle 1976a). Near cave 19, where some 111,000 gray bats disappeared in only 6 years, I censused 3 other caves that were used by gray bats within a 30 km radius and found declines in all 3. Cave 11, located only 20 km away is known to serve as the primary roosting place for the bachelor segment of this colony, yet even there numbers fell by 27%. There is no evidence that any nearby cave sheltered an increased number of bats following human vandalism and disturbance in cave 19.

Further studies of long-term changes in relative recapture rates among colony cohorts at winter hibernating sites have shed additional light on this subject. Over the past 9 years the cave 19 cohort ($N = 1,274$) has shown a greater decline ($P < 0.01$) than the cohort ($N = 5,713$) in the stable cave 4 colony (Stevenson and Tuttle, in prep). Based on this and additional winter band recovery data from the other localities, I believe that few declines noted in this study can be attributed to simple emigration.

Environmental Disturbances.--I hoped not only to quantify the relationship between disturbance and decline, but also to detect additional factors. The

very large proportion of gray bat decline that appears to be directly attributable to human disturbance renders detection of other potential problems extremely difficult. The fact that 5 of 7 rarely disturbed colonies remained essentially stable over the past 6 years certainly is encouraging when one considers the potential for recovery if human disturbance can be controlled. Unexplained declines of roughly 20% in caves 6 and 7 and the relatively high loss in cave 10, however, may indicate stressful influence from other sources as well.

The possible influence of pesticides in causing decline of North American populations of insectivorous bats has been reported (Mohr 1972, Reidinger 1972, 1976, Clark and Prouty 1976, Geluso et al. 1976), and a recent study has documented mortality and probable population decline in gray bats resulting from routine insecticide usage (Clark et al. 1978). Clearly, further investigation is needed. Donald Clark has received and is currently analyzing samples of guano from each of the 22 caves censused in this study. His initial results (pers. comm.) suggest considerable variation among localities, with levels of PCB, DDD, DDE, heptachlor epoxide, or lead at possibly dangerous levels in the guano from several caves.

A further possible cause of decline may involve other chemical pollution or siltation of waterways over which gray bats forage. Although studies of specific prey preferences are not yet complete, gray bats are known to forage primarily over rivers, streams, and reservoirs (Tuttle 1976a,b, LaVal et al. (1977) where, among other insects, they consume large numbers of mayflies (Tuttle 1976b, Tuttle, Stevenson, and Rabinowitz, in prep.). Mayflies are thought to be quite sensitive to aquatic pollution. Through broad areas of their former habitat, they have been virtually eliminated, and they are now rare in other areas of former abundance (Fremling 1968). Clearly, such declines could prove disastrous for predators that depend upon them as a major food source.

I have found few observations on the potential effects of siltation. Carlander et al. (1967) seemed to believe that at least some siltation benefited nymphs of the 2 species of mayflies that they studied, but other species apparently are unable to survive where the substrate consists of mud or silt (Lyman 1943, Minshall 1967). At least in areas surrrounding the Cumberland Plateau in Kentucky and Tennessee, recent increases in strip mining have produced levels of siltation which could have extreme and far-reaching effects on aquatic biota and consequently on the future survival of any gray bats living along affected waterways. None of the 5 colonies that remained relatively stable between 1970 and 1976 foraged over heavily silted waterways. One that did (from cave 20) declined markedly, but vandalism was so intense there that it alone may have accounted for the 86% loss. Problems involving the effects of both chemical and silt pollution on the aquatic insects upon which gray bats depend need more investigation.

Additionally, deforestation of areas near cave entrances and between caves and rivers or reservoirs where gray bats feed may have affected them detrimentally. In brief, perhaps critical, periods during exceptionally cold spring weather I have observed that gray bats sometimes appear to limit much of their foraging activities to forested areas near their caves. Also, during evening emergence, gray bats usually fly in the protection of forest canopy en route to rivers or

reservoirs where they feed (Tuttly 1976b). I repeatedly have observed gray bats traveling considerably out of their way in order to take advantage of even scattered trees along a fence row. I also have seen screech owls capturing emerging gray bats and have observed that these owls have much greater difficulty when the bats are able to take cover in the forest canopy.

Female gray bats produce their 1st young when they are 2 years old (Tuttle 1976a) and thereafter produce only 1 per year. Clearly, with such low reproductive rates, even slight increases in predation could prove significant. Young gray bats are slow and clumsy fliers during their 1st week of flight, and at caves surrounded by forest, they often spend several nights foraging in the forest before venturing father away. The trees provide convenient resting places for weak fliers and protection from predators and wind. Factors such as deforestation may account for the fact that at least 2 colonies (caves 1 and 5) have markedly declined in the past but stabilized at reduced sizes recently. Deforestation, however, cannot have caused losses since 1970 in the 22 caves studied because no major cutting of timber occurred near any of them in that period.

Natural Calamities.--Cave flooding is by far the most important natural calamity faced by gray bats, and it is becoming increasigly important as they retreat farther back into inaccessible places to avoid human disturbance. Summer colonies often retreat to roosts over deep water in order to avoid disturbance by humans. In some caves this is a successful avoidance strategy, but in others such roosts become death traps during flooding.

An additional problem involves cave entrance closure. On rare occasions cave-ins or gradual fill-in of sinkhole entrances render a cave entrance or an important passage too small for a large colony to pass through without greatly increased danger of predation. One Florida cave was abandoned by a large maternity colony following the collapse of the largest of its 3 entrances. No other cause for the abandonment could be found.

Impoundment of Waterways.--Gray bat preference for caves near rivers has made their roosts particularly vulnerable to inundation by man-made impoundments. The inital effect of long-established impoundments, such as the Tennessee Valley Authority reservoir system, is difficult to evaluate due to a lack of pre-impoundment data. The little information available indicates that many important caves, and probably their bat populations, were extirpated. An account by M'Murtrie (1874) describes a cave in Alabama, since flooded by a reservoir which was "inhabited by countless thousands of bats" and had guano piles 4.5 m deep. Longtime residents have told me of many other such caves now submerged. Timing of the inital flooding may be a critical factor in whether the flooded populations are destroyed immeditaely. The bats' strong philopatry and narrow ecological requirements, however, make survival of displaced populations questionable even if they escape initial destruction.

On the other hand, it was intially suspected that reservoirs might increase the amount and quality of foraging habitat for colonies that survived (Tuttle 1976b). Recent studies of gray bat foraging habitat and prey preference requirements support an opposite conclusion, however (Tuttle, Stevenson and Rabinowitz, in

prep.). Furthermore, recreational activity associated with reservoirs has greatly increased the number of people visiting gray bat habitat, and many caves formerly long distances from population centers and roads are now within easy access by boat.

MANAGEMENT RECOMMENDATIONS

Priorities for Site Protection.--Clearly, the immediate objective must be to reduce human disturbance in occupied caves. First, the locations of gray bat caves must be made known to appropriate federal, state and private agencies along with recommendations of options for protection. Locations of most gray bat wintering caves are known to bat researchers, and many summer caves also are known. Even those not yet known to researches are usually known locally to spelunkers. Access to such location lists, however, should be severaly restricted prior to protection of the sites.

Because resources are limited, there must be some systematic method of determining priorities for protection. I propose that as gray bat caves become known, they should be designated according to the following categories: (1) primary hibernating caves (those occupied now or in the past by more than 50,000 gray bats); (2) secondary hibernating caves (those used by less than 50,000); (3) primary maternity caves (those occupied now or in the past by 50,000 or more gray bats; (4) secondary maternity caves (those presently occupied by smaller colonies); (5) primary bachelor caves (those used now or in the past by more than 50,000 male and nonreproductive female gray bats); (6) secondary bachelor caves (those continuing to be used by smaller groups); (7) gray bat caves not included in the previous categories, such as caves which receive only brief seasonal use by small numbers of gray bats, and abandoned caves which in the past housed only small colonies. Bachelor caves often shelter pregnant and postlactating females as well as juveniles either before or after the maternity period in June and may sometimes receive as little as 60 days of major use annually. Their transient use pattern does not reduce the importance of these caves to their colonies.

All caves in categories 1, 3, and 5 should receive immediate protection, with those in categories 4 and 6 next in line. Categories 2 and 7 should receive consideration when possible, especially in marginal areas of the speices' range where large colonies do not exist. Few caves will be included in categories 1, 3 and 5, and over sizeable geographic areas outside of Alabama and Tennessee such large colonies may not occur at all. In such areas colony sizes accorded priority status probably should be lowered to as few as 25,000 gray bats for category 1 and 10,000 for categories 3 and 5. Occupied caves within a category should take priority over unoccupied caves, and some caves used only briefly by spring and fall migrants may also be critical. Individual summer colonies usually use, and may often require, several different caves throughout a single active season. This permits adjustment for seasonally changing temperature requirements as well as for more effcient exploitation of patchy food resources. The above recommendations are provided only as guidelines and are flexible.

There are only 9 caves known which fall in the first catagory (50,000 minimum population), and they are believed to contain roughly 95% of the known species

population for half of each year. If gray bats are to survive, it is imperative that these caves be acquired and protected by federal, state or private agencies. Without such action all other measures may prove meaningless.

As each primary hibernation population is protected, a special effort should be made to identify and protect the most important summer colonies, especially in categories 3 and 5 of which that population is composed. Only such a systematic approach, which provides year-round protection, can guarantee long-term survival of the species. As a result of extensive banding studies in Missouri (Myers 1964, Elder and Gunier 1978), Kentucky (Hall and Wilson 1966), and Alabama, Florida, Tennessee and Virginia (Tuttle 1976a), most geographic patterns of movement are relatively well known, making this approach feasible.

For example, the most important hibernation poulation known, with its complex of associated summer colonies, is located in northeastern Alabama. Three caves of this group all require immediate protection (caves 44, 45, and 50 in Tuttle 1976a; the 2 important summer caves - 45 and 50 - are numbered 11 and 19 in this paper). The hibernaculum contains between half and two-thirds of the entire known species population each winter, is privately owned, and is threatened increasingly by disturbance. Cave 19 recently has lost nearly all of its formerely large colony, and in January of 1977 the owner of cave 11, the largest summer colony known anywhere, applied for federal and state permission for construction of a major resort, train ride, and trout hatchery in that cave. Following state approval of the impact statement, personnel in the Division of Forestry, Fisheries, and Wildlife Developement of the Tennessee Valley Authority using information on file from Tuttle, recognized the potential disaster and notified proper authorities. Consequently, construction in the cave was halted and the U. S. Fish and Wildlife Service started purchase negotiations that will be completed in 1978.

The loss of at least 106,000 gray bats from cave 19 and the near loss of 127,000 in cave 11 within 6 years illustrate the need for immediate acquisition and protection of critical gray bat caves. Equally clear is the need for increased communication among members of the National Speleological Society, bat researchers, and fėderal, state and private agencies. Many potential problems can be detected and avoided only through the kind of information exchange and cooperation that saved cave 11.

Public Education.--Government officials at all levels should be educated regarding the ecological role of bats. Many officials, through exaggerated fear of bats as disease vectors, feel that the only good bat is a dead bat. Disease problems should be put in perspective and officials should be informed, for example, that the gray bats from cave 11 alone consume more than 900 pounds of insects nightly and 80 tons annually.

Major efforts should be made to educate and gain the cooperation of land-owners. Many would cooperate if contacted by local wildlife officials or conservation groups. Cave owners should be provided with an official written statement outlining the basic problem, the potential value of having the bats, and federal and state laws and penalties for disturbing them. Additionally, federal and state agencies should offer to post privately owned gray bat caves, as well as

posting their own, with signs briefly outlining reasons for protection and specific times during which entry is prohibited. At summer caves, this period should be 15 March through October, and at winter caves it should be 15 August through April. Some caves are important to gray bats only during migration, and others, including some maternity caves are used for 2 months or less annually. These caves may not require such long periods of protection, but when in doubt the best approach is to grant March to October protection. A few caves must be closed year-round.

Such procedures impress the landowner that protecting bats is important enough to warrant his participation and lets him "off the hook" with neighbors and others who might otherwise think of him as unfriendly. Also, informative signs often elicit cooperation even from would-be vandals, especially if a definate time period is stipulated.

Methods of Protection.--Some gates that were built to protect gray bats have done more harm than good (Tuttle 1977), and this continues to be a major prolem. It is difficult to construct vandal-resistant gates without restricting the free movement of bats or air. Gates should be used only where other protective measures are inadequate to prevent disturbance. Unfortunately, many caves cannot be adequately protected without fences or gates.

For advice on where and how to construct gates versus fences for protection of gray bat caves see Tuttle (1977). More investigation of this problem is needed, and in the meantime no gates should be built without careful planning. Follow-up studies to evaluate success or failure and to permit changes, where required, before critical populations are destroyed also are vital.

Progress Thus Far.--Although improperly constructed gates have resulted in the loss of several entire colonies, some correctly constructed gates have proven successful in protecting gray bat summer colonies in caves in Missouri and Oklahoma (R. K. LaVal, pers. comm.). Aside from 3 locations in Missouri, most gray bat wintering sites have not yet received adequate protection, and several have lost all or most of their once large populations. One hibernaculum in Arkansas has been gated for 3 years, but has received no follow-up study to evaluate the gate's effect (M. J. Harvey, pers. comm.). Such carelessness is potentially disastrous.

Since the gray bat was listed as endangered (Federal Register, 28 April 1976), encouraging progress has been made. The U. S. Fish and Wildlife Service is purchasing the major gray bat hibernating cave reported by Hall and Wilson (1966) in Kentucky as well as the most important known summer cave (no. 11 in this paper), and is considering other important acquisitions (H. W. Benson, pers. comm.). It also has fenced and posted cave 15 of this study on the Wheeler National Wildlife Refuge. During more than 10 years of precipitous decline, the formerly large maternity colony in cave 15 had been destroyed, and only a transient bachelor remnant of approximately 9,000 bats remained. Following only 2 years of strict protection from human disturbance, this colony has now returned to maternity status and has increased to more than 19,000 bats.

The Division of Forestry, Fisheries, and Wildlife Development, Tennessee Valley Authority, is supporting major investigations of habitat requirements and

status of gray bats in areas under its jurisdiction, has fenced and posted 1 summer cave, and is initiating efforts to post and otherwise protect several other important caves, including cave 19 of this study. The Army Corps of Engineers has gated 1 summer cave and has fenced another in Missouri, and has funded research on habitat requirements in that area. The Missouri Department of Conservation in early 1977 hired Richard and Margaret LaVal to conduct further investigations of the status and management needs of gray and Indiana bats (Myotis sodalis) in Missouri and has acquired 5 gray bat caves with furthur purchases anticipated.

Studies Needed.--Gray bat seasonal habitat requirements (Tuttle 1975, 1976a,b, LaVal et al. 1977) and movement patterns (Myers 1964, Hall and Wilson 1966, Tuttle 1976a, Elder and Gunier 1978) are relatively well understood, and available information is adequate to permit management initiatives. Nevertheless, several areas require further investigation. Especially in Arkansas, Kentucky, Missouri and Oklahoma, more information on critical cave locations, status, and recent and total declines is needed.

Throughout the range of gray bats, investigations of the effects of human environmental disturbance are essential. The most important areas of concern involve the potential effects of water pollution and siltation on aquatic insect life upon which gray bats depend, as well as those of pesticide contamination and local deforestation. Foraging habitat and prey preferences are necessary baseline data.

Guidelines for Researchers.--Plans for further studies raise the question of potential research-related disturbance. Gray bats are especially vulnerable to any disturbance during winter hibernation and immediately before and during their maternity period. Because roughly 95% of all known gray bats are believed to aggregate into only 9 caves in winter, it is important that these caves not be disturbed unnecessarily. Major banding of gray bats during winter hibernation should not be tolerated under any circumstances, and the frequency of all unnatural arousal must be kept to a minimum. As a general rule, disturbance of hibernating populations should be limited to once per winter and totally avoided except when essential for research purposes.

Whenever possible, entry into maternity caves should be avoided from April through at least mid-July. Research which demands visitation of maternity roosts during that period must be restricted to the 1st hour following the evening departure of adults to feed. Gray bats are far more tolerant of disturbance during late July and August than at any other time during the active season, and whenever possible, censusing and any other activities which might necessitate sampling or visual observation at summer roosts should be restricted to that period.

Preferably, major summer sampling of live bats should be limited to trapping or mist netting at cave entrances or foraging areas. As long as whole cave entrances are not blocked, and only a small proportion of any given colony is sampled, such disturbance is negligible, assuming that traps or nets are never left unattended and that this disturbance is not repeated nightly. At all times

the use of dim electric lights and avoidance of unnecessary noise greatly reduce disturbance. Lights that are adjustable for intensity are ideal. Also, captured bats should not be crowded, left in potentially stressful temperatures, or restrained any longer than necessary.

When the above recommendations are combined with common sense and sensitivity, the negative effects of research can be negligible. Even banding, when restricted to summer caves and careful use of number 2 lipped bands or size XCL When harm does occur it is usually the result of careless banding procedure or improper handling.

CONCLUSIONS

Although recent decline of gray bats has been precipitous there is no reason to believe that this trend cannot be reversed if adequate measures are taken to prevent human disturbance and vandalism. The rate of loss of major colonies and the rate of decline in general, however, demand that action be immediate. Once lost, some colonies may be difficult or even impossible to reestablish. Efforts by cave owners, state and federal agencies, private environmental groups, National Speleological Society members and researchers, and education of unorganized cavers as well as the general public, will be vital to the future of the species.

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APPENDIX II

CAVE MANAGEMENT

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CAVE MANAGEMENT

Signs, fences, and gates may be required to reduce or eliminate human disturbance at gray bat caves.

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 FIGURE 3. If potential vandals are undeterred by the warning message, they might be more responsive to an interpretive message, as exemplified by the one shown on the lower half of the sign in FIGURE 3. This sign is used at gray bat summer caves in Missouri, and is especially suitable for maternity caves. The interpretive message has been modified for certain other types of 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 certain caves it may be acceptable to permit entry of visitors during seasons when bats are not present. A smaller sign containing that message, plus information on how to obtain a key to a gated cave or other pertinent details, might discourage would-be vandals, and encourage the cooperation of spelunkers.

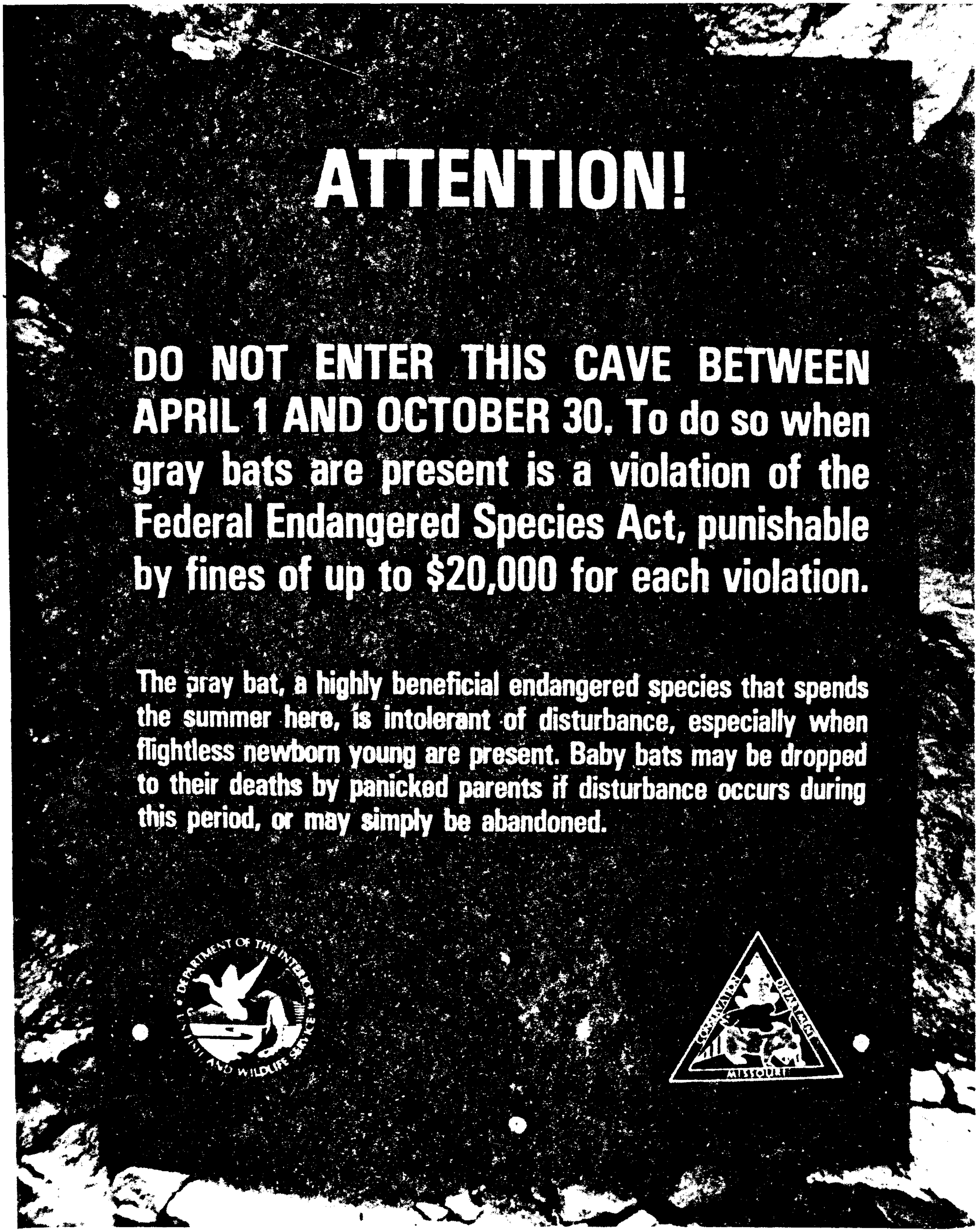

FIGURE 3: Warning signs used on a maternity cave by the Missouri Department of Conservation.

In cases where a cave is located in a public use area, the management agency may wish to use a much 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 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."

*This cave has not been designated critical habitat for any federally-listed species.

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 proven highly effective in reducing human disturbance, permitting gray bat maternity colonies to increase greatly in size. Fences have been used successfully to protect caves with flooded entrances adjacent to reservoirs (FIGURE 5).

Gates

Gates must be used only with extreme care to avoid detrimental effects. They should not be used at 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.

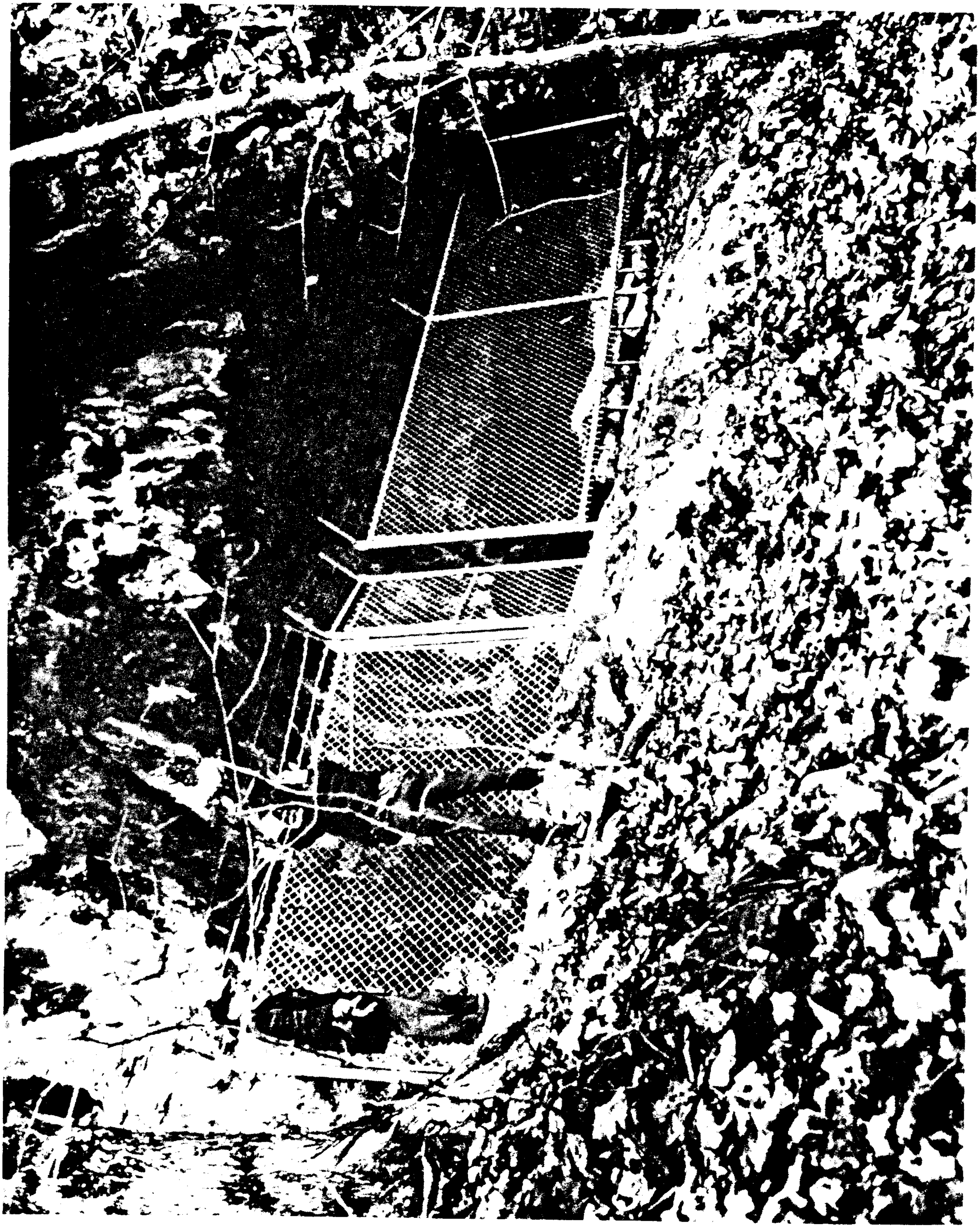

FIGURE 4: Fence errected at Norris Dam Cave, Tennessee by the Tennessee Valley Authority (Photo Credit R. Currie).

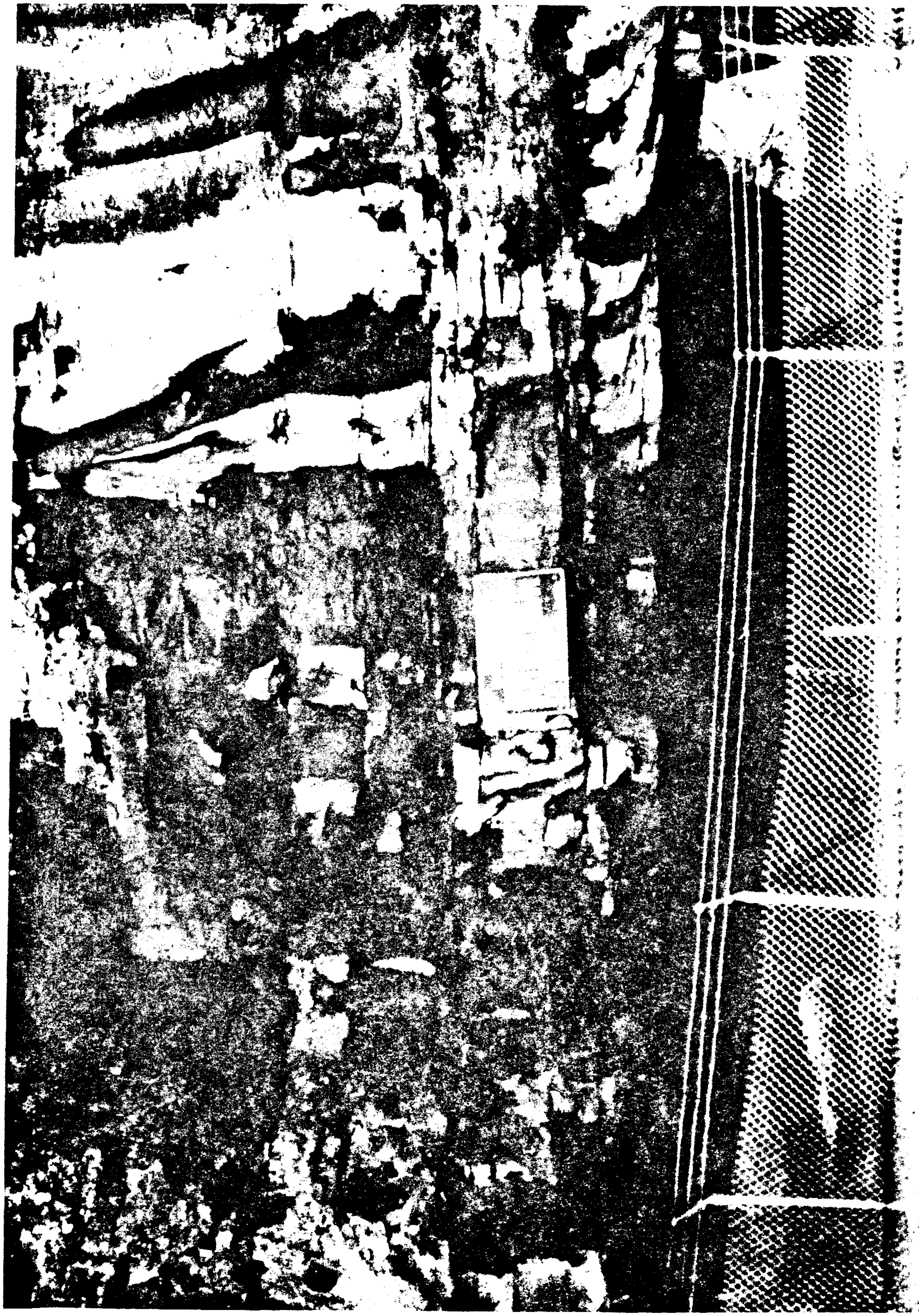

FIGURE 5: Fence erected at Hambrick Cave, Alabama by the Tennessee Valley Authority (Photo Credit - Tennessee Valley Authority). Fence is located approximately 30 feet from the cave entrance.

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" gate, similar to that shown in FIGURE 7.

Although gates that cover entire entrances may provide maximum security, their use should be restricted. Pregnant 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.

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.

Levees

The Kansas City District, Corps of Engineers has successfully used an earthern 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.

Resource Groups and Agencies

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:

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

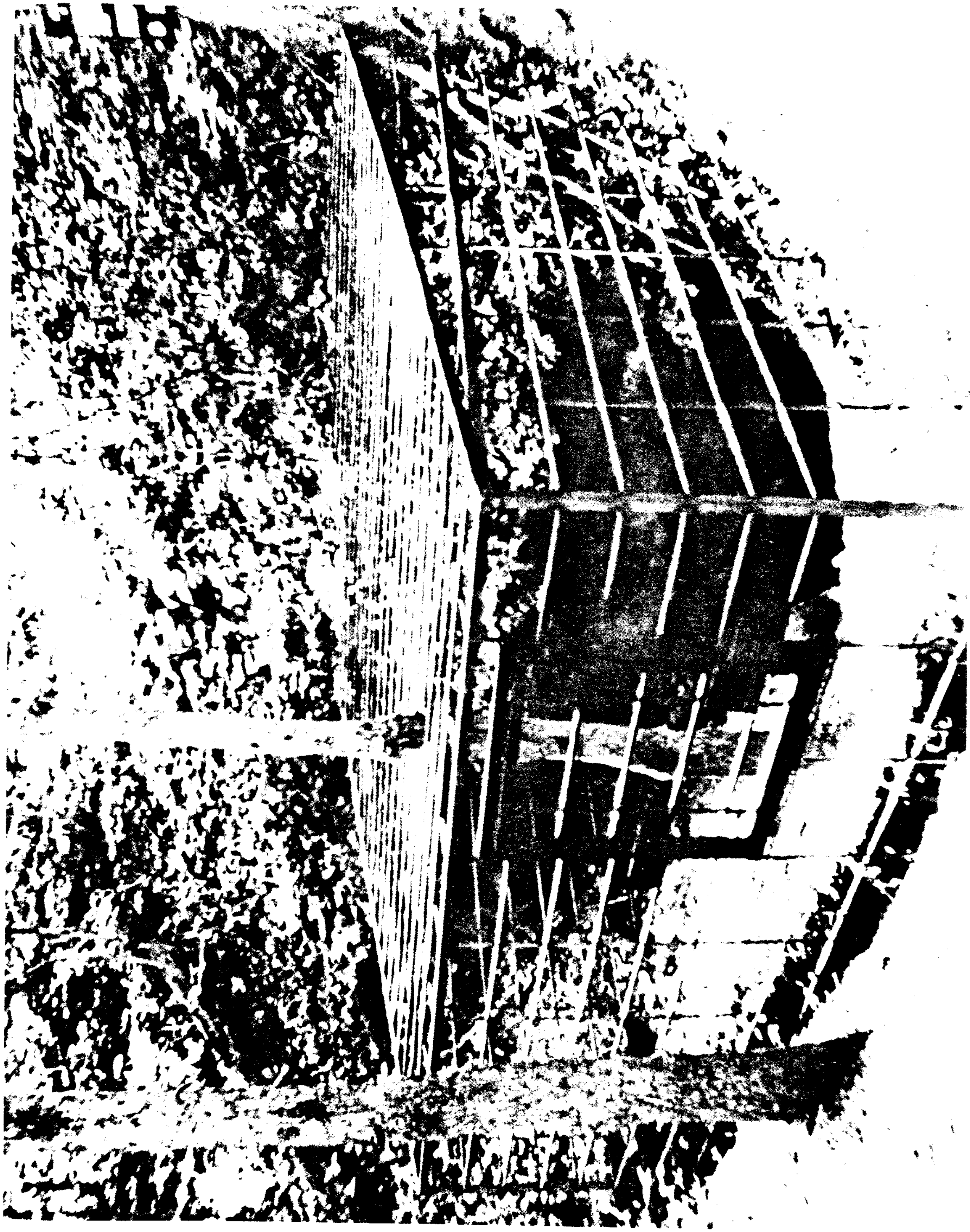

FIGURE 7: Bear Cave gate erected by the Missouri Department of Conservation (Photo Credit - R. Clawson).

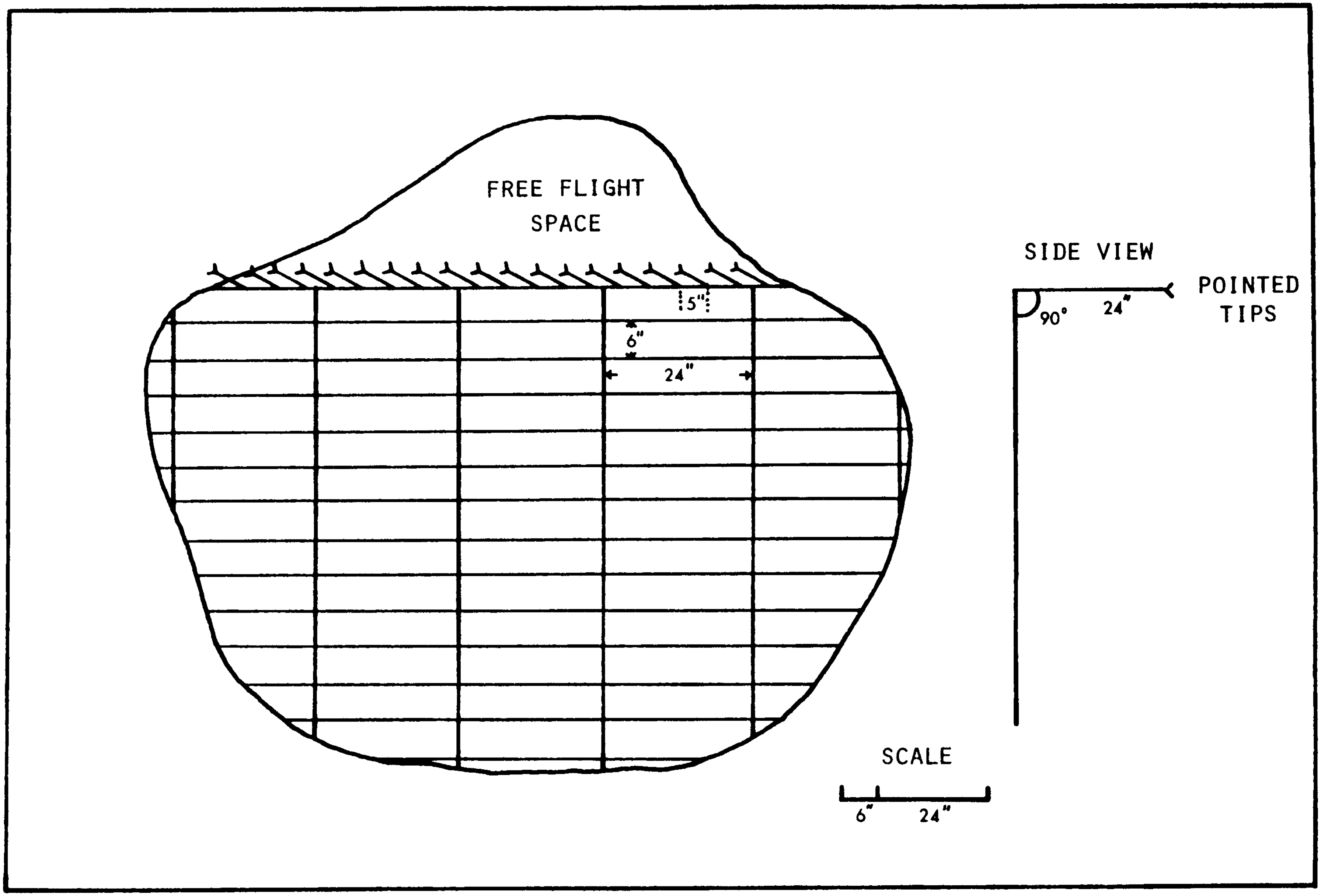

FIGURE 8. Drawing of a gate with free flight space, adapted from Blackwell Cave Gate, U. S. Army Corps of Engineers, Kansas City District.

(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

APPENDIX III

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The following persons, due either to their knowledge, experience, or position, have been contacted, or contributed in the gray bat recovery effort. The list is not necessarily complete, and does not include team members. Names are listed alphabetically.

Bagley, Fred
Barr, Donald
Bentley, Jerry
Black, Jeffrey
Brack, Virgil
Caire, William
Chitwood, Ken
Cope, James
Currie, Robert
Davis, Wayne
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Eager, Dan
Estes, Jerry and Beth
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Hensley, Steve
Holsinger, John
Jones, Rick
Jordan, Dennis
Lucas, Eldon
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APPENDIX IV

BIBLIOGRAPHY

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GRAY BAT (Myotis griesescens)

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APPENDIX V

FACT SHEET ON BATS

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FACT SHEET ON BATS

Only in the last 50 years has man learned much about bats and their life history. Their nocturnal habits, affinity for eerie places like caves, and silent, darting flight have made them the subjects of a great deal of folklore and superstition through the years. Active at a time when most people prefer to be indoors and able to function when and where man's most important sense, sight, is denied him, it is no wonder that bats seem supernatural. Actually, bats are superbly adapted creatures that have evolved to exploit resources such as night-flying insects and dark caverns that are unavailable to diurnal and sight-dependent animals.

Bats are the only mammals capable of true flight. Their fore limbs have the same general configuration as other mammals', but the bones of the fingers are greatly elongated to support membraneous wings. The hind limbs are modified to allow them to alight and hang, head-down, by their toes.

Bats feed at night. Most locate their food and navigate by uttering a continuous series of ultrasonic cries that return as echoes when the cries hit solid objects. In the daytime they seek shelter in a wide variety of places: caves, mines, buildings, rock crevices, under tree bark and amid foliage. When resting or hibernating, bats can lower their body temperature to nearly match the environment and thus lower their metabolism and conserve energy.

Most bats congregate in nursery colonies in the

spring. The young are born in May or June. Most Missouri bats produce one young per year; several species produce two, and one produces up to four. The young are fed on milk until they are capable of foraging on their own. Summer colonies disperse in July and August, when the bats begin migration to hibernation sites. A variety of sites are used for hibernation—caves, mines, buildings and hollow trees. Before hibernating, bats accumulate fat reserves to last throughout the foodless winter.

Bats are an important part of the natural system. They help control nocturnal insects, some of which are agricultural pests or annoying to man. Many forms of cave life depend upon the nutrients brought in by bats and released from their guano (feces). And bats have contributed much to man's knowledge through scientific studies of their echolocation abilities, their biology and certain aspects of their physiology.

Bat populations have been declining at an alarming rate in recent years. Some of the more important causes of this decline are destruction of habitat, pesticides and disturbance. Loss of roosting and foraging habitat has resulted from reservoir construction, watershed development, forest conversion, urbanization and cave commercialization. Lethal levels of pesticides have been found in dead bats in several studies. Vandalism and disturbance have eliminated or greatly reduced bats in a number of caves. Three species of bats in Missouri are on the federal Endangered Species List and are protected by the Endangered Species Act of 1973. All bats are protected by the Wildlife Code of Missouri.

All of the bats that occur in Missouri are insectivorous. They can be divided into two groups—those that roost only in trees and those that spend at least a portion of the year in caves.

Among the tree bats, red bats and hoary bats roost amid the leaves while silver-haired bats roost under loose bark and evening bats prefer cavities. Red bats are probably the most commonly seen species in the state. Occurring statewide, they emerge at dusk to forage along woods edges, over streams, along roads and frequently around street lamps in towns. In winter, they may be seen on warm afternoons foraging in forest openings. The hoary bat, so named because of white tips on its rich, dark brown fur, is the largest Missouri bat, weighing over an ounce and having a 15-inch wingspan. Silver-haired bats are primarily a northern species while evening bats raise young in Missouri but migrate south for the winter.

The remaining species occupy caves all or part of the year. Gray bats, Indiana bats and Ozark big-eared bats are on the federal Endangered Species List. Gray bats and Indiana bats are threatened with extinction largely because of their habit of amassing in very large numbers (up to hundreds of thousands) in only a few caves. Thus they are extremely vulnerable to disturbance (each time they are awakened from hibernation they use up vital fat reserves), destruction from natural catastrophes such as flooding or wanton slaughter by people, and loss of important caves to commercialization, inundation by reservoirs, or other causes. There now may only be a few hundred Ozark big-eared bats in existence. They are known from only a very few caves in southwest Missouri, northwest Arkansas and eastern Oklahoma.

Gray bats live underground year-round and thus are found only in areas with suitable caves (mostly the southern half of the state). Their summer caves are easily recognized because of the huge mounds of guano that accumulate beneath the bat roosts. The roosts themselves usually are evident as brown stains on the cave ceiling. In June and July, when flightless young are present, disturbance can lead to mass mortality as frightened females drop their young in the panic to flee from the intruder. Such clusters of gray bats are usually noisy, so if you enter a cave with a strong guano smell and hear bats, please turn around and leave immediately. Gray bats are known to hibernate in four caves in Missouri; three of them have pit (vertical) entrances that make human access difficult thus limiting disturbance. One of these caves is commercialized, but the owners are taking steps to protect the bats.

Indiana bats hibernate in a few cold caves in the Ozarks, and more than half of the entire world population winters in Missouri. They form dense clusters of hundreds or thousands of bats on cave ceilings, usually within or just beyond the twilight zone near the cave's entrance. At this time they are highly susceptable to disturbance by cave explorers. In summer, Indiana bats disperse and form small colonies. They live under tree bark and are not likely to be seen. Relatively little is known about their summer ecology because they are so difficult to locate.

Little brown bats hibernate in small numbers in many caves in Missouri. In summer, they sometimes form colonies in barns and attics. Keen's bats hide in crevices in caves and are rarely seen even though numbers of them can be trapped at cave entrances at night.

Eastern pipistrelle bats are pale in color and can be found hibernating singly in most caves in the state. Big brown bats hibernate in cold sites just inside cave entrances. They sometimes form colonies in barns and attics where their guano may create an odor problem. When a single bat is found inside a house, it is most likely a big brown that entered looking for a place to roost for the day.

Eastern and Ozark big-eared bats occur in small numbers in Missouri. They are easily recognized as they have huge ears that are nearly as long as the rest of their body. Least bats have been found in a few caves in the state, and free-tail bats were identified from a couple of locations.

At present, bat management consists primarily of protecting habitat. Some of the caves known to be occupied by endangered species have been acquired or leased. Caves that are especially critical to the survival of these species are being gated with welded steel bars set in concrete or rock. However, during the times of the year when the endangered bats are not present, these caves can be visited without harm to the bats. Many caves used by endangered species are posted with signs that explain which species is present and at what time of year entrance into the cave would disturb the bats. They also give some information on why the bats need protection. Entering a bat cave could lead to prosecution under the Endangered Species Act and bring a fine of up to $20,000.

If you have bats in your house or other building and wish to evict them, the best method is to block all access holes when the bats are out so that they cannot return. The best time is in the fall or winter after the bats have left for hibernation. Alternatively, you could wait until the bats have left to forage at dusk and then block up the holes. However, don't do this between May 15 and July 15 when flightless young might be present as they would die and create an additional odor problem. Killing the bats without stopping up their access holes may alleviate the problem for the time being, but the conditions that attracted the bats in the first place would still exist and other bats probably would use the site in the future. It has recently been found that spraying pesticides on a bat colony is not a good method of control, for several reasons—(1) not all the bats are killed, (2) dying bats fall near the treatment site and are likely to come in contact with humans and their pets, and (3) as above, the conditions that initially attracted the bats are not changed.

Appendix I gives a simple key and descriptions of the cave bats most likely to be encountered in Missouri. It also has identification tips to help distinguish the two endangered *Myotis* species from other, similar bats. Also attached is a page of drawings that depict several key characters to separate bats of the genus *Myotis* in Missouri. If you encounter endangered species or find any bats with numbered plastic bands on their wings, please send the number, color of band, date, locality and any other pertinent information to Richard Clawson, Fish and Wildlife Research Center, 1110 College Avenue, Columbia, Missouri 65201.

Bats need friends. They have suffered from misinformation and superstition for many years. As we learn more about these furry little "angels of the night" we realize their importance in the natural scheme of things. An enlightened public, realizing that the system is composed of many parts and that each has a role to play in maintaining the balance, will ultimately prove to be the bat's best friend.

This publication is made possible by the 1/8 of 1% sales tax dedicated to conservation in Missouri.

APPENDIX I

A SIMPLIFIED KEY TO MISSOURI CAVE BATS

A. Usually roosting in large clusters (hundreds or thousands)

1. Fur on back gray; guano piles under cave roosts; bats usually seen only in spring, summer or fall .... **Gray Bat**
2. Fur on back brownish gray; no guano piles under roosts; bats usually seen only in cold caves in late fall, winter and early spring .... **Indiana Bat**

B. Usually roosting singly or in very small clusters (fewer than 20)

1. Large size (total length 4" to 5"); fur on back dark brown .... **Big Brown Bat**
2. Small size (total length less than 4")
   a. Fur on back pale yellowish or pale reddish-brown .... **Pipistrelle Bat**
   b. Fur on back dark glossy brown
      Ears long (about 3/4") .... **Keen's Bat**
      Ears shorter (usually 5/8" or less) .... **Little Brown Bat**

A MORE DETAILED GUIDE TO IDENTIFICATION AND HABITS OF MISSOURI CAVE BATS

Gray Bat (*Myotis grisescens*) — ENDANGERED — Medium size; grayish color; usually in large active clusters; in absence of bats, evidenced by piles of bat guano and reddish-brown ceiling stains; in many caves in summer, few in winter.

Indiana Bat (*Myotis sodalis*) — ENDANGERED — Small size; grayish brown color, grayish ears and membranes; torpid clusters (often large) in cold caves in winter; no guano piles; mostly in a few caves in eastern Ozarks.

Little Brown Bat (*Myotis lucifugus*) — Small size; brown, glossy fur; blackish ears and membranes, as singles, pairs or small clusters; in most caves in winter, often near twilight.

Keen's Bat (*Myotis keenii*) — Small size; much like little brown bat, but much longer ears; roosts in crevices, so rarely seen, but a few do roost in the open on low ceilings.

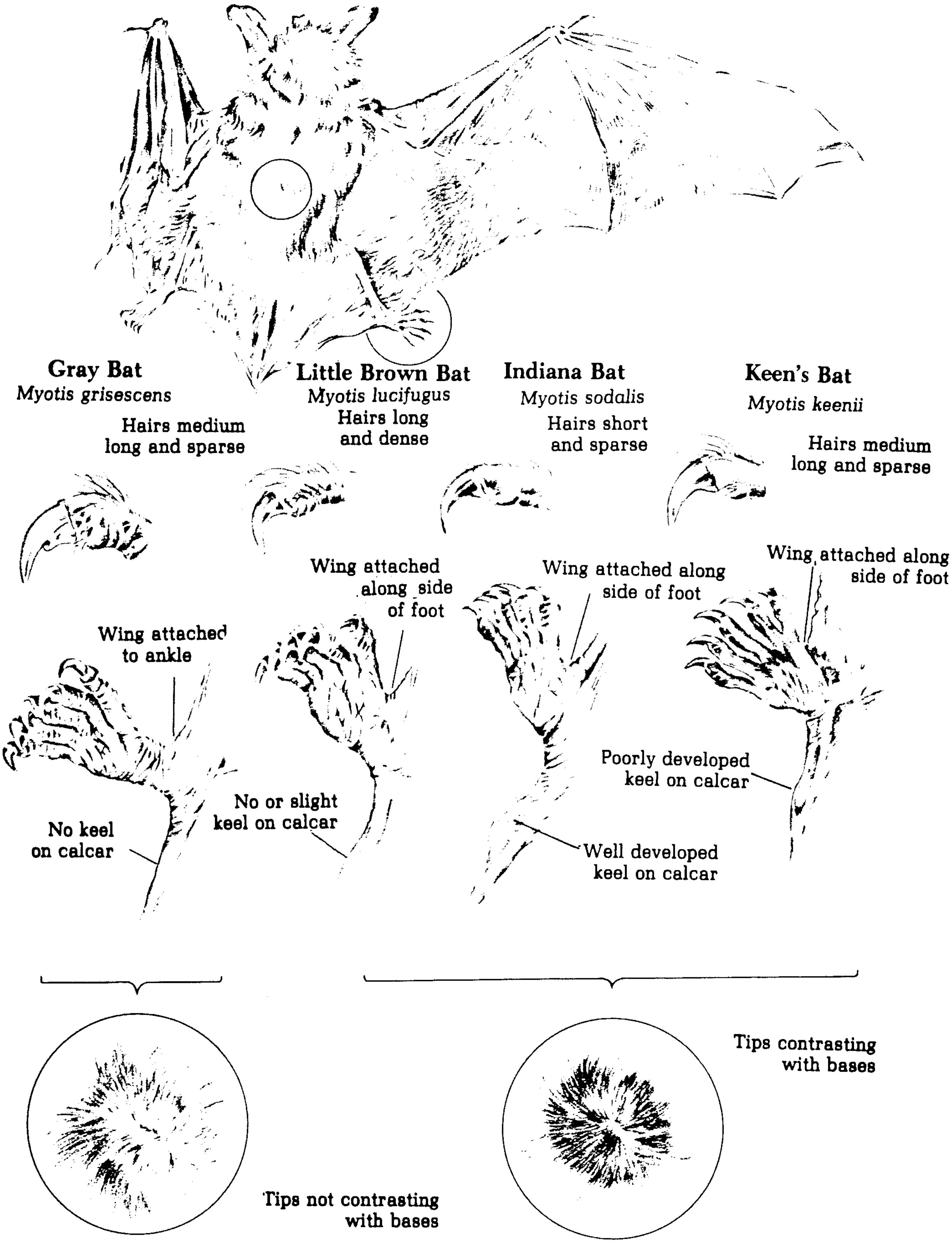
Big Brown Bat (*Eptesicus fuscus*) — Much larger than others listed here; brown color; dark ears and membranes; noisy and belligerent; singles and small groups in most caves, near entrance.

Eastern Pipistrelle Bat (*Pipistrellus subflavus*) — Smallest of our cave bats; pale color and very small size make it easy to recognize; singles in winter, sometimes also in summer; most caves in state, well past twilight in constant temperature zone.

IDENTIFICATION OF INDIVIDUAL BATS IN THE HAND

Identification of individual bats in hand can be difficult. The key to Missouri cave bats may prove adequate, especially if roosting conditions were observed. Otherwise the following drawings will be very useful. They use the color of the fur, as revealed by blowing in the center of the back to part the fur; the position of attachment of the tail membrane; the length and density of distribution of hairs on the toes; and the degree of development of a fleshy keel on the calcar, which is a cartilaginous supporting structure on the rear edge of the tail membrane. These are the characters used by bat biologists to distinguish among these species.

How To Distinguish Certain Species of *Myotis* By The Hind Foot And Fur



APPENDIX VI

GRAY BAT CAVES BY STATE

Most of the recommended actions in the step-down plan involve individual gray bat caves. The following pages contain a list of these caves, their location by state and county, an index number for computer purposes, priority level (1-4), levels of biological significance (1-7; See item 1.2.2.1.1.1) based on size and type of colony, protection needs, and recommended management agencies. Priority levels were set based on biological significance, location, vulnerability and concensus of opinion of a variety of respondents to the cave survey (see Part 1.2.2.(1). of the step-down plan). Priority 1 caves are major hibernacula and their most important maternity colonies. Priority 2 caves are those containing fewer bats that are important for geographic or other reasons. Priority 3 caves are those that require further investigation. Priority 4 are all remaining known caves, most of which are of marginal consequence and require no action. The recommended management agencies should initiate planning and budget initiatives to effect the listed protection needs.

TABLE 3. ABBREVIATIONS USED IN GRAY BAT RECOVERY PLAN (TABLES 4-19)

AGFC	= Arkansas Game and Fish Commission
ALDOC	= Alabama Department of Conservation and Natural Resources
ALDNR	= Alabama Department of Natural Resources
CHCS	= Cookson Hills Christian School
DNR	= Missouri Deparment of Natural Resources
DR	= Don Russell
ENL	= Eligible Natural Landmark
FL	= Florida Game and Inland Fisheries Commission
GADNR	= Georgia Department of Natural Resources
IL	= State of Illinois
KNPC	= Kentucky Nature Preserves Commission
MDC	= Missouri Department of Conservation
MPM	= Milwaukee Public Museum
NC	= Nature Conservancy
NNL	= National Natural Landmark
NPS	= National Park Service
NSS	= National Speleological Society
OK	= Oklahoma Department of Wildlife Conservation
OUL	= Ozark Underground Laboratory
PIN	= Private Individual
PLCA	= Purchase, Lease, or Cooperative Agreement
PVTNSS	= Private National Speleologist Society
SDC	= Silver Dollar City
TVA	= Tennessee Valley Authority
TWRA	= Tennessee Wildlife Resources Survey
USACE	= U.S. Army Corps of Engineers
USADOD	= U.S. Department of Defense
USFS	= U.S. Forest Service
USFWS	= U.S. Fish and Wildlife Service
VAGF	= Virginia Commission of Game and Inland Fisheries
*	= Already Accomplished

TABLE 4. PRIORITY 1 CAVES FOR GRAY BATS.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
ALABAMA	COLBERT	GEORGETOWN CAVE	155	1	2	MODIFY FENCE	NPS
ALABAMA	CONECUH	SANDERS CAVE (TURK)	296	1	4	PLCA, 1/2 GATE	USFWS
ALABAMA	JACKSON	FERN CAVE	170	1	1	PLCA, SIGN ONLY	USFWS
ALABAMA	JACKSON	SAUTA CAVE	134	1	2	REGULAR PATROL, MAINTENANCE	USFWS
ALABAMA	LAUDERDALE	KEY CAVE	149	1	2	FENCE	TWRA OR TVA
ALABAMA	MARSHALL	HAMBRICK CAVE	191	1	2	FENCE*, SIGN*	ALDOC OR TVA
ALABAMA	MORGAN	CAVE SPRINGS CAVE	148	1	2	FENCE*, SIGN*	USFWS
ARKANSAS	BAXTER	BONANZA CAVE	007	1	1	MODIFY GATE*	USFS
ARKANSAS	BENTON	LOGAN CAVE	016	1	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	INDEPENDEN	BONE CAVE	009	1	2	PLCA, 1/2 GATE	AGFC OR USFWS
FLORIDA	JACKSON	GEROMES CAVE	284	1	2	PLCA, SIGN ONLY	PIN
FLORIDA	JACKSON	GIRARDS CAVE	287	1	2	PLCA, FENCE	USFWS
FLORIDA	JACKSON	JUDGES CAVE	286	1	2	PLCA, FENCE	USFWS
FLORIDA	JACKSON	OLD INDIAN CAVE	285	1	3	FENCE, REMOVE GATES	FL
ILLINOIS	HARDIN	CAVE SPRING CAVE	111	1	4	PLCA, GATE	IL OR USFS
KENTUCKY	ALLEN	HOLLAND CAVE	260	1	2	PLCA, GATE, SIGNS	KNPC, USFWS, OR TVA
KENTUCKY	EDMONSON	JESSE JAMES CAVE	209	1	1	PLCA, MODIFY GATE	USFWS
KENTUCKY	JESSAMINE	CHRISMANS CAVE	269	1	2	PLCA, GATE, SIGNS	KNPC OR USFWS
KENTUCKY	JESSAMINE	OVERSTREET CAVE	270	1	2	PLCA, GATE, SIGN	KNPC OR USFWS

KENTUCKY	TRIGG	COOL SPRINGS CAVE	252	1	2	PLCA, GATE, SIGNS	KNPC, USFWS, OR TVA
MISSOURI	CAMDEN	MAUSS CAVE	038	1	2	PLCA, SIGN ONLY*	MDC
MISSOURI	CAMDEN	MOLES CAVE	022	1	2	BLOCK ROAD, FENCE, SIGN*	MDC
MISSOURI	DENT	BAT CAVE	053	1	2	PLCA, GATE	MDC
MISSOURI	FRANKLIN	ROARING SPRINGS CAVE	059	1	2	LEASE*, SIGN*	MDC
MISSOURI	HICKORY	BECK CAVE	062	1	2	FENCE*, SIGN*, LEVEE*	USACE
MISSOURI	LACLEDE	COFFIN CAVE	067	1	1	FENCE*, SIGN*	MDC
MISSOURI	PULASKI	INCA CAVE	092	1	2	FENCE*, SIGN*	MDC
MISSOURI	SHANNON	CHIMNEY CAVE	099	1	1	ROAD BLOCK, SIGN	NPS
MISSOURI	STONE	MARVEL CAVE	104	1	1	MAINTAIN, SIGN ONLY*	MDC AND SDC
MISSOURI	STONE	SALTPETER CAVE	105	1	2	PLCA, FENCE	USFS
MISSOURI	TANEY	TUMBLING CREEK CAVE	107	1	2	GATE*	OUL
OKLAHOMA	DELAWARE	STANSBERRY'S CAVE	121	1	2	PLCA, SIGN, GATED*	OWNERS
TENNESSEE	CLAIBORNE	WHITE BUIS CAVE	140	1	2	PLCA, SIGN ONLY	TWRA
TENNESSEE	DEKALB	CRIPPS MILL CAVE	154	1	2	PLCA, SIGN ONLY	TWRA
TENNESSEE	GRAINGER	INDIAN CAVE	141	1	2	PLCA, 1/2 GATE	TWRA OR USFWS
TENNESSEE	HAWKINS	PEARSON CAVE	130	1	1,3	PLCA, SIGN ONLY	TWRA OR USFWS
TENNESSEE	MARION	NICKAJACK CAVE	133	1	1,2	FENCE*, SIGN*	TWRA OR TVA
TENNESSEE	MONTGOMERY	BELLAMY CAVE	145	1	4	COOP AGREE*, SIGN*, FENCE*	TWRA
TENNESSEE	STEWART	TOBACCOPORT SALTPETER CAVE	158	1	1,5	PLCA, FENCE, SIGN	TWRA
TENNESSEE	UNION	OAKS CAVE	129	1	2	SIGN ONLY	TWRA
TENNESSEE	WARREN	HUBBARDS CAVE	169	1	1	PLCA, 1/2 GATE	USFWS

TABLE 5. PRIORITY 1 HIBERNACULA AND ASSOCIATED PRIORITY 1 MATERNITY COLONIES FOR GRAY BATS.

Hibernaculum	Maternity colony
Fern Cave, AL (170)	Nickajack Cave, TN (133) Sauta Cave, AL (134) Bellamy Cave, TN (145) Cave Springs Cave, AL (148) Key Cave, AL (149) Georgetown Cave, AL (155) Hambrick Cave, AL (191) Sanders Cave, AL (296)
Bonanza Cave, AR (007)	Bone Cave, AR (009) Logan Cave, AR (016) Saltpeter Cave, MO (105) Tumbling Creek Cave, MO (107)
Old Indian Cave, FL (285)	Geromes Cave, FL (284) Judges Cave, FL (286) Girards Cave, FL (287)
Jesse James Cave, KY (209)	Cave Spring Cave, IL (111) Cool Springs Cave, KY (252) Holland Cave, KY (260) Chrismans Cave, KY (269) Overstreet Cave, KY (270)
Coffin Cave, MO (067)	Moles Cave, MO (022) Mauss Cave, MO (038) Beck Cave, MO (062) Inca Cave, MO (092)
Chimney Cave, MO (099)	Bat Cave, MO (053) Roaring Springs Cave, MO (059)
Marvel Cave, MO (104)	Saltpeter Cave, MO (105) Tumbling Creek Cave, MO (107)
Pearson Cave, TN (130)	Oaks Cave, TN (129) Nickajack Cave, TN (133) White Buis Cave, TN (140) Indian Cave, TN (141)
Tobaccoport Saltpeter Cave, TN (158)	Bellamy Cave, TN (145)
Hubbards Cave, TN (169)	Nickajack Cave, TN (133) Bellamy Cave, TN (145) Cripps Mill Cave, TN (154)

TABLE 6. PRIORITY 2 CAVES FOR GRAY BATS.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
ALABAMA	COLBERT	BAKER CAVE	156	2	4	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	DEKALB	LYKES CAVE	185	2	1	PLCA, FENCE	ALDOC, USFWS, OR TVA
ALABAMA	DEKALB	PORTERSVILLE BAT CAVE	152	2	5	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	JACKSON	GROSS SKELETON CAVE	193	2	3	SIGN ONLY	ALDOC OR TVA
ALABAMA	JACKSON	NITRE CAVE	147	2	5	PLCA, SIGN	ALDOC, USFWS, OR TVA
ALABAMA	LAUDERDALE	BLOWING SPRINGS CAVE	157	2	5	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	LIMESTONE	INDIAN CAVE	173	2	4	FENCE*, SIGN	ALDOC OR TVA
ALABAMA	MADISON	SHELTA CAVE	177	2	2	REPLACE GATE WITH FENCE, SIGNS	NSS
ALABAMA	MARSHALL	DUNHAM CAVE	190	2	5	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	GUNTERSVILLE CAVERNS	210	2	4	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	KING'S SCHOOL CAVE	159	2	5	STOP CONTAMINATION SOURCE	ALDOC
ALABAMA	MARSHALL	OLD BLOWING CAVE	188	2	5	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	SHELBY	ANDERSON CAVE	293	2	5	PLCA, SIGN ONLY	ALDOC OR USFWS
ARKANSAS	BAXTER	OLD JOE CAVE (BAT)	004	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	BENTON	CAVE SPRINGS CAVE	010	2	2	PLCA, SIGN ONLY	AGFC OR USFWS
ARKANSAS	BENTON	CRYSTAL CAVE	011	2	2	FENCE*, SIGN	AGFC OR USFWS
ARKANSAS	BENTON	PIGEON ROOST CAVE	019	2	2	FENCE, PREVENT FLOODING	USACE
ARKANSAS	BENTON	WAR EAGLE CAVERNS	021	2	2	PLCA, 1/2 GATE	AGFC OR USFWS

ARKANSAS	BOONE	BREWER CAVE	246	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	CARROLL	BENNETT CAVE	247	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	INDEPENDEN	HANKINS CAVE	244	2	7	PLCA, FULL GATE	AGFC OR USFWS
ARKANSAS	MADISON	HORSETHIEF CAVE (DENNEY)	014	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	NEWTON	CAVE MOUNTAIN CAVE (BAT, BOXLEY)	003	2	7	PURCHASE*, FENCE	NPS
ARKANSAS	NEWTON	DIAMOND CAVE	012	2	2	PLCA	AGFC OR USFWS
ARKANSAS	NEWTON	JOHN EDDINGS CAVE	015	2	2	FENCE	NPS
ARKANSAS	NEWTON	LITTLE BEAR CAVE	241	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	SEARCY	CRANE CAVE	245	2	2	FENCE	NPS
ARKANSAS	SEARCY	FALLOUT CAVE	013	2	2	FENCE	NPS
ARKANSAS	SEARCY	PETER CAVE	018	2	2	FENCE	NPS
ARKANSAS	SHARP	BLAGG CAVE (CENTER)	005	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	SHARP	OZARK ACRES CAVE	240	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	STONE	BALD SCRAPPY CAVE (ALLISON)	002	2	2	1/2 GATE	USFS
ARKANSAS	STONE	BLANCHARD SPRINGS CAVERNS	006	2	3	FULL FENCE, GATE, AVOID DISTUR	USFS
ARKANSAS	STONE	CAVE RIVER CAVE	008	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	STONE	HELL CREEK CAVE	243	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	STONE	JOE BRIGHT CAVE	242	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	STONE	OPTIMUS CAVE	017	2	2	1/2 GATE	USFS
ARKANSAS	STONE	RORY CAVE (MITCHELL)	020	2	7	PLCA	AGFC OR USFWS

ARKANSAS	STONE	ROWLAND CAVE	239	2	7	FULL GATE	USFS
FLORIDA	JACKSON	FEARS CAVE	289	2	5	PLCA, SIGN ONLY	FL
FLORIDA	JACKSON	RIVER CAVE	292	2	7	SIGNS ONLY	FL
FLORIDA	JACKSON	SNEADS BAT CAVE	291	2	7	PLCA, SIGN ONLY	FL
KANSAS	CRAWFORD	STORM SEWER	300	2	2	NONE	PITTSBURG
KENTUCKY	ADAIR	JONES CAVE	261	2	2	PLCA	KNPC OR USFWS
KENTUCKY	ALLEN	UNKNOWN	282	2	2	PLCA	KNPC, USFWS, OR TVA
KENTUCKY	BARREN	TEMPLE HILL SALTPETER CAVE	257	2	2	OWNER COOPERATION	KNPC OR USFWS
KENTUCKY	CLINTON	CANEY BRANCH CAVE	273	2	2	PLCA, GATE	KNPC
KENTUCKY	EDMONSON	COACH CAVE (HUNDRED DOME)	211	2	7	PLCA, MODIFY GATES	USFWS
KENTUCKY	EDMONSON	LONG CAVE	258	2	2	MODIFY GATE	NPS
KENTUCKY	HART	RYDERS MILL CAVE	267	2	2	GATE, SIGNS	KNPC OR USFWS
KENTUCKY	JESSAMINE	DANIEL BOONE'S CAVE	268	2	2	PLCA, MODIFY GATE	KNPC OR USFWS
KENTUCKY	NELSON	BURGESS CAVE	255	2	2	PLCA, GATE, SIGN	KNPC OR USFWS
KENTUCKY	PULASKI	BLOWING CAVE	264	2	2	PLCA, GATE, SIGNS	KNPC
KENTUCKY	TRIGG	BIG SULFUR SPRINGS CAVE (PEE DEE	272	2	2	SIGN	KNPC, USFWS, OR TVA
MISSOURI	BENTON	ESTES CAVE	031	2	4	PLCA, SIGN ONLY	MDC
MISSOURI	BOONE	BOONE CAVE	029	2	4	PLCA, SIGN ONLY	MDC
MISSOURI	BOONE	DEVIL'S ICEBOX CAVE	027	2	4	SIGN ONLY	DNR
MISSOURI	BOONE	HOLTON CAVE	025	2	4	PLCA, SIGN ONLY	OWNERS

MISSOURI	BOONE	HUNTERS CAVE	026	2	5	PLCA, GATE	MDC OR DNR
MISSOURI	BOONE	LEWIS AND CLARK CAVE	024	2	2	PLCA, FENCE, EXPTL GATE	USFWS
MISSOURI	CAMDEN	ADKINS CAVE	023	2	2,3	PLCA, GATE	MDC
MISSOURI	CAMDEN	CARROLL CAVE	033	2	4	PLCA, MODIFY GATE	MDC
MISSOURI	CAMDEN	FIERY FORKS CAVE	034	2	7	NONE	
MISSOURI	CAMDEN	GRANDPA CHIPPLEY'S CAVE	036	2	2	PLCA, GATE	DNR
MISSOURI	CAMDEN	HANNAH CAVE	035	2	7	PLCA, SIGN ONLY	MDC
MISSOURI	CAMDEN	LOWER BURNT MILL CAVE	037	2	2	PLCA, FENCE	MDC
MISSOURI	CAMDEN	PRAIRIE HOLLOW CAVE	039	2	5	PLCA, SIGN ONLY	MDC
MISSOURI	CAMDEN	RIVER CAVE - HA HA TONKA	040	2	2	GATE,SIGN*	DNR
MISSOURI	CARTER	COAL BANK CAVE	041	2	4	BLOCK ACCESS ROAD,SIGN*	OWNER
MISSOURI	CHRISTIAN	RANTZ CAVE	042	2	2	PLCA, SIGN ONLY	MDC
MISSOURI	COLE	UNNAMED CAVE #2	043	2	2	PLCA, FENCE	MDC
MISSOURI	CRAWFORD	ONYX CAVE	046	2	7	MAINTAIN,GATE*,SIGN*	USACE
MISSOURI	CRAWFORD	SALOON CAVE	001	2	4	1/2 GATE, SIGN*	USACE
MISSOURI	CRAWFORD	TWENTY-THREE DEGREE CAVE	047	2	5	PLCA, FENCE	USFS
MISSOURI	DADE	MAZE CAVE	048	2	2	PLCA, FENCE	MDC
MISSOURI	DALLAS	CAT HOLLOW CAVE	049	2	3	PLCA, GATE	MDC OR DNR
MISSOURI	DALLAS	HILDERBRAND CAVE	050	2	2	PLCA, GATE	MDC
MISSOURI	DALLAS	MCKEE CAVE	051	2	3	PLCA, GATE	MDC
MISSOURI	FRANKLIN	BAT CAVE #2	055	2	4	PLCA, FENCE	MDC
MISSOURI	FRANKLIN	FISHER CAVE	057	2	2	MAINTAIN, IMPROVE GATE	DNR

MISSOURI	FRANKLIN	TWIN SPRINGS CAVE	060	2	7	SIGN ONLY	MDC
MISSOURI	HICKORY	BLACKWELL CAVE	063	2	2	MAINTAIN, 1/2 GATE*	USACE
MISSOURI	JASPER	COOLBROOK CAVE	064	2	4	PLCA, GATE	MDC OR NC
MISSOURI	LACLEDE	BAT CAVE	066	2	2	PLCA, GATE, BLOCK ROAD	MDC OR USFWS
MISSOURI	LACLEDE	MARY LAWSON CAVE	069	2	2	PLCA, GATE	MDC
MISSOURI	LACLEDE	MAYFIELD CAVE	070	2	2	GATE	USFS
MISSOURI	LACLEDE	SHAMEL CAVE (DREW)	074	2	2	PLCA, SIGN ONLY	MDC
MISSOURI	MARIES	INDIAN FORD CAVE	077	2	4	PLCA	MDC
MISSOURI	MILLER	BAT CAVE #1	079	2	2	SIGN*	MDC
MISSOURI	MILLER	MCDOWELL CAVE	080	2	5	PLCA, FENCE	DNR
MISSOURI	MORGAN	DRY BRANCH CAVE	081	2	5	PLCA, GATE	DNR
MISSOURI	OREGON	BAT CAVE	082	2	2	PLCA, GATE	USFS
MISSOURI	OREGON	BIG MOUTH CAVE	083	2	5	PLCA, SIGN ONLY	USFS
MISSOURI	OZARK	BAT CAVE	085	2	2	MAINTAIN,GATE*,SIGN*	USFS
MISSOURI	PIKE	FRANKFORD CAVE	096	2	4	PLCA, GATE	MDC
MISSOURI	PULASKI	BAT CAVE #1	086	2	2	PLCA, GATE	MDC OR USFS
MISSOURI	PULASKI	BAT CAVE #2	087	2	2	PLCA, SIGN ONLY	MDC
MISSOURI	PULASKI	FREEMAN CAVE	089	2	7	RESTRICT ACCESS (CLOSE ROAD)	U.S. ARMY
MISSOURI	PULASKI	PIQUET CAVE	093	2	2	PLCA, GATE	MDC
MISSOURI	PULASKI	TUNNEL CAVE	094	2	2	PLCA, GATE	MDC
MISSOURI	PULASKI	WINDY CAVE	091	2	7	PLCA, SIGN ONLY	MDC
MISSOURI	RALLS	FISHER CAVE	095	2	4	PLCA, SIGN ONLY	MDC

MISSOURI	REYNOLDS	COOKS CAVE	097	2	2	PLCA, FENCE	USFS
MISSOURI	SHANNON	BAT CAVE	098	2	4,6	PLCA, GATE	NPS
MISSOURI	SHANNON	MARTIN CAVE ENTRANCE #2	100	2	4	PLCA, FENCE	NPS
MISSOURI	SHANNON	ROUND SPRING CAVE	101	2	2	NO VISITORS, CHANGE GATE	NPS
MISSOURI	WASHINGTON	GREAT SCOTT CAVE	109	2	7	MAINTAIN,GATE*,SIGN*	MDC
MISSOURI	WRIGHT	SMITTLE CAVE	110	2	2	PLCA, GATE	USFWS
OKLAHOMA	ADAIR	CHARLEY OWL CAVE	114	2	2	GATE	NC
OKLAHOMA	DELAWARE	LINDA BEAR PAW CAVE	117	2	4	PLCA, SIGN ONLY	DR
OKLAHOMA	DELAWARE	SPAVINAW BAT CAVE	115	2	2	SIGNS, RESTRICT RESEARCH	USFWS
TENNESSEE	BEDFORD	SHIPMAN CREEK CAVE	165	2	7	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	CAMPBELL	NORRIS DAM CAVE	137	2	2	FENCE*, SIGN*	TWRA OR TVA
TENNESSEE	CLAY	MARKHAM CAVE	174	2	5	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	DECATUR	FEATHERFOOT CAVE	160	2	7	FENCE	TWRA OR TVA
TENNESSEE	DEKALB	GIN BLUFF CAVE	205	2	5	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	FRANKLIN	CANEY HOLLOW CAVE	143	2	4	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	FRANKLIN	WOOD'S DAM	234	2	4	COOP AGREE*	TWRA, USFWS, OR TVA
TENNESSEE	GRUNDY	TRUSSELL CAVE	132	2	4	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	HAWKINS	HORNER CAVE	183	2	7	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	HICKMAN	BAT CAVE	144	2	4	COOP AGREE*, SIGN ONLY*	TWRA, USFWS, OR TVA
TENNESSEE	JACKSON	DUD'S CAVE	206	2	5	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	KNOX	BALONEY CAVE	135	2	7	PLCA, FENCE, SIGN	TWRA, USFWS, OR TVA
TENNESSEE	LINCOLN	BAT CAVE	178	2	4	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA

TENNESSEE	MAURY	BENDERMAN CAVE	203	2	5	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	MEIGS	BLYTHE FERRY CAVE	139	2	5	FENCE, SIGN	TWRA AND TVA
TENNESSEE	MEIGS	EVES CAVE	181	2	5	SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	MEIGS	SENSABAUGH CAVE	180	2	5	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	PERRY	ALEXANDER CAVE	161	2	4	PLCA, 1/2 GATE	TWRA, USFWS, OR TVA
TENNESSEE	PUTNAM	AMENT CAVE	146	2	5	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	RHEA	GRASSY CREEK CAVE	131	2	2	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	RHEA	HARRIS CAVE	138	2	2	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	RUTHERFORD	HERRING CAVE	202	2	5	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	SMITH	BRIDGEWATER CAVE	207	2	5	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	SMITH	PIPER CAVE	184	2	4	PLCA, FENCE	TWRA, USFWS, OR TVA
TENNESSEE	UNION	LOST CREEK CAVE	232	2		FENCE	TWRA, USFWS, OR TVA
VIRGINIA	SCOTT	CLINCHPORT CAVE	295	2	7	PLCA, SIGN ONLY	VAGF, USFWS, OR TVA

TABLE 7. PRIORITY 3 CAVES FOR GRAY BATS.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
ALABAMA	COLBERT	MCKINNEY CAVE #2	199	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	DEKALB	STANLEY CARDEN CAVE	218	3	7	SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	JACKSON	HORSESKULL CAVE	195	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	JACKSON	LITTLE BAT CAVE	171	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	JACKSON	ORCE STWELLS CAVE	194	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	LAUDERDALE	BAT CAVE	167	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	LAUDERDALE	COLLIER CAVE	200	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MADISON	HERING CAVE (CAVE SPRING)	186	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	BISHOP CAVE	189	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	HONEYCOMB CAVE	187	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	KINGS SPRING CAVE	196	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	LEDBETTER CAVE	179	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MORGAN	HUGHES CAVE	164	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MORGAN	TALUCAH CAVE	197	3		PLCA	ALDOC, USFWS, OR TVA
ALABAMA	MORGAN	WOODY CAVE	198	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ARKANSAS	BOONE	SILVER VALLEY MINE	230	3	7	MAINTAIN	AGFC
ARKANSAS	BOONE	WET CAVE	237	3	7	SURVEY TO DETERMINE NEEDS	AGFC OR USFWS
GEORGIA	POLK	BEATCHS CAVE	301	3		SURVEY TO DETERMINE NEEDS	TVA

GEORGIA	POLK	WHITE RIVER CAVE	302	3		SURVEY TO DETERMINE NEEDS	TVA
KENTUCKY	GARRARD	ISONS CAVE	275	3	4	SURVEY TO DETERMINE NEEDS	KNPC
KENTUCKY	HART	BUCKNER SPRING CAVE	277	3		SURVEY TO DETERMINE NEEDS	KNPC
KENTUCKY	LEE	BOBO CAVE	297	3		SURVEY TO DETERMINE NEEDS	KNPC
KENTUCKY	LEE	WOLF HOLLOW CAVE (ARMINE BRANCH)	278	3		SURVEY TO DETERMINE NEEDS	KNPC
KENTUCKY	TAYLOR	BOONES CAVE	274	3	4	SURVEY TO DETERMINE NEEDS	KNPC
KENTUCKY	TODD	POTATO CAVE	276	3		SURVEY TO DETERMINE NEEDS	KNPC, USFWS, OR TVA
KENTUCKY	WARREN	UNKNOWN	281	3		SURVEY TO DETERMINE NEEDS	KNPC
MISSOURI	BENTON	COAL CAMP CAVE	030	3	7	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	BENTON	FLIPPIN CAVE	028	3	7	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	CRAWFORD	BAT CAVE	045	3	4	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	DALLAS	SALTPETER CAVE	052	3	5	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	FRANKLIN	BAT CAVE #3	056	3	4	PLCA, SIGN ONLY	MDC
MISSOURI	FRANKLIN	LONE HILL ONYX CAVE	058	3	7	REGATE	MDC
MISSOURI	GREENE	LOW WATER BRIDGE	061	3	2	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	JEFFERSON	PLEASANT VALLEY CAVE	065	3	2	MODIFY GATE, OR FENCE	NC
MISSOURI	LACLEDE	UNNAMED CAVE #8	075	3	2	PLCA, FENCE	USFS
MISSOURI	LAWRENCE	RUARK CAVE #3	076	3	2	PLCA	MDC
MISSOURI	MCDONALD	HENSON CAVE	078	3	4	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	OSAGE	RIVER CAVE (WELCHMEYER'S)	084	3	4	PLCA, SIGN ONLY	MDC
MISSOURI	PULASKI	BROWN CAVE #1	088	3	4	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	PULASKI	BROWN CAVE #2	128	3	7	PLCA, SIGN ONLY	MDC

MISSOURI	STONE	STILLHOUSE CAVE	106	3	4	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	TEXAS	BAT CAVE	108	3	5	SURVEY TO DETERMINE NEEDS	MDC
OKLAHOMA	ADAIR	ADAIR BAT CAVE	118	3	2	MNIN, GATE*, LOCK, RESTR TRAFF	CHCS
OKLAHOMA	ADAIR	THREE FORKS CAVE (4)	116	3	4	PLCA, SIGN ONLY	OKDWC, USFWS, OR DF
OKLAHOMA	DELAWARE	ROBERTS CAVE	120	3	7	PLCA, SIGN, GATE	OKDWC
OKLAHOMA	DELAWARE	TALBOTT CAVE	122	3	4	PLCA	USFWS
OKLAHOMA	DELAWARE	TWIN CAVE	113	3	2	FENCE OR REGATE, SIGN	OKDWC
TENNESSEE		RATTLING PIT CAVE	294	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	CAMPBELL	MEREDITH CAVE	150	3	7	PLCA, MODIFY GATE	TWRA, USFWS, OR TVA
TENNESSEE	CANNON	ESPEY CAVE	221	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	CLAIBORNE	STATION CREEK CAVE	172	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	DECATUR	BAUGUS CAVE	162	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	DECATUR	SWALLOW BLUFF CAVE	163	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	FRANKLIN	PENNINGTON CAVE	222	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	COFFEE	ARCH CAVE	175	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	HICKMAN	ONLY SALTPETER CAVE	212	3	7	SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	JACKSON	HAILE CAVE	223	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	MONTGOMERY	COLEMAN CAVE	166	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	OVERTON	ROBINSON CAVE	230	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	PERRY	BLOWING CAVE #1	231	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	PERRY	SHORT CREEK CAVE	217	3	7	SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	ROBERTSON	DRY CAVE	228	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA

TENNESSEE	SMITH	NEW PIPER CAVE	233	3	SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	SULLIVAN	MORRELL CAVE	229	3	SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	WAYNE	ICE CAVE	227	3	SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	WHITE	WARD CAVE	226	3	SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	WILSON	GALLATIN CAVE	168	3	SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR USACE

TABLE 8. PRIORITY 4 CAVES FOR GRAY BATS.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
ALABAMA	MARSHALL	CATHEDRAL CAVERNS	192	4	6	NONE	ALDCC OR USFWS
ARKANSAS	IZARD	BERGMAN CAVE	248	4	7	NONE	
FLORIDA	JACKSON	BUSH CAVE	288	4	7	NONE	
ILLINOIS	PIKE	TWIN CULVERT CAVE	112	4	7	NONE	
KENTUCKY	ADAIR	SAM THOMAS CAVE	298	4	7	NONE	
KENTUCKY	ADAIR	TODDS CAVE	265	4	7	NONE	
KENTUCKY	CALDWELL	MILL BLUFF CAVE	283	4	7	NONE	
KENTUCKY	CARTER	BAT CAVE	266	4	7	NONE	
KENTUCKY	CHRISTIAN	CAMPBELLS CAVE	271	4	4	NONE	
KENTUCKY	EDMONSON	ANDY COLLINS CRYSTAL ONYX CAVE	279	4	2	NONE	
KENTUCKY	EDMONSON	DIXON CAVE	259	4	7	NONE	
KENTUCKY	EDMONSON	MAMMOTH CAVE (HISTORIC ENTRANCE)	254	4	7	NONE	
KENTUCKY	HARDIN	BELT CAVE	256	4	7	NONE	
KENTUCKY	JESSAMINE	HERMIT CAVE	253	4	7	NONE	
KENTUCKY	MEADE	MORGANS CAVE	262	4	7	MODIFY GATE	
KENTUCKY	PULASKI	SLOANS VALLEY CAVE	280	4	7	NONE	
KENTUCKY	TAYLOR	SALTPETER CAVE	263	4	7	NONE	
MISSOURI	CAMDEN	BUNCH CAVE	032	4	4	NONE	

MISSOURI	CRAWFORD	ONONDAGA CAVE	044	4	2	NONE	DNR
MISSOURI	FRANKLIN	BAT CAVE #1	054	4	7	NONE	
MISSOURI	HENRY	KNISELY QUARRY	071	4	7	NONE	
MISSOURI	HICKORY	BAT CAVE #2	072	4	7	NONE	
MISSOURI	HICKORY	BAT CAVE #1	073	4	4	NONE	
MISSOURI	LACLEDE	DAVIS CAVE #2	068	4	7	NONE	
MISSOURI	PULASKI	BRUCE CAVE	090	4	4	NONE	
MISSOURI	SHANNON	WIND CAVE	102	4	7	NONE	
MISSOURI	ST. CLAIR	LIME KILN CAVE	103	4	7	NONE	
OKLAHOMA	CHEROKEE	ETTA CAVE	299	4	7	NONE	
TENNESSEE	BLEDSOE	PATTON CAVE	153	4	7	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	CHEATHAM	NEPTUNE SALTPETER CAVE	208	4	7	NONE	
TENNESSEE	GRAINGER	COON CAVE	142	4	7	NONE	
TENNESSEE	GREENE	CEDAR CREEK CAVE	151	4	7	NONE	
TENNESSEE	HANCOCK	ROCKHOUSE CAVE	219	4	7	NONE	
TENNESSEE	KNOX	BLOWING HOLE CAVE	136	4	7	NONE	
TENNESSEE	KNOX	MUD FLATS CAVE	235	4	7	NONE	
TENNESSEE	MOORE	JACK DANIEL CAVE	176	4	7	NONE	
TENNESSEE	SEQUATCHIE	WILMOTH CAVE	201	4	7	NONE	TWRA
TENNESSEE	SMITH	JOHN FISHER CAVE	220	4	7	NONE	
TENNESSEE	WHITE	BAKER CAVE	204	4	7	NONE	
TENNESSEE	WHITE	HASKELL SIMS CAVE	224	4	7	NONE	

TENNESSEE	WHITE	ROSE CAVE	225	4	7	NONE
VIRGINIA	LEE	GIBSON-FRAZIER CAVE	214	4	7	NONE
VIRGINIA	LEE	LITTON CAVE #1	215	4	7	NONE
VIRGINIA	LEE	MOFFELL CAVE	213	4	7	NONE
VIRGINIA	LEE	TRITT CAVE	236	4	7	NONE
VIRGINIA	SCOTT	GRIGSBY CAVE	182	4	5	NONE

TABLE 9. GRAY BAT CAVES IN ALABAMA.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
ALABAMA	COLBERT	GEORGETOWN CAVE	155	1	2	MODIFY FENCE	NPS
ALABAMA	CONECUH	SANDERS CAVE (TURK)	296	1	4	PLCA, 1/2 GATE	USFWS
ALABAMA	JACKSON	FERN CAVE	170	1	1	PLCA, SIGN ONLY	USFWS
ALABAMA	JACKSON	SAUTA CAVE	134	1	2	REGULAR PATROL, MAINTENANCE	USFWS
ALABAMA	LAUDERDALE	KEY CAVE	149	1	2	FENCE	TWRA OR TVA
ALABAMA	MARSHALL	HAMBRICK CAVE	191	1	2	FENCE*, SIGN*	ALDOC OR TVA
ALABAMA	MORGAN	CAVE SPRINGS CAVE	148	1	2	FENCE*, SIGN*	USFWS
ALABAMA	COLBERT	BAKER CAVE	156	2	4	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	DEKALB	LYKES CAVE	185	2	1	PLCA, FENCE	ALDOC, USFWS, OR TVA
ALABAMA	DEKALB	PORTERSVILLE BAT CAVE	152	2	5	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	JACKSON	GROSS SKELETON CAVE	193	2	3	SIGN ONLY	ALDOC OR TVA
ALABAMA	JACKSON	NITRE CAVE	147	2	5	PLCA, SIGN	ALDOC, USFWS, OR TVA
ALABAMA	LAUDERDALE	BLOWING SPRINGS CAVE	157	2	5	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	LIMESTONE	INDIAN CAVE	173	2	4	FENCE*, SIGN	ALDOC OR TVA
ALABAMA	MADISON	SHELTA CAVE	177	2	2	REPLACE GATE WITH FENCE, SIGNS	NSS
ALABAMA	MARSHALL	DURHAM CAVE	190	2	5	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	GUNTERSVILLE CAVERNS	210	2	4	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	KING'S SCHOOL CAVE	159	2	5	STOP CONTAMINATION SOURCE	ALDOC

ALABAMA	MARSHALL	OLD PLOWING CAVE	188	2	5	PLCA, SIGN ONLY	ALDOC, USFWS, OR TVA
ALABAMA	SHELBY	ANDERSON CAVE	293	2	5	PLCA, SIGN ONLY	ALDOC OR USFWS
ALABAMA	COLBERT	MCKINNEY CAVE #2	199	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	DEKALB	STANLEY CARDEN CAVE	218	3	7	SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	JACKSON	HORSESKULL CAVE	195	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	JACKSON	LITTLE NAT CAVE	171	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	JACKSON	ORCESTWELLS CAVE	194	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	LAUDERDALE	BAT CAVE	167	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	LAUDERDALE	COLLIER CAVE	200	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MADISON	HERING CAVE (CAVE SPRING)	186	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	BISHOP CAVE	189	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	HONEYCOMB CAVE	187	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	KINGS SPRING CAVE	196	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	LEDBETTER CAVE	179	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MORGAN	HUGHES CAVE	164	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MORGAN	TALUCAH CAVE	197	3		PLCA	ALDOC, USFWS, OR TVA
ALABAMA	MORGAN	WOODY CAVE	198	3		SURVEY TO DETERMINE NEEDS	ALDOC, USFWS, OR TVA
ALABAMA	MARSHALL	CATHEDRAL CAVERNS	192	4	6	NONE	ALDOC OR USFWS

TABLE 10. GRAY BAT CAVES IN ARKANSAS.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
ARKANSAS	BAXTER	BONANZA CAVE	007	1	1	MODIFY GATE*	USFS
ARKANSAS	BENTON	LOGAN CAVE	016	1	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	INDEPENDEN	BONE CAVE	009	1	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	BAXTER	OLD JOE CAVE (BAT)	004	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	BENTON	CAVE SPRINGS CAVE	010	2	2	PLCA, SIGN ONLY	AGFC OR USFWS
ARKANSAS	BENTON	CRYSTAL CAVE	011	2	2	FENCE*, SIGN	AGFC OR USFWS
ARKANSAS	BENTON	PIGEON ROOST CAVE	019	2	2	FENCE, PREVENT FLOODING	USACE
ARKANSAS	BENTON	WAR EAGLE CAVERNS	021	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	BOONE	BREWER CAVE	246	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	CARROLL	BENNETT CAVE	247	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	INDEPENDEN	HANKINS CAVE	244	2	7	PLCA, FULL GATE	AGFC OR USFWS
ARKANSAS	MADISON	HORSETHIEF CAVE (FENNEY)	014	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	NEWTON	CAVE MOUNTAIN CAVE (BAT, BOXLEY)	003	2	7	PURCHASE*, FENCE	NPS
ARKANSAS	NEWTON	DIAMOND CAVE	012	2	2	PLCA	AGFC OR USFWS
ARKANSAS	NEWTON	JOHN EDDINGS CAVE	015	2	2	FENCE	NPS
ARKANSAS	NEWTON	LITTLE BEAR CAVE	241	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	SEARCY	CRANE CAVE	245	2	2	FENCE	NPS
ARKANSAS	SEARCY	FALLOUT CAVE	013	2	2	FENCE	NPS

ARKANSAS	SEARCY	PETER CAVE	018	2	2	FENCE	NPS
ARKANSAS	SHARP	BLAGG CAVE (CENTER)	005	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	SHARP	OZARK ACRES CAVE	240	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	STONE	BALD SCRAPPY CAVE (ALLISON)	002	2	2	1/2 GATE	USFS
ARKANSAS	STONE	BLANCHARD SPRINGS CAVERNS	006	2	3	FULL FENCE, GATE, AVOID DISTUR	USFS
ARKANSAS	STONE	CAVE RIVER CAVE	008	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	STONE	HELL CREEK CAVE	243	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	STONE	JOE BRIGHT CAVE	242	2	2	PLCA, 1/2 GATE	AGFC OR USFWS
ARKANSAS	STONE	OPTIMUS CAVE	017	2	2	1/2 GATE	USFS
ARKANSAS	STONE	RORY CAVE (MITCHELL)	020	2	7	PLCA	AGFC OR USFWS
ARKANSAS	STONE	ROWLAND CAVE	239	2	7	FULL GATE	USFS
ARKANSAS	BOONE	SILVER VALLEY MINE	238	3	7	MAINTAIN	AGFC
ARKANSAS	BOONE	WET CAVE	237	3	7	SURVEY TO DETERMINE NEEDS	AGFC OR USFWS
ARKANSAS	IZARD	BERGMAN CAVE	248	4	7	NONE	

TABLE 11. GRAY BAT CAVES IN FLORIDA.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
FLORIDA	JACKSON	GEROMES CAVE	284	1	2	PLCA, SIGN ONLY	PIN
FLORIDA	JACKSON	GIRARDS CAVE	287	1	2	PLCA, FENCE	USFWS
FLORIDA	JACKSON	JUDGES CAVE	286	1	2	PLCA, FENCE	USFWS
FLORIDA	JACKSON	OLD INDIAN CAVE	285	1	3	FENCE, REMOVE GATES	FL
FLORIDA	JACKSON	FEARS CAVE	289	2	5	PLCA, SIGN ONLY	FL
FLORIDA	JACKSON	RIVER CAVE	292	2	7	SIGNS ONLY	FL
FLORIDA	JACKSON	SNEADS BAT CAVE	291	2	7	PLCA, SIGN ONLY	FL
FLORIDA	JACKSON	BUSH CAVE	288	4	7	NONE	

TABLE 12. GRAY BAT CAVES IN GEORGIA.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
GEORGIA	POLK	BEATCHS CAVE	301	3		SURVEY TO DETERMINE NEEDS	TVA
GEORGIA	POLK	WHITE RIVER CAVE	302	3		SURVEY TO DETERMINE NEEDS	TVA

TABLE 13. GRAY BAT CAVES IN ILLINOIS.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
ILLINOIS	HARDIN	CAVE SPRING CAVE	111	1	4	PLCA, GATE	IL OR USFS
ILLINOIS	PIKE	TWIN CULVERT CAVE	112	4	7	NONE	

TABLE 14. GRAY BAT CAVES IN KANSAS.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
KANSAS	CRAWFORD	STORM SEWER	300	2	2	NONE	PITTSBURG

TABLE 15. GRAY BAT CAVES IN KENTUCKY.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
KENTUCKY	ALLEN	HOLLAND CAVE	260	1	2	PLCA, GATE, SIGNS	KNPC, USFWS, OR TVA
KENTUCKY	EDMONSON	JESSE JAMES CAVE	209	1	1	PLCA, MODIFY GATE	USFWS
KENTUCKY	JESSAMINE	CHRISMANS CAVE	269	1	2	PLCA, GATE, SIGNS	KNPC OR USFWS
KENTUCKY	JESSAMINE	OVERSTREET CAVE	270	1	2	PLCA, GATE, SIGN	KNPC OR USFWS
KENTUCKY	TRIGG	COOL SPRINGS CAVE	252	1	2	PLCA, GATE, SIGNS	KNPC, USFWS, OR TVA
KENTUCKY	ADAIR	JONES CAVE	261	2	2	PLCA	KNPC OR USFWS
KENTUCKY	ALLEN	UNKNOWN	282	2	2	PLCA	KNPC, USFWS, OR TVA
KENTUCKY	BARREN	TEMPLE HILL SALTPETER CAVE	257	2	2	OWNER COOPERATION	KNPC OR USFWS
KENTUCKY	CLINTON	CANEY BRANCH CAVE	273	2	2	PLCA, GATE	KNPC
KENTUCKY	EDMONSON	COACH CAVE (HUNDRED DOME)	211	2	7	PLCA, MODIFY GATES	USFWS
KENTUCKY	EDMONSON	LONG CAVE	258	2	2	MODIFY GATE	NPS
KENTUCKY	HART	RYDERS MILL CAVE	267	2	2	GATE, SIGNS	KNPC OR USFWS
KENTUCKY	JESSAMINE	DANIEL BOONE'S CAVE	268	2	2	PLCA, MODIFY GATE	KNPC OR USFWS
KENTUCKY	NELSON	BURGESS CAVE	255	2	2	PLCA, GATE, SIGN	KNPC OR USFWS
KENTUCKY	PULASKI	BLOWING CAVE	264	2	2	PLCA, GATE, SIGNS	KNPC
KENTUCKY	TRIGG	BIG SULFUR SPRINGS CAVE (PEE DEE	272	2	2	SIGN	KNPC, USFWS, OR TVA
KENTUCKY	GARRARD	ISONS CAVE	275	3	4	SURVEY TO DETERMINE NEEDS	KNPC
KENTUCKY	HART	BUCKNER SPRING CAVE	277	3		SURVEY TO DETERMINE NEEDS	KNPC

ARKANSAS	STONE	ROWLAND CAVE	239	2	7	FULL GATE	USFS
FLORIDA	JACKSON	FEARS CAVE	289	2	5	PLCA, SIGN ONLY	FL
FLORIDA	JACKSON	RIVER CAVE	292	2	7	SIGNS ONLY	FL
FLORIDA	JACKSON	SNEADS BAT CAVE	291	2	7	PLCA, SIGN ONLY	FL
KANSAS	CRAWFORD	STORM SEWER	300	2	2	NONE	PITTSBURG
KENTUCKY	ADAIR	JONES CAVE	261	2	2	PLCA	KNPC OR USFWS
KENTUCKY	ALLEN	UNKNOWN	282	2	2	PLCA	KNPC, USFWS, OR TVA
KENTUCKY	BARREN	TEMPLE HILL SALTPETER CAVE	257	2	2	OWNER COOPERATION	KNPC OR USFWS
KENTUCKY	CLINTON	CANEY BRANCH CAVE	273	2	2	PLCA, GATE	KNPC
KENTUCKY	EDMONSON	COACH CAVE (HUNDRED DOME)	211	2	7	PLCA, MODIFY GATES	USFWS
KENTUCKY	EDMONSON	LONG CAVE	258	2	2	MODIFY GATE	NPS
KENTUCKY	HART	RYDERS MILL CAVE	267	2	2	GATE, SIGNS	KNPC OR USFWS
KENTUCKY	JESSAMINE	DANIEL BOONE'S CAVE	268	2	2	PLCA, MODIFY GATE	KNPC OR USFWS
KENTUCKY	NELSON	BURGESS CAVE	255	2	2	PLCA, GATE, SIGN	KNPC OR USFWS
KENTUCKY	PULASKI	BLOWING CAVE	264	2	2	PLCA, GATE, SIGNS	KNPC
KENTUCKY	TRIGG	BIG SULFUR SPRINGS CAVE (PEE DEE	272	2	2	SIGN	KNPC, USFWS, OR TVA
MISSOURI	BENTON	ESTES CAVE	031	2	4	PLCA, SIGN ONLY	MDC
MISSOURI	BOONE	BOONE CAVE	029	2	4	PLCA, SIGN ONLY	MDC
MISSOURI	BOONE	DEVIL'S ICEBOX CAVE	027	2	4	SIGN ONLY	DNR
MISSOURI	BOONE	HOLTON CAVE	025	2	4	PLCA, SIGN ONLY	OWNERS

TABLE 16. GRAY BAT CAVES IN MISSOURI.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
MISSOURI	CAMDEN	MAUSS CAVE	038	1	2	PLCA, SIGN ONLY*	MDC
MISSOURI	CAMDEN	MOLES CAVE	022	1	2	BLOCK ROAD, FENCE, SIGN*	MDC
MISSOURI	DENT	BAT CAVE	053	1	2	PLCA, GATE	MDC
MISSOURI	FRANKLIN	ROARING SPRINGS CAVE	059	1	2	LEASE*, SIGN*	MDC
MISSOURI	HICKORY	BECK CAVE	062	1	2	FENCE*, SIGN*, LEVEE*	USACE
MISSOURI	LACLEDE	COFFIN CAVE	067	1	1	FENCE*, SIGN*	MDC
MISSOURI	PULASKI	INCA CAVE	092	1	2	FENCE*, SIGN*	MDC
MISSOURI	SHANNON	CHIMNEY CAVE	099	1	1	ROAD BLOCK, SIGN	NPS
MISSOURI	STONE	MARVEL CAVE	104	1	1	MAINTAIN, SIGN ONLY*	MDC AND SDC
MISSOURI	STONE	SALTPETER CAVE	105	1	2	PLCA, FENCE	USFS
MISSOURI	TANEY	TUMBLING CREEK CAVE	107	1	2	GATE*	OUL
MISSOURI	BENTON	ESTES CAVE	031	2	4	PLCA, SIGN ONLY	MDC
MISSOURI	BOONE	BOONE CAVE	029	2	4	PLCA, SIGN ONLY	MDC
MISSOURI	BOONE	DEVIL'S ICEBOX CAVE	027	2	4	SIGN ONLY	DNR
MISSOURI	BOONE	HOLTON CAVE	025	2	4	PLCA, SIGN ONLY	OWNERS
MISSOURI	BOONE	HUNTERS CAVE	026	2	5	PLCA, GATE	MDC OR DNR
MISSOURI	BOONE	LEWIS AND CLARK CAVE	024	2	2	PLCA, FENCE, EXPIL GATE	USFWS
MISSOURI	CAMDEN	ADKINS CAVE	023	2	2,3	PLCA, GATE	MDC

MISSOURI	CAMDEN	CARROLL CAVE	033	2	4	PLCA, MODIFY GATE	MDC
MISSOURI	CAMDEN	FIERY FORKS CAVE	034	2	7	NONE	
MISSOURI	CAMDEN	GRANDPA CHIPPLLY'S CAVE	036	2	2	PLCA, GATE	DNR
MISSOURI	CAMDEN	HANNAH CAVE	035	2	7	PLCA, SIGN ONLY	MDC
MISSOURI	CAMDEN	LOWER BURNT MILL CAVE	037	2	2	PLCA, FENCE	MDC
MISSOURI	CAMDEN	PRAIRIE HOLLOW CAVE	039	2	5	PLCA, SIGN ONLY	MDC
MISSOURI	CAMDEN	RIVER CAVE - HA HA TONKA	040	2	2	GATE,SIGN*	DNR
MISSOURI	CARTER	COAL BANK CAVE	041	2	4	BLOCK ACCESS ROAD,SIGN*	OWNER
MISSOURI	CHRISTIAN	RANTZ CAVE	042	2	2	PLCA, SIGN ONLY	MDC
MISSOURI	COLE	UNNAMED CAVE #2	043	2	2	PLCA, FENCE	MDC
MISSOURI	CRAWFORD	ONYX CAVE	046	2	7	MAINTAIN,GATE*,SIGN*	USACE
MISSOURI	CRAWFORD	SALOON CAVE	001	2	4	1/2 GATE, SIGN*	USACE
MISSOURI	CRAWFORD	TWENTY-THREE DEGREE CAVE	047	2	5	PLCA, FENCE	USFS
MISSOURI	DADE	MAZE CAVE	048	2	2	PLCA, FENCE	MDC
MISSOURI	DALLAS	CAT HOLLOW CAVE	049	2	3	PLCA, GATE	MDC OR DNR
MISSOURI	DALLAS	HILDERBRAND CAVE	050	2	2	PLCA, GATE	MDC
MISSOURI	DALLAS	MCKEE CAVE	051	2	3	PLCA, GATE	MDC
MISSOURI	FRANKLIN	BAT CAVE #2	055	2	4	PLCA, FENCE	MDC
MISSOURI	FRANKLIN	FISHER CAVE	057	2	2	MAINTAIN, IMPROVE GATE	DNR
MISSOURI	FRANKLIN	TWIN SPRINGS CAVE	060	2	7	SIGN ONLY	MDC
MISSOURI	HICKORY	BLACKWELL CAVE	063	2	2	MAINTAIN, 1/2 GATE*	USACE
MISSOURI	JASPER	COOLBROOK CAVE	064	2	4	PLCA, GATE	MDC OR NC

MISSOURI	SHANNON	ROUND SPRING CAVE	101	2	2	NO VISITORS, CHANGE GATE	NPS
MISSOURI	WASHINGTON	GREAT SCOTT CAVE	109	2	7	MAINTAIN,GATE*,SIGN*	MDC
MISSOURI	WRIGHT	SMITTLE CAVE	110	2	2	PLCA, GATE	USFWS
MISSOURI	BENTON	COAL CAMP CAVE	030	3	7	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	BENTON	FLIPPIN CAVE	028	3	7	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	CRAWFORD	BAT CAVE	045	3	4	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	DALLAS	SALTPETER CAVE	052	3	5	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	FRANKLIN	BAT CAVE #3	056	3	4	PLCA, SIGN ONLY	MDC
MISSOURI	FRANKLIN	LONE HILL ONYX CAVE	058	3	7	REGATE	MDC
MISSOURI	GREENE	LOW WATER BRIDGE	061	3	2	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	JEFFERSON	PLEASANT VALLEY CAVE	065	3	2	MODIFY GATE, OR FENCE	NC
MISSOURI	LACLEDE	UNNAMED CAVE #8	075	3	2	PLCA, FENCE	USFS
MISSOURI	LAWRENCE	RUARK CAVE #3	076	3	2	PLCA	MDC
MISSOURI	MCDONALD	HENSON CAVE	078	3	4	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	OSAGE	RIVER CAVE (WELCHMEYER'S)	084	3	4	PLCA, SIGN ONLY	MDC
MISSOURI	PULASKI	BROWN CAVE #1	088	3	4	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	PULASKI	BROWN CAVE #2	128	3	7	PLCA, SIGN ONLY	MDC
MISSOURI	STONE	STILLHOUSE CAVE	106	3	4	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	TEXAS	BAT CAVE	108	3	5	SURVEY TO DETERMINE NEEDS	MDC
MISSOURI	CAMDEN	BUNCH CAVE	032	4	4	NONE	
MISSOURI	CRAWFORD	ONONDAGA CAVE	044	4	2	NONE	DNR
MISSOURI	FRANKLIN	BAT CAVE #1	054	4	7	NONE	

MISSOURI	LACLEDE	BAT CAVE	066	2	2	PLCA, GATE, BLOCK ROAD	MDC OR USFWS
MISSOURI	LACLEDE	MARY LAWSON CAVE	069	2	2	PLCA, GATE	MDC
MISSOURI	LACLEDE	MAYFIELD CAVE	070	2	2	GATE	USFS
MISSOURI	LACLEDE	SHAMEL CAVE (DREW)	074	2	2	PLCA, SIGN ONLY	MDC
MISSOURI	MARIES	INDIAN FORD CAVE	077	2	4	PLCA	MDC
MISSOURI	MILLER	BAT CAVE #1	079	2	2	SIGN*	MDC
MISSOURI	MILLER	MCDOWELL CAVE	080	2	5	PLCA, FENCE	DNR
MISSOURI	MORGAN	DRY BRANCH CAVE	081	2	5	PLCA, GATE	DNR
MISSOURI	OREGON	BAT CAVE	082	2	2	PLCA, GATE	USFS
MISSOURI	OREGON	BIG MOUTH CAVE	083	2	5	PLCA, SIGN ONLY	USFS
MISSOURI	OZARK	BAT CAVE	085	2	2	MAINTAIN,GATE*,SIGN*	USFS
MISSOURI	PIKE	FRANKFORD CAVE	096	2	4	PLCA, GATE	MDC
MISSOURI	PULASKI	BAT CAVE #1	086	2	2	PLCA, GATE	MDC OR USFS
MISSOURI	PULASKI	BAT CAVE #2	087	2	2	PLCA, SIGN ONLY	MDC
MISSOURI	PULASKI	FREEMAN CAVE	089	2	7	RESTRICT ACCESS (CLOSE ROAD)	U.S. ARMY
MISSOURI	PULASKI	PIQUET CAVE	093	2	2	PLCA, GATE	MDC
MISSOURI	PULASKI	TUNNEL CAVE	094	2	2	PLCA, GATE	MDC
MISSOURI	PULASKI	WINDY CAVE	091	2	7	PLCA, SIGN ONLY	MDC
MISSOURI	RALLS	FISHER CAVE	095	2	4	PLCA, SIGN ONLY	MDC
MISSOURI	REYNOLDS	COOKS CAVE	097	2	2	PLCA, FENCE	USFS
MISSOURI	SHANNON	BAT CAVE	098	2	4,6	PLCA, GATE	NPS
MISSOURI	SHANNON	MARTIN CAVE ENTRANCE #2	100	2	4	PLCA, FENCE	NPS

MISSOURI	HENRY	KNISELY QUARRY	071	4	7	NONE
MISSOURI	HICKORY	BAT CAVE #1	073	4	4	NONE
MISSOURI	HICKORY	BAT CAVE #2	072	4	7	NONE
MISSOURI	LACLEDE	DAVIS CAVE #2	068	4	7	NONE
MISSOURI	PULASKI	BRUCE CAVE	090	4	4	NONE
MISSOURI	SHANNON	WIND CAVE	102	4	7	NONE
MISSOURI	ST. CLAIR	LIME KILN CAVE	103	4	7	NONE

TABLE 17. GRAY BAT CAVES IN OKLAHOMA.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
OKLAHOMA	DELAWARE	STANSBERRY'S CAVE	121	1	2	PLCA, SIGN, GATED*	OWNERS
OKLAHOMA	ADAIR	CHARLEY OWL CAVE	114	2	2	GATE	NC
OKLAHOMA	DELAWARE	LINDA BEAR PAW CAVE	117	2	4	PLCA, SIGN ONLY	DR
OKLAHOMA	DELAWARE	SPAVINAW BAT CAVE	115	2	2	SIGNS, RESTRICT RESEARCH	USFWS
OKLAHOMA	ADAIR	ADAIR BAT CAVE	118	3	2	MNTN, GATE*, LOCK, RESTR TRAFF	CHCS
OKLAHOMA	ADAIR	THREE FORKS CAVE (4)	116	3	4	PLCA, SIGN ONLY	OKDWC, USFWS, OR DR
OKLAHOMA	DELAWARE	ROBERTS CAVE	120	3	7	PLCA, SIGN, GATE	OKDWC
OKLAHOMA	DELAWARE	TALBORT CAVE	122	3	4	PLCA	USFWS
OKLAHOMA	DELAWARE	TWIN CAVE	113	3	2	FENCE OR REGATE, SIGN	OKDWC
OKLAHOMA	CHEROKEE	ETTA CAVE	299	4	7	NONE	

TABLE 16. GRAY BAT CAVES IN TENNESSEE.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
TENNESSEE	CLAIBORNE	WHITE BUIS CAVE	140	1	2	PLCA, SIGN ONLY	TWRA
TENNESSEE	DEKALB	CRIPPS MILL CAVE	154	1	2	PLCA, SIGN ONLY	TWRA
TENNESSEE	GRAINGER	INDIAN CAVE	141	1	2	PLCA, 1/2 GATE	TWRA OR USFWS
TENNESSEE	HAWKINS	PEARSON CAVE	130	1	1,3	PLCA, SIGN ONLY	TWRA OR USFWS
TENNESSEE	MARION	NICKAJACK CAVE	133	1	1,2	FENCE*, SIGN*	TWRA OR TVA
TENNESSEE	MONTGOMERY	BELLAMY CAVE	145	1	4	COOP AGREE*, SIGN*, FENCE*	TWRA
TENNESSEE	STEWART	TOBACCOPORT SALTPETER CAVE	158	1	1,5	PLCA, FENCE, SIGN	TWRA
TENNESSEE	UNION	OAKS CAVE	129	1	2	SIGN ONLY	TWRA
TENNESSEE	WARREN	HUBBARDS CAVE	169	1	1	PLCA, 1/2 GATE	USFWS
TENNESSEE	BEDFORD	SHIPMAN CREEK CAVE	165	2	7	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	CAMPBELL	NORRIS DAM CAVE	137	2	2	FENCE*, SIGN*	TWRA OR TVA
TENNESSEE	CLAY	MARKHAM CAVE	174	2	5	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	DECATUR	FEATHERFOOT CAVE	160	2	7	FENCE	TWRA OR TVA
TENNESSEE	DEKALB	GIN BLUFF CAVE	205	2	5	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	FRANKLIN	CANEY HOLLOW CAVE	143	2	4	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	FRANKLIN	WOOD'S DAM	234	2	4	COOP AGREE*	TWRA, USFWS, OR TVA
TENNESSEE	GRUNDY	TRUSSELL CAVE	132	2	4	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	HAWKINS	HORNER CAVE	183	2	7	PLCA	TWRA, USFWS, OR TVA

TENNESSEE	HICKMAN	BAT CAVE	144	2	4	COOP AGREE*, SIGN ONLY*	TWRA, USFWS, OR TVA
TENNESSEE	JACKSON	DUD'S CAVE	206	2	5	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	KNOX	BALONEY CAVE	135	2	7	PLCA, FENCE, SIGN	TWRA, USFWS, OR TVA
TENNESSEE	LINCOLN	BAT CAVE	178	2	4	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	MAURY	BENDERMAN CAVE	203	2	5	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	MEIGS	BLYTHE FERRY CAVE	139	2	5	FENCE, SIGN	TWRA AND TVA
TENNESSEE	MEIGS	EVES CAVE	181	2	5	SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	MEIGS	SENSABAUGH CAVE	180	2	5	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	PERRY	ALEXANDER CAVE	161	2	4	PLCA, 1/2 GATE	TWRA, USFWS, OR TVA
TENNESSEE	PUTNAM	AMENT CAVE	146	2	5	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	RHEA	GRASSY CREEK CAVE	131	2	2	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	RHEA	HARRIS CAVE	138	2	2	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	RUTHERFORD	HERRING CAVE	202	2	5	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	SMITH	BRIDGEWATER CAVE	207	2	5	PLCA	TWRA, USFWS, OR TVA
TENNESSEE	SMITH	PIPER CAVE	184	2	4	PLCA, FENCE	TWRA, USFWS, OR TVA
TENNESSEE	UNION	LOST CREEK CAVE	232	2		FENCE	TWRA, USFWS, OR TVA
TENNESSEE		RATTLING PIT CAVE	294	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	CAMPBELL	MEREDITH CAVE	150	3	7	PLCA, MODIFY GATE	TWRA, USFWS, OR TVA
TENNESSEE	CANNON	ESTEY CAVE	221	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	CLAIBORNE	STATION CREEK CAVE	172	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	DECATUR	BAUGUS CAVE	162	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	DECATUR	SWALLOW BLUFF CAVE	163	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA

TENNESSEE	FRANKLIN	PENNINGTON CAVE	222	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	GREENE	ARCH CAVE	175	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	HICKMAN	ONLY SALTPETER CAVE	212	3	7	SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	JACKSON	HAILE CAVE	223	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	MONTGOMERY	COLEMAN CAVE	166	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	OVERTON	ROBINSON CAVE	230	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	PERRY	BLOWING CAVE #1	231	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	PERRY	SHORT CREEK CAVE	217	3	7	SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	ROBERTSON	DRY CAVE	228	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	SMITH	NEW PIPER CAVE	233	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	SULLIVAN	MORRELL CAVE	229	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	WAYNE	ICE CAVE	227	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	WHITE	WARD CAVE	226	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR TVA
TENNESSEE	WILSON	GALLATIN CAVE	168	3		SURVEY TO DETERMINE NEEDS	TWRA, USFWS, OR USACE
TENNESSEE	BLEDSOE	PATTON CAVE	153	4	7	PLCA, SIGN ONLY	TWRA, USFWS, OR TVA
TENNESSEE	CHEATHAM	NEPTUNE SALTPETER CAVE	208	4	7	NONE	
TENNESSEE	GRAINGER	COON CAVE	142	4	7	NONE	
TENNESSEE	GREENE	CEDAR CREEK CAVE	151	4	7	NONE	
TENNESSEE	HANCOCK	ROCKHOUSE CAVE	219	4	7	NONE	
TENNESSEE	KNOX	BLOWING HOLE CAVE	136	4	7	NONE	
TENNESSEE	KNOX	MUD FLATS CAVE	235	4	7	NONE	
TENNESSEE	MOORE	JACK DANIEL CAVE	176	4	7	NONE	

TENNESSEE	SEQUATCHIE	WILMOTH CAVE	201	4	7	NONE	TWRA
TENNESSEE	SMITH	JOHN FISHER CAVE	220	4	7	NONE	
TENNESSEE	WHITE	BAKER CAVE	204	4	7	NONE	
TENNESSEE	WHITE	HASKELL SIMS CAVE	224	4	7	NONE	
TENNESSEE	WHITE	ROSE CAVE	225	4	7	NONE	

TABLE 19. GRAY BAT CAVES IN VIRGINIA.

STATE	COUNTY	CAVE NAME	INDEX	PRTY	SIG	PROTECTION NEEDS	REC MGMT AGENCY
VIRGINIA	SCOTT	CLINCHPORT CAVE	295	2	7	PLCA, SIGN ONLY	VAGF, USFWS, OR TVA
VIRGINIA	LEE	GIBSON-FRAZIER CAVE	214	4	7	NONE	
VIRGINIA	LEE	LITTON CAVE #1	215	4	7	NONE	
VIRGINIA	LEE	MORRELL CAVE	213	4	7	NONE	
VIRGINIA	LEE	TRITT CAVE	236	4	7	NONE	
VIRGINIA	SCOTT	GRIGSBY CAVE	182	4	5	NONE	

APPENDIX VII

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