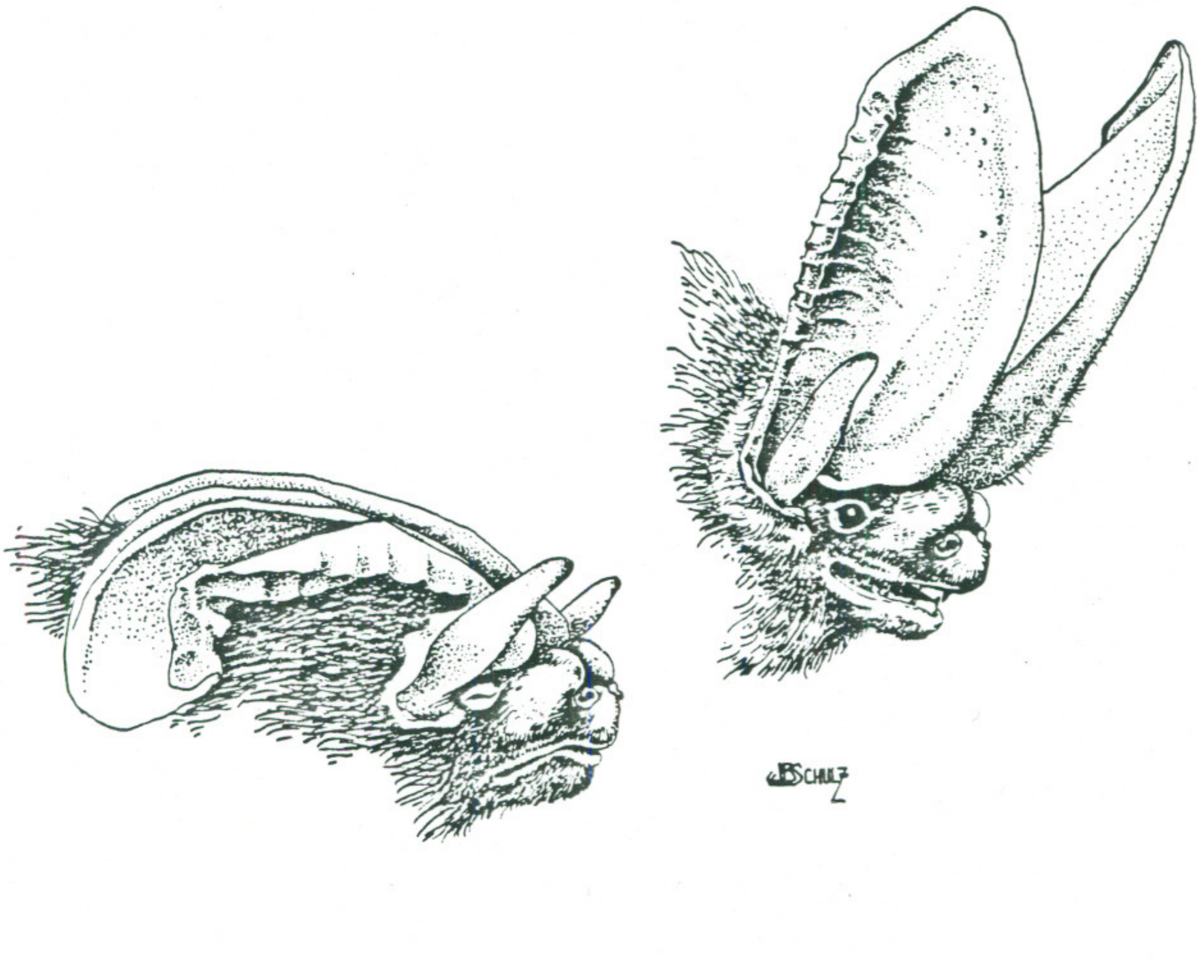
RECOVERY PLAN

OZARK BIG-EARED BAT AND

VIRGINIA BIG-EARED BAT



A RECOVERY PLAN FOR THE OZARK BIG-EARED BAT AND THE VIRGINIA BIG-EARED BAT

Prepared by

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For the

U. S. Fish and Wildlife Service

Region III, Twin Cities, MN

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Date: MAY 8 - 1984

ACKNOWLEDGMENTS

Much of the material contained in Part I has been taken verbatim from the work of John Hall, Michael Harvey, Stephen Humphrey, Tom Kunz, Robert Martin, and Oliver Pearson. Other persons who have contributed data or assisted in some manner include: Dick Biggins, John Brady, Martha Carlisle, Rick Clawson, Robert Currie, Dave Derowitsch, Everette Grigsby, Tom Kunz, Dave Langowski, John MacGregor, Andy Moser, Nora Murdock, Ginny Tipton, Merlin Tuttle, and Leonard Walker. These people have made this recovery plan possible and their assistance is gratefully acknowledged. Special thanks to Judy Jacobs for contributing many ideas and assisting in the preparation of the plan.

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PART I: INTRODUCTION

Background

On November 30, 1979, the Fish and Wildlife Service published in the Federal Register a final rulemaking indicating its determination that the Ozark big-eared bat (*Plecotus townsendii ingens* (Handley)) and the Virginia big-eared bat (*Plecotus townsendii virginianus* (Handley)) are endangered species under the Endangered Species Act of 1973, as amended. They are considered endangered due to their small population size, limited distribution and vulnerability to human disturbance. This vulnerability is due to their habit of concentrating large segments of the total population in a small number of caves to form maternity colonies in the spring and summer, and hibernating colonies in the winter. Due to growing interest in cave-related research and sport spelunking, this disturbance has increased in recent years. The vulnerability of big-eared bats is increased further by their exotic appearance which makes them targets of collection and intensive observation and their apparent lower tolerance to disturbance than most bats.

The Ozark big-eared bat and the Virginia big-eared bat are subspecies of Townsend's big-eared bat (*Plecotus townsendii*). The Ozark big-eared bat has colony sites in extreme eastern Oklahoma in Adair County (Grigsby and Puckette, 1982), and in northwestern and northcentral Arkansas in Washington and Marion Counties (Harvey *et al.*, 1981, Figure 1). This subspecies has been reported

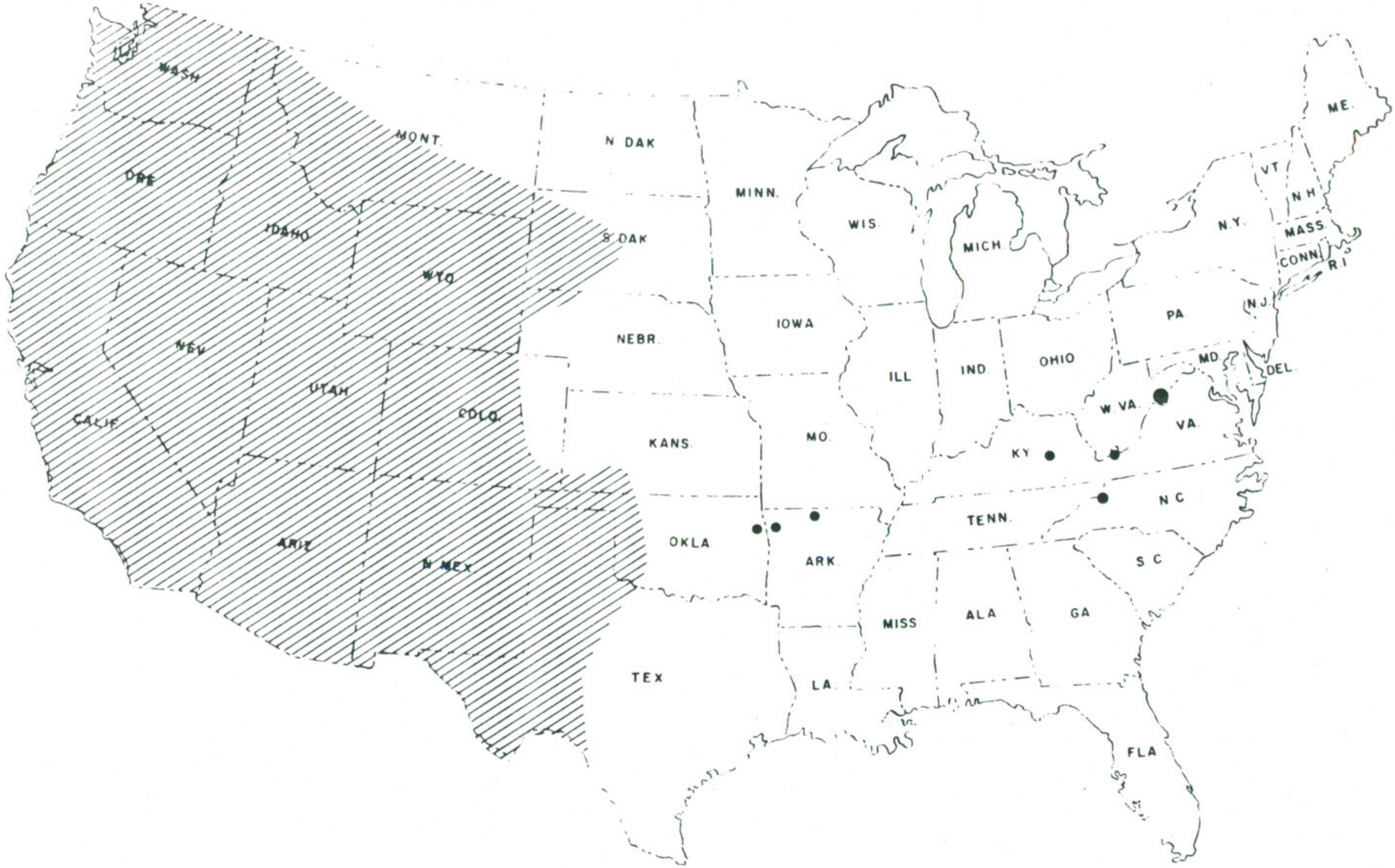

Figure 1. Distribution of Townsend's big-eared bat in the United States. Dots indicate location of endangered subspecies. Shading indicates distribution of non-endangered subspecies.

previously from southwestern Missouri; however, no active colony sites are currently known to occur there (Rick Clawson, Missouri Department of Conservation, personal communication). The Virginia big-eared bat has colony sites in Lee County, Kentucky (John MacGregor, Kentucky Department of Fish and Wildlife Resources, personal communication), Avery County, North Carolina, (Robert Currie, U.S. Fish and Wildlife Service, personal communication), Tazewell County, Virginia, (Virginia Tipton, Radford University, personal communication) and Pendleton, Grant, and Tucker Counties, West Virginia (John Hall, Albright College, personal communication).

The non-endangered subspecies of Townsend's big-eared bat include *P. t. townsendii*, *P. t. pallescens* and *P. t. australis*. These are found along the west coast and throughout much of western North America from British Columbia, Idaho, southern Montana and the Black Hills of South Dakota, south across western Texas through Mexico to Oaxaca and east to the edge of the Edwards Plateau. Isolated populations also occur in the gypsum cave region of Kansas, northern Oklahoma and Texas (Barbour and Davis, 1969).

Description

Townsend's big-eared bat (Figure 2) is a medium sized bat with large ears (more than 2.5 centimeters long) connected across the forehead, mitten-shaped glandular masses on the muzzle, and elongated nostril openings (Handley *et al*., 1978). The adults weigh from 5 to 13 grams (Handley, 1959). Townsend's big-eared bat closely resembles the eastern big-eared bat, *Plecotus rafinesquii*. They can be distinguished most easily by hair color. Townsend's big-

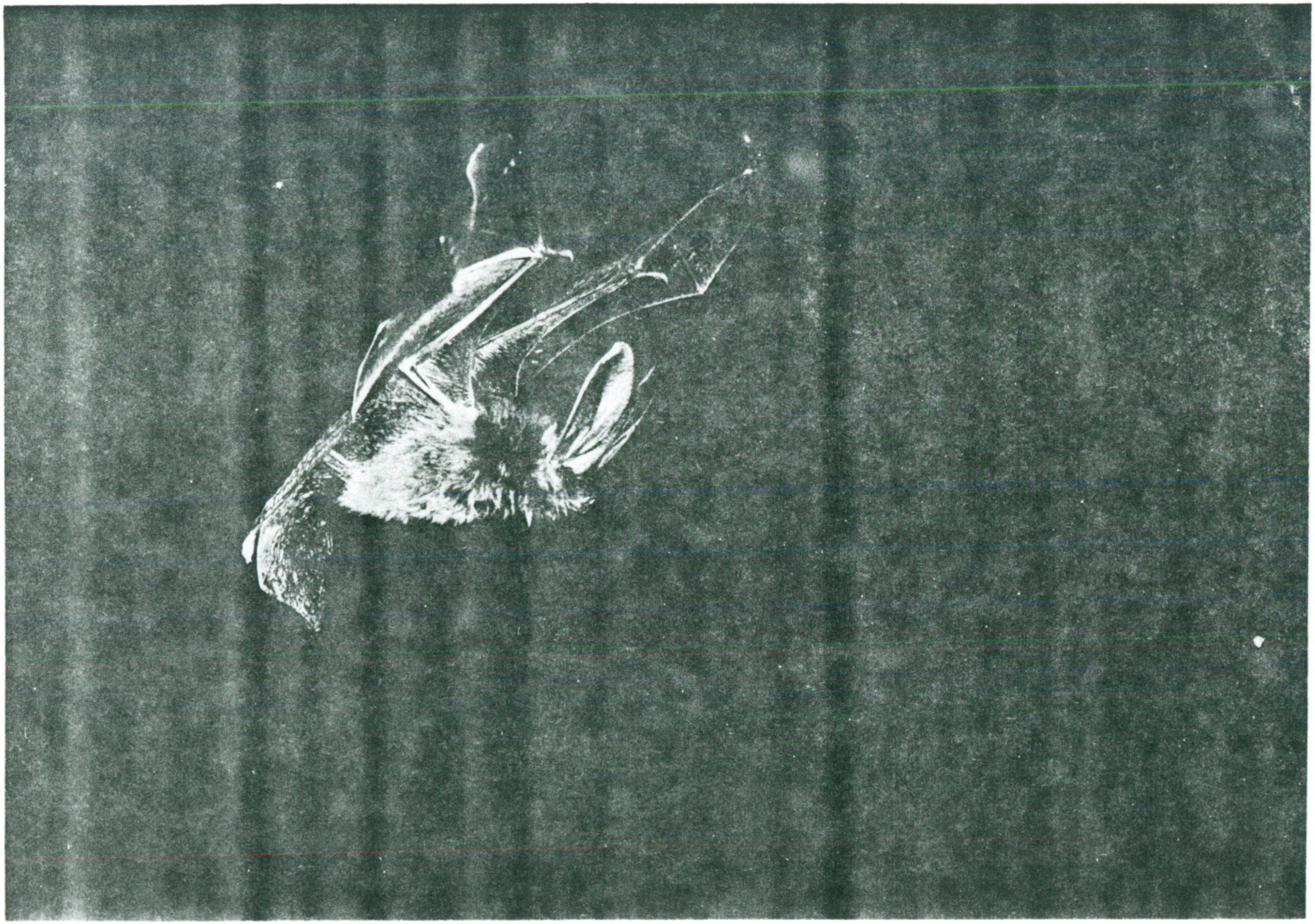

Figure 2. Photograph of non-endangered subspecies of Townsend's big-eared bat (by Scott Altenbach).

eared bat has tan underparts and brown dorsal fur in contrast to the whitish underparts and the gray dorsal fur of the eastern big-eared bat (Barbour and Davis, 1969).

The Ozark big-eared bat, Plecotus townsendii ingens, is the largest and reddest of the five subspecies. It may be distinguished from the Rocky Mountain form (Plecotus townsendii pallescens, the only geographically adjacent subspecies) by its darker, more orange or reddish coloration, larger average size, relatively larger auditory bullae, more inflated rostrum, relatively more robust molariform teeth and more frequent development of a secondary cusp on the first upper incisor (Handley, 1959). The Virginia big-eared bat is more sooty dorsally than the Ozark big-eared bat and averages slightly smaller in all dimensions. The first upper incisor rarely has a trace of a secondary cusp and the rostrum is less heavy and inflated (Handley, 1959).

Status

Tables 1 and 2 list colony sites of the Ozark and the Virginia big-eared bats. Appendix 1 lists caves in which individual bats have been observed but no colony was present. A brief summary of the theories which attempt to explain the disjunct distribution apparent in these tables appears in Appendix 2. The following discussion relates to the current status of known colony sites.

Table 1. Ozark big-eared bat colony sites

State	County	Cave	Type Colony	Management Structures	Max. past Pop.	Date	Max. recent Pop.	Date
Arkansas[1,4]	Marion	Blue Heaven	maternity	None	120	July 13, 1978	170	June 18, 1979
							99	May 22-23, 1983
Arkansas[1]	Marion	Marble Falls	hibernaculum	None	420	Winter 1980	156	Winter 1980-81
							200	Winter 1981-82
							240	Winter 1982-83
Arkansas[1]	Washington	Devil's Den Crevice	hibernaculum	None	60	February 1975	1	Feb. 13, 1981
							2	Winter 1981-82
							3	Winter 1982-83
Oklahoma[2]	Adair	AD-3	hibernaculum	None	75	February 7, 1981	180	Dec. 30, 1982
							205	Dec. 23, 1983
Oklahoma[3]	Adair	AD-9	NA	Gated (6-8 years ago)	Several Hundred	Approx. 1968	4	December 1983
Oklahoma[2,4]	Adair	AD-10	maternity	None	15-18	July 23, 1981	97	July 3, 1982
							150	May 28-29, 1983
			hibernaculum		NA	NA	15-20	Jan. 23, 1983
							1	Dec. 23, 1983

Table 1. Ozark big-eared bat colony sites (contd)

State	County	Cave	Type Colony	Management Structures	Max. past Pop.	Date	Max. recent Pop.	Date
Oklahoma[2,4]	Adair	AD-17/18	maternity	None	NA	NA	156	July 3, 1982
							62	May 26-27, 1983
			hibernaculum		NA	NA	6	Dec. 20, 1982
							0	Dec. 23, 1983
Oklahoma[2]	Adair	AD-19	maternity	None	NA	NA	16+	July 6, 1981

1 Source - M. Harvey

2 Source - W.L. Puckette

3 Source - M. Looney and W.L. Puckette

4 Source - J. Jacobs and F. Bagley

NA Not Available

Note: AD-17 and 18 are separate caves in close proximity to one another. The associated colony appears to use one cave or the other in different years.

Table 2. Virginia big-eared bat colony sites

State	County	Cave	Type Colony	Management Structures	Max. past Pop.	Date	Max. recent Pop.	Date
WV[1]	Pendleton	Hellhole	hibernaculum	Fenced 7/81	500	1972-73	0	March 22, 1982
		Hellhole	bachelor		70		NA	NA
WV[1,6]	Pendleton	Cave Mountain	maternity	Initial gating 3/76; regated 3/81	1000+	1972-73	600	July 30, 1981
							808	June 20, 1983
WV[1,2,6,7]	Pendleton	Hoffman School	maternity	Gated 4/81	1000	1964	800-1000	June 3, 1981
							755	June 26-27, 1983
			hibernaculum		NA	NA	300	Oct. 24, 1981
							9	Feb. 14, 1984
WV[1,6,7]	Pendleton	Sinnit	maternity	Gated 3/81	250	1972	250	June 3, 1981
							153	June 24-25, 1983
			hibernaculum		NA	NA	2	Feb. 14, 1984
WV[1,6]	Pendleton	Mystic	maternity	None	NA	NA	250	July 29, 1981
							254	June 1983
WV[1,6,7]	Pendleton	Minor Rexrode	hibernaculum	Fenced 3/82	Occasional	1972	162	Jan. 15, 1982
							135	Feb. 22, 1984
		Minor Rexrode	maternity		NA	NA	125	Aug. 1, 1981
							95	June 13-14, 1983

Table 2. (continued)

State	County	Cave	Type Colony	Management Structures	Max. past Pop.	Date	Max. recent Pop.	Date
Virginia[4]	Tazewell	Cassell Farm No. 2	maternity	None	200-300	1950's & 1960's	200-300 292	Aug. 9, 1981 June 24, 1983
	Tazewell	Higgenbothams	hibernaculum	None	NA	NA	several hundred	Feb. 11, 1984
Kentucky[5,8]	Lee	Stillhouse	hibernaculum	None	1000	Oct. 1963	1696	March 11, 1982
	Lee	Wind	maternity bachelor		75 75	Jun. 24, 1980 Jun. 24, 1980	0 0	July 1, 1982 July 1, 1982
North Carolina[9]	Avery	Black Rock Cliffs	hibernaculum	None	NA	NA	20	March 25, 1984

1 Source - J. Hall

2 Source - F. Grady

3 Source - J. Jacobs, A. Moser and F. Bagley

4 Source - V. Tipton and Dave Derowitsch

5 Source - J. MacGregor

6 Source - J. Jacobs and F. Bagley

7 Source - A. Moser, K. Knight, J. Hall and L. Walker

8 Source - M. Harvey

9 Source - B. Currie, D. Lee and C. Holler

NA Not Available

Note: Thorn Mountain Cave connects to Sinnit Cave.
Arbegast Cave connects to Cave Hollow Cave.

Table 2. (continued)

State	County	Cave	Type Colony	Management Structures	Max. past Pop.	Date	Max. recent Pop.	Date
WV[1,6,7]	Grant	Peacock	hibernaculum	None	NA	NA	27	Jan. 14, 1982
							24	Feb. 13, 1984
		Peacock	maternity		NA	NA	225	Sep. 9, 1981
							160	June 16-17, 1983
WV[1,6,7]	Tucker	Arbegast/	maternity	None	NA	NA	350	July 31, 1981
							650	June 1983
		Cave Hollow	hibernaculum		500	1972	400	Jan. 12, 1982
							400	Feb. 10, 1984
WV[1,6]	Pendleton	Smoke Hole	hibernaculum	None	Occasional	NA	Occasional	NA
		Smoke Hole	maternity		NA	NA	75	Aug. 1, 1981
							1	June 9, 1983
WV[3]	Pendleton	School House	maternity	None	NA	NA	463	July 3, 1982
							338	June 1983
WV[1,3]	Pendleton	Thorn Moun-tain	maternity	Gated 3/81	0	1960's & 1970's	114	July 1, 1982
							14	June 24, 1983

Ozark big-eared bat. In Oklahoma, 210 hibernating Ozark big-eared bats were observed in December 1983. Two hundred and five of these were observed in a single cave in Adair County on December 23 (W. L. Puckette, personal communication). In late May 1983, two maternity colonies, both in Adair County, were surveyed. One had 150 bats, the other had 62 bats (Jacobs and Bagley, personal observation). One colony site, AD-9, which contained several hundred big-eared bats in the late 1960's, contained four big-eared bats in December 1983.

In Arkansas, only two caves, a hibernaculum and a maternity site, are known to be inhabited by colonies of the Ozark big-eared bat. Blue Heaven Cave, Marion County, the only known maternity site in Arkansas, had a population of 99 individuals on May 22-23, 1983 (Jacobs and Bagley, personal observation). Marble Falls Cave, Marion County, houses the largest known hibernating colony of the Ozark big-eared bat. During 1978-1981, this colony numbered up to 420 individuals (Harvey et al., 1981). A third cave, a hibernaculum, appears to have been abandoned in recent years. Harvey (1975) reported finding a hibernating colony of 60 Ozark big-eared bats during the winter of 1974-1975 at a cave in Devil's Den State Park, Washington County. Thirty-five were observed there on March 8, 1978. During Harvey's 1978-1981 study, only two Ozark big-eared bats were observed in Devil's Den State Park.

Assuming that the Devil's Den colony still exists, only three or four populations of Ozark big-eared bats are known, two in Arkansas (Devil's Den and Blue Heaven/Marble Falls) with a total maximum number of 480 (Harvey et al., 1981) and one or two in eastern Oklahoma with a total of perhaps 425 (estimate made by doubling maternity colony population).

Virginia big-eared bat. In Kentucky, only one Virginia big-eared bat colony location is known. This colony, located in Stillhouse Cave, Lee County, contained about 1,000 hibernating individuals in October 1963. The highest survey estimate since that date was about 1,700 on March 11, 1982 (John MacGregor, personal communication). The site of the maternity colony for this population is not known.

Twenty hibernating Virginia big-eared bats were reported in Black Rock Cliffs Cave, Avery County, North Carolina, on March 25, 1984 (Robert Currie, personal communication). Prior to this date, there were no Virginia big-eared bat colonies known to occur in North Carolina.

In Virginia, only two active Virginia big-eared bat colony locations are known. Cassell Farm No. 2 Cave, Tazewell County, contains a maternity colony estimated to have contained 200-300 individuals on surveys conducted in the 1950's, 1960's and on June 24, 1983 (Virginia Tipton, personal communication). A hibernaculum, housing several hundred big-eared bats, was found in Higgenbothams Cave, Tazewell County, on February 11, 1984.

In West Virginia, 10 caves are known to have served as colony sites for Virginia big-eared bat colonies in recent years. Four of these caves have contained both hibernation and maternity colonies (Hoffman School, Minor Rexrode, Peacock and Arbegast/Cave Hollow). Four other caves are significant primarily as maternity sites (Cave Mountain, Sinnit/Thorn Mountain, Mystic and School House). Smoke Hole Cave contained a maternity colony on August 1, 1981, but is not known to have housed a colony on any other occasion. Hellhole Cave formerly housed a hibernation (1972-73) and a bachelor colony but has not done so in more recent years. Hibernacula surveys conducted from February 10-22, 1984, yielded a total of 576 hibernating big-eared bats. Combined data from the 1983 summer survey, yielded a total maternity colony estimate of 3072-3381 female big-eared bats in West Virginia. (Note: maternity colony estimates do not include the majority of the male population.)

Habitat Requirements

Ozark and Virginia big-eared bats inhabit caves during both summer and winter. These caves typically are located in karst regions dominated by oak-hickory or beech-maple-hemlock associations (Barbour and Davis, 1969). The Virginia big-eared bats in West Virginia hibernate in portions of caves where temperatures are 12°C or less but above freezing (John Hall, personal communication). Air temperatures near the hibernating colony in Stillhouse Cave, Kentucky, ranged from 6.0 to 7.5°C in March 1982 (Robert Currie, personal communication). Ambient air temperatures recorded near hibernating Ozark big-eared bat colonies and individuals in Arkansas caves were all within a range of 4-9°C; relative humidity ranged from 80-95% (Harvey *et al.*, 1981).

The only known Ozark big-eared bat maternity colony in Arkansas is located in a small, relatively warm cave. Ambient temperature under the roost site averaged 15°C. The relative humidity was 97% (Michael Harvey, Memphis State University, personal communication). Ozark big-eared bat maternity colonies are often located just beyond the twilight zone of the cave entrance. Virginia big-eared bat maternity colonies are typically located deeper within the caves.

Life History

Much of the data presented below is based on studies of the non-endangered subspecies of Townsend's big-eared bat due to the lack of information available on the endangered subspecies.

Migratory movements. Townsend's big-eared bat appears to be a relatively sedentary species. No long distance migrations have been reported. Barbour and Davis (1969) recorded movements of 64.4 Km (40 mi) in Kentucky. The Arkansas colony moves only about 6.5 Km (4 mi) between the hibernaculum and maternity cave (Harvey et al., 1981). This species exhibits a high degree of site attachment, returning year after year to the same maternity roosts (Pearson et al., 1952). Winter activity may include short movements among nearby hibernacula (Humphrey and Kunz, 1976).

Feeding. Townsend's big-eared bat feeds principally on small moths (Microlepidoptera), averaging 6mm in length (range 3 to 10 mm), and also may take other insects, including representatives of Neuroptera, Coleoptera, Diptera, and Hymenoptera (Hamilton, 1943; Ross, 1967; Whitaker et al., 1977). Howell (1920) noted that Townsend's big-eared bat captured insects from leaves and other places. However, Bell (in Kunz and Martin, 1982) noted that big-eared bats feed mostly in the air along forested edges and should not be regarded as foliage gleaners.

Reproduction, growth and development. This aspect of Townsend's big-eared bat biology was studied by Pearson et al. (1952) in California. The following is a summary by Kunz and Martin (1982) of Pearson's work:

> Estrus and subsequent copulation begin in autumn and the peak of copulations occurs from November through February, although some females apparently mate before arriving at hibernacula. Young females are reproductively active and mate in their first autumn. Spermatozoa are stored in the reproductive tracts of females until spring, when ovulation, fertilization, and gestation occur. Ovulation may occur either before or after females leave hibernation. Development of a single embryo takes place in the right uterine horn. The length of gestation varies from 56 to 100 days, depending on spring temperatures and the varying amounts of torpor experienced by different individuals. Parturition occurs in late spring and early summer, followed by an anestrous period.
>
> In adult males, spermatogenesis occurs during the summer, reaching maximum activity in September. By late September and early October, the testes of adults begin to atrophy, coinciding with the appearance of sperm in the enlarging eipididymides. The accessory glands reach full size in late October. Copulation is preceded by a ritualized precopulatory behavior characterized by the production of audible vocalizations, followed by head nuzzling which may be directed at either torpid or active individuals. Young males fail to reach sexual maturity in their first autumn.
>
> As in other bats, baby Townsend's big-eared bats are large at birth, weighing nearly 25% of their mother's post-partum mass. Newborn bats are naked and their large ears lie over their unopened eyes for the first few days. Within a few hours after birth they can produce audible 'chirps' which may play an important role in mother-infant recognition. At the age of one week, young bats are capable of producing adult-like audible 'squawks'. Young bats grow rapidly, nearly reaching adult forearm size in one month. They are capable of flight at 2.5 to 3 weeks and are fully weaned by 6 weeks.

Natality and survivorship. Kunz and Martin (1982) have provided the following summary of this aspect of Townsend's big-eared bat biology. No such data has been collected on the endangered subspecies.

> Natality rates are comparable throughout the species range, varying from 90 to 100% (Fenton, 1969; Hall, 1946; Pearson et al., 1952; Turner and Jones, 1968; Humphrey and Kunz, 1976). Pre-weaning post-natal mortality was 5% in South Dakota (Turner and Jones, 1968) and 4% in Kansas and Oklahoma (Humphrey and Kunz, 1976). Pearson et al. (1952) estimated survival rates of females by recording the number of yearling

and adult females that returned to maternity colonies each year. The number returning in a 3-year period ranged from 70 to 80% for adults and 38 to 40% for yearlings. Of the yearlings that survived the first year, 75 percent returned as 2 year olds and 80% of these returned as 3 year olds. Judging from the percentage of young bats observed in hibernation, Pearson et al. (1952) postulated that most mortality in the first year occurred before bats entered hibernation. Maximum longevity reported for this species is 16 years 5 months, based on recoveries of banded bats in California (Paradiso and Greenhall, 1967).

Hibernation (Paraphrased from Kunz and Martin, 1982). Townsend's big-eared bat prefers relatively cold places for hibernation, often near entrances and in well ventilated parts of caves (Pearson et al., 1952; Dalquest, 1947; Twente, 1955; Barbour and Davis, 1969; Martin and Hawks, 1972; Humphrey and Kunz, 1976). During hibernation, they assume body temperatures that are highly correlated with ambient air temperature and the temperature of the substrate on which they roost (Humphrey and Kunz, 1976). In winter they often move deeper into the more thermally stable parts of the same cave or move to other nearby caves if temperatures near entrances become too extreme (Twente, 1955, 1960; Pearson et al., 1952; Martin and Hawks, 1972; Humphrey and Kunz, 1976). Over half of the autumn body mass in Townsend's big-eared bats may be lost during hibernation with the greatest loss occurring in the first months of winter (Humphrey and Kunz, 1976). The periodic arousal and movement of the bats contributes to loss of fat reserves.

During hibernation, Townsend's big-eared bat assumes postures that appear to buffer it from environmental extremes, yet afford sensitivity to climatic changes and disturbance. The ears may be held erect or coiled like a ram's horn (Dalquest, 1947; Pearson et al., 1952; Barbour and Davis, 1969; Humphrey and Kunz, 1976). Solitary bats often hang pendant by one or both feet with wings wrapped around the body and interlocked ventrally. The long pelage is erected to afford maximum insulation (Twente, 1955). In contrast, the wings of clustered bats are usually folded tightly against the body and the ears may or may not be coiled (Twente, 1955; Pearson et al., 1952; Humphrey and Kunz, 1976).

Townsend's big-eared bat may be found hibernating solitarily or in clusters of a few to several hundred individuals. In Arkansas, Harvey et al. (1981) found what appeared to be almost the entire Marble Falls/Blue Heaven population hibernating in a single cluster. The age and sex of individuals hibernating in small clusters appears to be random (Martin and Hawks, 1972; Humphrey and Kunz, 1976), but large clusters are more often comprised of nearly equal numbers of both sexes (Rippy and Harvey, 1965; Humphrey and Kunz, 1976).

Maternity Colonies. During late March or early April, female big-eared bats congregate and form maternity colonies in the warm parts of certain caves. Although there may be occasional periods of torpor, the females usually remain alert and active in the maternity roost. Shortly after dark, the females emerge from the cave to forage. The nocturnal activity pattern of bats in maternity colonies varies as the maternity season progresses. During May and most of June, the colony remains outside the cave most of the night. By late June and July a portion of the colony returns during the night and often re-emerges in a pattern that probably is related to the age and development of the young (Appendix 3).

During the maternity period, most males are solitary (Pearson et al., 1952; Barbour and Davis, 1969; Humphrey and Kunz, 1976). However, a few males may live in or visit caves occupied by maternity colonies.

Limiting Factors and Causes of Decline

Pearson _et al_. (1952) commented that the Townsend's big-eared bat of the west is likely limited by the number of suitable winter roosting sites and the number of summer roosting sites surrounded by adequate foraging habitat. Within the range of the Ozark and the Virginia big-eared bats there appears to be available unoccupied habitat; however, unknown ecological factors may restrict the bats from expanding into these areas.

Evidence of predation on the endangered subspecies is limited to five occasions: one on August 20, 1980, at Cave Mountain Cave, West Virginia, where parts of three dead big-eared bats were found at the base of the entrance gate and four incidents of predation (evidenced by torn body parts) at Sinnit Cave, West Virginia which have occurred since a gate was installed (Leonard Walker, personal communication). After the third incident, a male house cat was caught in a live trap a few feet from where eight carcasses were collected. Pearson _et al_. (1952) had three records of house cats bringing in dead specimens, but did not know how or by what these bats actually were killed. Big-eared bat predators may include raccoons, bobcats, house cats, skunks, screech owls and snakes. Too little information is available on the influence of food supply and disease to comment on their significance as limiting factors.

Causes of decline of Townsend's big-eared bat likely include loss of habitat, vandalism, and increased human visitation to maternity roosts and hibernacula (Harvey, 1975; Humphrey and Kunz, 1976). Human disturbance at maternity and hibernation sites has been a major concern. Barbour and Davis (1969) said "the bats seem to be abandoning more caves each year, apparently as a result of ever-increasing human disturbance as spelunking becomes more popular. The species seems destined to perish in the eastern United States unless the caves it uses receive protection . . . ." Pearson et al. (1952) witnessed the abandonment of a cave by an entire colony. The young had been banded after the adults departed the cave at night. By morning, the adults had returned, picked up their young, and moved to an alternate roost 2.1 km (1.3 mi) away. Graham (1966) suggested that the cause of abandonment of each of six maternity roost sites in California was the same, disturbance through excessive visitation by people as the caves became popular. He chronicled the shifting of one colony to ever more inaccessible regions of its cave until the cave was finally abandoned in 1961.

Humphrey and Kunz (1976) had similar experiences with colonies they studied in northern Oklahoma and Kansas, and commented: "clearly handling and simply the presence of people cause this species to desert preferred roosts as well as alternate roosts. It is unknown whether reduction results from direct loss of embryos or young, delayed development followed by failure to overwinter or failure of living females to occupy the nursery the next year. Whatever the mechanism, nursery populations decline after disturbance and do not recover in the following year."

The immediate impact of human disturbance on Townsend's big-eared bat colonies is probably comparable to similar disturbances of gray bat colonies.

The disturbance of big-eared bat colonies during April and May risks, at a minimum, the abandonment of the site by the colony. Disturbance later in the maternity season (June, July and early August) additionally risks a high mortality of young. Disturbances during hibernation also may produce adverse effects. A limited number of arousals from hibernation is natural and necessary, but each arousal from hibernation is energetically expensive. Energy reserves (in the form of fat) cannot be replaced before spring emergence. If the number of arousals of a hibernating bat are increased by human disturbance until its energy stores are exhausted, it likely will leave the cave prematurely in search of food and die outside where its fate will go unnoticed (Brady _et al_., 1982).

The above section has pointed out the concern with human disturbance of colonies. The solution would seem to be to gate caves in order to exclude human entry. The following section will discuss concerns about impacts of gates themselves upon big-eared bats. A major problem in big-eared bat conservation will be to determine whether and under what conditions big-eared bats are better off with or without gates at colony sites.

Response to Cave Gates

In the spring of 1981, the U.S. Fish and Wildlife Service constructed five gates on Virginia big-eared bat maternity colony caves in order to protect these colonies from human disturbance. Concern about the possible impact of these gates on big-eared bat maternity colonies subsequently arose because of the abandonment of two caves by gray bat maternity colonies when full gates were placed on their cave entrances. It has since been found that although the gating of big-eared bat colony sites in West Virginia has not caused the abandonment of any caves, the gates have caused an increase in circling behavior inside and outside of the gates and in at least one case appear to have caused an increase in predation. It is difficult to fully interpret the importance of increased circling, because circling also occurs in large rooms within cave systems (personal observation and George Haas, personal communication). If the increased activity at gates results in a significant increase in energy expenditure by bats, it could have unknown negative effects upon pregnant females, young learning to fly and bats storing energy for hibernation.

The possibility of increased predation resulting from gates is a greater concern. Tuttle (1977) discussed this problem in regard to colonial cave bats: "Restrictive gates often cause bats to slow down and circle in front before entering. This increases vulnerability to predators that wait for emerging and returning bats. I have observed both raccoons and feral house cats catching slowly circling bats in mid-air in front of gated entrances . . ." There have been at least four separate instances of predation accounting for the loss of more than 24 big-eared bats at Sinnit Cave since it was gated (total population prior to predation estimated to be 200-250, June 3, 1981, by John Hall and Andy Moser). There were no reports of predation at this frequently visited cave prior to its gating. It is not known if predation at gated big-eared bat caves is restricted to Sinnit Cave or if the events at Sinnit are indicative of a similar but less obvious problem at other gated caves.

The availability of a minimally disturbing survey technique (see page 23) and the presence of the existing gates presents the opportunity to determine the value of gating in conserving these endangered bats before additional gates are constructed. This may be done by comparing population trends over several years at gated and ungated caves. Such a comparison is imperative, because even a small increase in mortality due to gates could have a disastrous long-term impact on a subspecies with such a small population size.

Recovery Actions Already Accomplished or Underway

Cave Surveys. In recent years, many caves have been searched for colony sites throughout the range of the Ozark and Virginia big-eared bats. This effort should be expanded to include a search of the caves near Stone County, Missouri. Big-eared bats were last observed in this area in the early 1960's. In coming years, efforts in other states should emphasize location of unknown colony sites for known populations. For example, in Kentucky, a large hibernating colony is known from Stillhouse Cave but the site of the majority of this population's maternity colony is unknown and should be located. Also, in West Virginia, approximately 3200 bats are known from maternity colonies but only 576 are known from hibernacula. Future cave surveys in West Virginia should focus on locating the additional hibernacula.

Gate and Fence Construction. Five caves in West Virginia (Sinnit, Thorn Mountain, Hoffman School, and Upper and Lower Cave Mountain) have been gated (Leonard Walker, personal communication). In Oklahoma, two *P. t. ingens* caves have been gated, AD-8 and AD-9 (Puckette, personal communication). Information on construction of the West Virginia gates is presented in Appendix 4. The West Virginia gates were designed and constructed in the manner believed to be the most appropriate for protection of cave bats from human disturbance. The comments appearing under the section on 'Response to Gates' should not be taken as a denouncement of the construction of these gates. They may well prove to be of great benefit to the bats.

Three caves in West Virginia (Hellhole, Minor Rexrode, and Schoolhouse) have been fenced. 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. Several fences have proven highly effective in reducing human disturbance of gray bat maternity colonies and have permitted these colonies to increase greatly in size (Brady et al., 1982).

Signed cooperative agreements have been obtained for the four privately-owned caves in West Virginia that have been gated or fenced (See Appendix 5). The primary objective of these agreements was to obtain permission to construct government-owned gates or fences on private property and to secure the landowners' cooperation in restricting human entry to the cave for the time period prescribed by the Fish and Wildlife Service.

Survey Techniques. The most widely used technique for estimating the populations of big-eared bat maternity colonies to date involved entering the caves where colonies were believed to occur, locating the bat clusters, shining a light on them, and estimating the number of bats present. This technique relied upon one's ability to find all the clusters in a cave and to estimate the number of bats present. These surveys were made at varying times during the maternity season. If data acquired in this manner is used to study population trends, the assumption must be made that the population at each colony was stable throughout the season. This assumption is not true; population levels are unstable when the colony is forming, when young are being born and when it is breaking up. As stated earlier, visits such as these have been cited in the literature as causing temporary abandonment of colony sites (usually involving movement to other sites in the same cave). Despite the drawbacks of this technique for maternity colonies, it was the best available until recently. It remains the only reliable census technique for hibernacula.

During 1982, another technique for determining population size was investigated (Appendix 6). Big-eared bats, which were identified by their conspicuous ears, body size, and flight pattern, were counted as they flew through a beam of infrared light at the cave entrance. The observers viewed the bats through a night vision scope. It was hoped that this would be an accurate, non-disturbing method of determining maternity colony population size. This technique requires the ability to identify the big-eared bats as they emerge and/or knowledge of the seasonal time period when few other bats will be present in the caves. In most cases such a survey requires about two hours per cave. Similar emergence counts have been used by Tuttle (personal communication) on gray bats and by Kunz (1982) on little brown bats.

This technique was studied during the spring and summer of 1982. A period from June 7 to June 28 was identified when a stable population was present at Mystic Cave in West Virginia. The fifteen counts of the population made during this period revealed a population of 253.9 ± 6.9 adult big-eared bats at a 99% confidence level. After twenty nights of observation and thirty-nine counts of the population, the colony by late July had reproduced to the level predicted by Pearson et al. (1952) and Humphrey and Kunz (1976) (i.e., 90-100% of all adult females had one young). In view of the above, it has been concluded that this technique is consistent and can be used to determine population levels without disturbing the bats.

Essential Habitat. Five colony sites have been designated as critical habitat (Federal Register, November 30, 1979) for the Virginia big-eared bat. These are Cave Mountain Cave, Hellhole Cave, Hoffman School Cave and Sinnit Cave, each in Pendleton County, West Virginia, and Cave Hollow Cave in Tucker County, West Virginia. All of the colony sites listed in Tables 1 and 2 should be considered as habitat essential to the continued existence of these endangered subspecies. Therefore, the present critical habitat designation is incomplete. At this time there is no need to correct the designation. However, if at some time in the future a decision is made that all habitat essential to the survival of the species must be designated as critical habitat to receive protection, then all the habitat listed in Tables 1 and 2 should be so designated.

Recovery Actions to be Accomplished

Recovery actions initially will focus on ensuring long-term protection of highly significant surface and subsurface habitat, determining range wide population trends and assessing the impacts of existing full gates on these populations. No additional maternity caves should be gated with full gates until at least four consecutive annual population surveys have been conducted at all gated and ungated maternity sites. During this period, a single hibernating site should be studied and gated to assess the impact of a gate on the population hibernating therein.

Based on this information, the U.S. Fish and Wildlife Service will have to reassess the benefits of full gates to the species and formulate gating plans or alternative methods of protection for each cave. During the four years that will be required to obtain the needed population trend data, an effort to secure the cooperation of landowners, caving groups and the general public in reducing human disturbance must go forward. Also, during this period fences and half gates which have been carefully designed to avoid restricting flight space required by bats may be used where appropriate to prevent human disturbance of colony sites (see Gray Bat Recovery Plan, Appendix page 2-4 for additional comments on fences).

An integral part of this recovery plan will be to ensure that a non-intrusive technique (such as the infrared census technique discussed on page 23) is used in future maternity colony surveys. Such a technique must allow monitoring of population trends without disturbing the colony.

As previously alluded to, very little is known of the surface habitat requirements of these subspecies. This aspect of the Ozark and Virginia big-eared bat must be studied in order to ensure proper management of surface habitat with regard to these bats.

PART II: RECOVERY

A. Recovery Objective Narrative

Objective: To prevent the extinction of the Ozark big-eared bat and to reclassify the Virginia big-eared bat from endangered to threatened status.

In order to prevent the extinction of the Ozark big-eared bat, it will be necessary to ensure long-term protection of all known active colony sites and to maintain stable or increasing populations at all active maternity and hibernating sites. It is unlikely that the Ozark big-eared bat's status can be changed to threatened in the foreseeable future due to its small population size, low reproductive rate, and its habit of concentrating the majority of its population in just a few caves.

The criteria for the change to threatened status for the Virginia big-eared bat will be documentation of long-term protection of 95% of all known active colony sites and documentation of stable or increasing populations at 95% of the known active maternity sites and hibernacula for a period of five years. It seems unlikely that the Virginia big-eared bat will recover to a point where it can be removed from the threatened list. However, this matter should be reconsidered at the time its status is reduced from endangered to threatened. Foraging habitat for both subspecies must be identified, and restored as much as possible. However, a given amount of foraging habitat can not be required in the objective at this time due to lack of information on colony needs. Finally, a periodic monitoring program must be established to ensure a continued awareness of the status of these animals.

B. Step-Down Outline

Objective: To prevent the extinction of the Ozark big-eared bat and to reclassify the Virginia big-eared bat from endangered to threatened status.

1. Monitor population trends.

   1.1 Develop and refine a minimally disturbing census technique for maternity colonies.

   1.2 Monitor status of populations in maternity colonies.

   1.3 Census population in all hibernacula once every two years.

2. Search for undocumented caves of importance to big-eared bats.

   2.1 Maternity colonies.

   2.2 Hibernacula.

2.3 Caves providing habitat for solitary big-eared bats.

3. Prevent human disturbance of maternity colonies and hibernacula.

3.1 Obtain long-term authority to manage and protect colony sites.

3.1.1 Reassess all existing habitat protection measures.

3.2 Determine impact of human disturbance on colony population trends.

3.3 Study and manage cave gating.

3.3.1 Determine long-term impact of existing gates on maternity colony populations.

3.3.2 Gather information on behavior, predation, and environmental problems resulting from gates on maternity colonies.

3.3.3 Modify or remove any problem-causing gates.

3.3.4 Design and test gates to alleviate problems revealed in 3.3.1 and 3.3.2.

3.3.5 Revise recovery plan position on gating maternity colonies.

3.3.6 Obtain information on the effects of gating at a hibernaculum.

3.3.6.1 Gather information on any existing gates at hibernacula of non-endangered big-eared bats.

3.3.6.2 Gate one hibernaculum.

3.3.7 Maintain fences and gates.

3.4 Place warning/interpretive signs at cave entrances.

3.5 Utilize law enforcement agencies to protect colony sites.

4. Protection of caves providing habitat for solitary big-eared bats.

5. Prevent adverse modifications to essential habitat.

5.1 Prevent adverse modifications to the subsurface, including entrances.

5.2 Determine surface habitat used by maternity and hibernating colonies.

5.2.1 Conduct pilot study to select and test the most appropriate means of obtaining information required in Task 5.2.

5.2.2 Conduct a study to obtain information required in Task 5.2.

5.3 Identify essential surface habitat for each colony site.

5.4 Protect essential surface habitat.

5.5 Include surface and subsurface habitat in Section 7 consultation process.

5.6 Make locations of important roost sites and surface habitat available to agencies able to assist in protection.

5.7 Prevent pollution of big-eared bat habitat.

5.7.1 Gather data on toxic substances used in big-eared bat habitat.

5.7.2 Gather baseline data on current toxic substance exposure of big-eared bats.

5.8 Study prey species.

6. Develop and maintain public support for species protection.

6.1 Landowner support.

6.2 Public support.

6.3 Caver support.

7. Prepare and maintain a management profile for each colony site.

8. Appoint a coordinator for all recovery efforts.

C. Recovery Outline Narrative

1. Monitor population trends: The present population trends of these subspecies are not known. These data are needed to allow determination of the population status and the response of the population to recovery efforts.

1.1 Develop and refine a minimally disturbing census technique for maternity colonies. Continue to improve the infrared scoping technique with emphasis on the lighting scheme.

Document the June departure of other bat species from big-eared bat maternity caves in West Virginia. This will allow improved scheduling of non-intrusive surveys in late June so as to reduce possible confusion of emerging big-eared bats with other bat species.

1.2 Monitor status of populations in maternity colonies. Annual population censuses utilizing a non-intrusive technique (e.g. the infrared observation technique) should be conducted at each maternity colony for a period of at least four consecutive years to determine the population trend at each cave. After the four year survey effort is completed, each colony should be censused periodically. The frequency of this census should be determined from consideration of the initial four years of census data.

1.3 Census all hibernacula once every two years. This census would document the continued use of the site. The census party (2-3 persons) shall limit its total time in the immediate vicinity of hibernating big-eared bats to five minutes. An estimate of the bat cluster size should be made if this can be done within the five minute census period. No living big-eared bats should be handled; nor should they be disturbed other than by the presence of the observers. Red lights are recommended for use in the immediate vicinity of the colony.

2. <u>Search for undocumented caves of importance to big-eared bats</u>. In most parts of the range, this effort will emphasize location of unknown colony sites for known populations. In Missouri, this task will require a search for both maternity colonies and hibernacula in the vicinity of Stone County. There are no known active colonies in this area. However, reports from the early 1960's indicate that a hibernaculum of at least 20 big-eared bats existed in this vicinity (Henry Mitchell, University of Missouri, Kansas City, personal observation). It is possible that the colony still occurs in the area.

2.1 <u>Maternity colonies</u>. Caves suspected of housing undocumented big-eared bat maternity colonies should be examined by bat biologists. The initial search may require that investigators enter the area of the roost site to verify the presence of bats. Once a colony has been located, all subsequent surveys should be conducted by a non-intrusive census technique. The search for maternity colonies in Kentucky will be of particular importance as none are known for the Stillhouse hibernaculum population.

A priority ranking for this task has been assigned in the implementation schedule for each state in which a search is needed. States with poorly known potential habitat were given higher priority rankings than states with recent, thorough surveys of likely habitat. Thus, Oklahoma, Missouri, Kentucky, and Virginia received rankings of 1 as each of these states possess potential habitat which has not been explored for big-eared bat maternity colonies. Arkansas was ranked as a 2 because it has had a recent cave survey although some additional work is needed. West Virginia was ranked as a 3 because it has had a thorough survey of the habitat in which maternity colonies are likely to occur. The emphasis in West Virginia should now be upon investigating new reports of big-eared bat colonies received from cavers.

2.2 Hibernacula. The search for hibernacula in Virginia, West Virginia, Missouri and Oklahoma will be of particular importance as they are unknown for large portions of these populations. Therefore, these states were given a priority ranking of 1. Arkansas and Kentucky were ranked as priority 3. Additional searches may be warranted in some portions of these two states. However, they were given a low ranking as the hibernacula for the known maternity colonies in these states are well documented.

2.3 Caves providing habitat for solitary big-eared bats. In the performance of Tasks 2.1 and 2.2, data (in addition to that included in Appendix 1) will be collected on caves providing habitat for solitary (or non-colonial) big-eared bats. This may include summer sites for males and non-reproducing females, winter sites for solitary males and females and caves used by transient big-eared bats. This data, along with that from other sources, should be reported to and compiled by the responsible agency (Appendix 8) and by the coordinator identified in Task 8.

3. Prevent human disturbance of maternity colonies and hibernacula. Human disturbance is the primary factor believed to be causing the decline of these subspecies. Data should be obtained to quantify the impact of human disturbance on colony population trends in order to provide a better understanding of this phenomenon. Data on the impact of gates upon big-eared bat populations should be accumulated to allow assessment of the value of gates in conserving big-eared bat populations. During this data gathering process, no additional maternity caves will be closed with full gates (exceptions discussed under 3.3.1). However, appropriate alternatives to full gates in colony protection should continue to be utilized. These include half gates, fences, and signs. Measures should be taken to prevent human disturbance of colony sites, particularly from March 15 to October 31 at maternity colonies and from August 15 to April 30 at hibernacula.

3.1 Obtain long-term authority to manage and protect colony sites. The Fish and Wildlife Service or other appropriate agencies should obtain the authority to restrict human access and conduct other necessary management for all of the caves listed in Tables 1 and 2 and for any future colony sites. The available mechanisms for habitat protection include cooperative agreements, donations, land exchanges, purchase of easements, and fee-simple title acquisition. In order to fulfill the recovery objectives, the mechanism chosen for colony site protection must provide long-term protection which will not be affected by changes in landowner attitudes or sale of property. The most effective means of providing the needed protection is fee-simple title acquisition. Purchase of easements will be of value in some cases, however, the future management of such areas may be troublesome to the responsible agencies. Cooperative agreements have functioned well in providing short term authority to protect and manage colony sites. These agreements do not provide the long-term protection necessary to insure the continued existence of these animals as they may be easily cancelled by the landowner. Cooperative agreements should be recognized as temporary measures. They should be used after attempts such as fee-simple title acquisition and purchase of easements have failed or as interim measures prior to obtaining more permanent protection.

3.1.1 Reassess all existing habitat protection measures. All existing cooperative agreements should be reviewed to determine if adequate long-term protection has been provided. If these agreements are found to be inadequate in providing the necessary long-term protection, they should be replaced preferably by fee-simple title acquisition or purchase of easements. Landowners that are not willing to sell may be receptive to a habitat protection easement containing a clause providing the purchasing agency 'the first option to buy' if the landowner should ever decide to sell the property in the future.

3.2 Determine impact of human disturbance on colony population trends. This item will require that the level of human visitation be determined for several study caves. Preferably this would be done by monitoring human entry into certain caves to obtain a quantitative measure of human visitation. If this cannot be done, it will be necessary to categorize the caves based on evidence of human visitation (e.g., footprints in the cave, trash, etc.) in a qualitative manner (e.g., heavy visitation, moderate visitation, low visitation). The amount of human visitation will then be compared to the population trends obtained in item 1.2 to assess the impact of human disturbance on the maternity colony.

3.3 Study and manage cave gating. Gating is the most effective publicly acceptable barrier available for limiting human access to caves. Unfortunately, a full gate (one extending from floor to ceiling and wall to wall) also hinders the passage of big-eared bats into and out of a cave. The purpose of the actions listed below is to determine if the benefits of cave gates outweigh the negative impacts for endangered bats and to attempt to improve gate designs.

3.3.1 Determine long-term impact of existing gates on maternity colony populations. This item will require that data obtained in item 1.2 be organized to allow comparison of population trends at gated caves, ungated caves with low human disturbance and ungated caves with high human disturbance. No full gates should be built during the four year study period. This will allow determination of the long term impacts of full gates on maternity colonies before proceeding with additional gating efforts. If immediate gating seems to be necessary to prevent loss of a colony by excessive human visitation, the gating should be coordinated with bat authorities and the coordinator identified in item 8, and a study should be designed and implemented to reveal changes in behavior of the bats as a result of erection of the gate.

3.3.2 Gather information on behavior, predation, and environmental problems resulting from gates on maternity colonies. In carrying out item 1.2, information on behavioral changes and predation associated with gates should be accumulated. The current gating study being conducted by Patuxent Wildlife Research Center will provide information on the effects of cave gating on behavior, predation, air flow, temperature, and humidity. Although this study will focus on the endangered gray bat, it is anticipated that it will provide insight into the problems of big-eared bats as well.

3.3.3 Modify or remove problem-causing gates. The populations of big-eared bats at gated caves should be monitored carefully through item 1.2. Gates which appear to be causing population declines should be either modified to alleviate the problem or be removed and replaced with an alternative means of protection.

3.3.4 Design and test gates to alleviate problems revealed in 3.3.1 and 3.3.2. The Patuxent study, mentioned in 3.3.2, will attempt to design and test gates to alleviate behavioral and predation problems. Improvements in gate design resulting from the Patuxent study on gray bats or from other studies should be tested on big-eared bat maternity colonies, if this seems appropriate.

3.3.5 Revise recovery plan position on gating maternity colonies. After completion of items 3.3.1 through 3.3.4, the recovery plan should be revised to reflect conclusions on the impacts of gating maternity colonies resulting from those work items. The role of gating in the recovery of big-eared bats will be assessed in the revised plan. This revision should be conducted before gating is re-initiated.

3.3.6 Develop information on effects of gating a hibernaculum. No information is currently available on the impacts of gating hibernacula upon big-eared bat populations. Possible concerns include increased predation and loss of significant energy reserves due to increased circling by big-eared bats during swarming. However, experiences at gated gray bat and Indiana bat hibernacula indicate that properly designed gates probably would have a positive influence on big-eared bat populations. Due to these uncertainties, the gating of big-eared bat hibernacula must be undertaken in a cautious manner.

3.3.6.1 Gather information on any existing gates on hibernacula of non-endangered big-eared bats. There is apparently at least one gated hibernaculum on Bureau of Land Management property in New Mexico. Information on the impact of this and any other gates upon hibernating big-eared bat populations should be made available.

3.3.6.2 Gate one hibernaculum. Initially a single hibernaculum that appears to be in need of protection should be selected as a test situation. If possible, this should be done concurrently with the maternity gating study, item 3.3.1. Sufficient annual population data should be gathered prior to and after construction of the gate to allow assessment of the gate's impact upon the population. Data now being gathered on gated gray bat and Indiana bat hibernacula will also be utilized in drawing conclusions concerning the effects of gating big-eared bat caves. Once this has been done, the recovery plan should be revised to direct the further treatment of hibernacula in regard to gating. During the study period, a hibernating population in imminent danger may be protected by gating, but only after coordination with other bat authorities and the coordinator identified in item 8.

3.3.7 Maintain fences and gates. All fences and gates which are functioning in the conservation of big-eared bat populations must be maintained to insure their continued effectiveness.

3.4 Place warning/interpretive signs at cave entrances. Gates and fences should be accompanied by a warning/interpretive sign (See Appendix 7). Placement of a warning/interpretive sign at an ungated, unfenced cave must be considered carefully. In many cases it may attract people to the cave and actually increase human disturbance of the colony. In some cases, however, a sign placed to avoid attracting undue attention to a colony site (for example, a sign placed in a cave passage not visible from outside the cave) may be a positive measure in colony protection. The decision whether or not to utilize signs at ungated, unfenced caves will be left up to the biologist most knowledgeable on the subject colony and its needs.

3.5 Utilize law enforcement agencies to protect colony sites.

The law enforcement agency (Federal, State, or local) most capable of responding to cave trespass and vandalism at each Table 1 and 2 colony site will be identified. Efforts will be made to ensure that this agency will respond promptly to landowner complaints regarding cave trespass and vandalism. Personnel of the identified agency shall be informed of big-eared bat conservation efforts and familiarized with colony site locations and landowners. Each colony site landowner will be informed of the law enforcement agency contact to whom incidents of cave trespass and cave-related vandalism should be reported. It may be determined that at certain caves this action will not benefit bat conservation. In such a case, the coordinator identified in Task 8 will be so informed and no additional action will be taken.

4. Protection of caves providing habitat for solitary big-eared bats.

The importance of protecting caves that provide habitat for solitary and transient big-eared bats is poorly understood (See Task 2.3 and Appendix 1). Therefore, the responsible agencies (identified in Appendix 8) should be encouraged, but not required, to protect such habitat. The need for increased protective efforts for such habitat should be considered in the annual reviews and revisions of this plan.

5. Prevent adverse modifications to essential habitat. Appropriate subsurface and surface habitat must be maintained to insure the continued survival and recovery of these bats.

5.1 Prevent adverse modifications to the subsurface, including entrances. Adverse modifications to the subsurface which would alter the suitability of cave environments for big-eared bats should be identified and eliminated or prevented. No such modifications are known to exist currently.

5.2 Determine surface habitat used by maternity and hibernating colonies. In order to evaluate the impacts of past and future surface modifications, the following information regarding surface habitat use and habitat requirements must be obtained:

a. requirements for forest cover;
b. habitat used for foraging areas;
c. distance from colony to foraging areas;
d. movements of bats to and from foraging areas;
e. changes in nightly movements and habitat use throughout the year;
f. alternate night roost sites; and
g. significance of water quality in vicinity of colony site.

This information will be used to identify and conserve habitat essential to the maintenance and growth of each colony (Task 5.3, 5.4, 5.5, and 5.6).

5.2.1 Conduct pilot study to select and test the most appropriate means of obtaining information required in Task 5.2. Problems involved in tracking a small flying mammal in the dark will make fulfillment of Task 5.2 difficult. Therefore, the objectives of this task will be to study the available means of gathering such data, select an appropriate technique and test the technique. Possible techniques include use of cyalume tags, light emitting diodes, ultrasonic monitors, standard radio telemetry, and back scatter tags with portable tagged material detectors. Cyalume tags should not be used as they could poison the bat if it should bite into the capsule. Light emitting diodes may be of value if the light is bright enough to see and the bat does not pull the tag off. Ultrasonic monitors may be useful in determining habitat use but will not allow tracking of a given animal. Weight is the primary problem in the use of standard radio telemetry techniques on small bats. It has been recommended that telemetry devices not weigh more than 3% of a flying animals body weight in order to avoid behavior changes. Therefore, an appropriate radio transmitter and battery for a 13 gram big-eared bat should weigh about 0.39 grams. Unfortunately, the smallest radio transmitter and battery currently available weighs 1.1 grams.

An alternative to standard radio telemetry techniques might be the use of back scatter tags and portable tagged material detectors. The energy required for detection of a 'back scatter tag' originates from the observors 'portable tagged material detector'. The tag extracts energy from the electromagnetic waves beamed toward it by the detector and reradiates the signal back to the detector. The tag is very light (.25 grams) as it does not need its own battery. The tracking range of this type of technique is 500 to 1,000 feet. Each tag can be electronically coded for identification in the field. The tag life is 3 to 4 years. This technique has not been previously used in wildlife management but appears to offer great promise in the tracking of small flying animals.

5.2.2 Conduct a study to obtain information required in Task 5.2. Utilizing the technique identified in Task 5.2.1, obtain the information required in Task 5.2 in such a manner that it will be useful throughout the range.

5.3 Identify essential surface habitat for each colony site. Surface habitats identified in 5.2 (above) must be conserved to provide for maintenance and expansion of each colony. Until such time as 5.2 above is completed, the area within a radius of 1 mile of each colony site shall be considered to contain habitat essential to the colony. This essential habitat will be monitored by the Fish and Wildlife Service for potential threats.

5.4 Protect essential surface habitat. The Fish and Wildlife Service or other appropriate agency should obtain the authority to conserve the essential surface habitat identified in Task 5.3. The mechanisms to accomplish this (i.e. fee-simple title acquisition, purchase of easements, or conservation agreements) should be chosen in light of comments made in Task 3.1.

5.5 Include surface and subsurface habitat in Section 7 consultation process. Data developed in items 5.2 and 5.3 must be utilized in Section 7 evaluations of projects in the vicinity of the colony sites.

5.6 Make locations of important roost sites and surface habitat available to agencies able to assist in protection. Data developed in 5.2 and 5.3 should be distributed to all such agencies. Colony site locations should be considered confidential and should be restricted to agencies which will be assisting in protecting or managing these sites.

5.7 Prevent pollution of big-eared bat habitat. Chemical and biological pollution are not known to currently constitute a threat to any big-eared bat colonies. However, it seems prudent for the Fish and Wildlife Service to take steps to insure that such problems do not arise.

5.7.1 Gather data on toxic substances used in big-eared bat habitat. Information should be maintained on toxic substances introduced into the environment in the vicinity of colony sites and foraging areas.

5.7.2 Gather baseline data on current toxic substance exposure of big-eared bats. An organized effort to collect guano samples from a representative number of colony sites throughout the range should be conducted. These samples should be analyzed by the Patuxent Wildlife Research Center for the presence of toxic substances. This effort must be kept in perspective with two main considerations (1) the collections must be made in a manner that will not disturb the endangered bats (i.e. guano from maternity sites must be collected in late fall or winter) and (2) the cost of the effort must be appropriate for a situation where toxic substances have not become a real threat. The coordinator (identified in Task 8) will be responsible for organizing this effort.

5.8 Study prey species. Determine prey species and the population trends of these species. This effort should allow recognition of links between big-eared bat population declines and declines in prey species availability. It will also assist in understanding the significance of surface habitat and the implications of chemical contamination of that habitat.

6. Develop and maintain public support for species protection. The ultimate fate of endangered bats depends in large part upon the level of public support and cooperation. The pursuit of public support must be carefully planned to evoke concern for survival of the big-eared bats without increasing disturbance of colony sites by curious individuals.

6.1 Landowner support. All landowners of big-eared bat habitat should be informed of the value of big-eared bats, the significance of their property to big-eared bats, and what the landowner can do voluntarily to help protect the big-eared bat. These contacts should be maintained over the years to assure continued landowner support.

6.2 Public support. Through distribution of pamphlets and newspaper articles, the general public should be informed of the value of bats in general, the value of big-eared bats, their endangered status, and the major problems for survival of big-eared bats. This should be done in a low key, non-sensational manner that divulges only the counties and states in which the colonies occur.

6.3 Caver support. The cooperation of caving groups must be sought in educating their members on the need to avoid disturbance of big-eared bat colonies. This may be done through slide presentations, pamphlets and articles in the organization's newsletter. Whenever possible, local caving groups should be involved in efforts to protect big-eared bats in order to foster a commitment to bat conservation among these groups. Willing landowners could be encouraged to open their caves to sport spelunkers during periods when bats are not present.

7. Prepare and maintain a management profile for each colony site. A management profile should be prepared and maintained on each colony site to include: (a) name and location of the cave,

(b) name, address, and telephone number of the cave owner(s), (c) name, address, and telephone number of significant surface habitat owner(s), (d) a photograph of the entrance, (e) all available historical information on population levels of the colony, (f) results of annual surveys for maternity colonies (results of periodic surveys of hibernacula), (g) a map designating the essential habitat, (h) measures taken or planned to protect surface and subsurface habitat from human disturbance, (i) an album of aerial photographs to encompass a minimum of one mile radius around the colony site (photographs should be taken at 5 year intervals to reveal land use changes and should be of appropriate scale to allow identification of all relevant features), (j) a brief history of known human use of the cave and a diary of human disturbance of the site to be maintained as such events occur, (k) a copy of the cooperative agreements with the landowners, and (l) a record of any incidences of predation or other natural disturbances.

8. Appoint a coordinator for all recovery and research efforts. A single individual or a group of individuals should be appointed to coordinate the recovery and conservation effort throughout the range of these endangered subspecies. This is necessary because of the great distances between colony sites and lack of coordination among biologists working at these sites. All plans for recovery and conservation efforts throughout the range will be submitted to this individual for coordination. The coordinator will assure that each action is consistent with the recovery plan and the well-being of these bats.

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PART III: IMPLEMENTATION SCHEDULE

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

Priority 1 - All actions that are absolutely essential to prevent extinction of the species.

Priority 2 - All actions necessary to maintain the species' current population status.

Priority 3 - All other actions necessary to provide for full recovery of the species.

LIST OF ABBREVIATIONS

Arkansas Department of Parks and Tourism = ADPT
Arkansas Game and Fish Commission = AGFC
Bureau of Land Management = BLM
Denver Wildlife Research Center = DWRC
Endangered Species Program (Federal) = SE
Kentucky Department of Fish and Wildlife Resources = KDFWR
Missouri Department of Conservation = MDC
Missouri Division of Parks and Historic Preservation = MDPHP
National Park Service = NPS
Office of Endangered Species = OES
Oklahoma Department of Wildlife Conservation = ODWC
Oklahoma Tourism and Recreation Department = OTRD
Patuxent Wildlife Research Center = PWRC
The Nature Conservancey = TNC
U.S. Fish and Wildlife Service = USFWS
U.S. Forest Service = USFS
Virginia Commission of Game and Inland Fisheries = VCGIF
West Virginia Department of Natural Resources = WVDNR

Part III Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency FWS Region	Responsible Agency FWS Program	Responsible Agency Other	Estimated Fiscal Year Costs FY 1	FY 2	FY 3	Comments/Notes
R1	Study June behavior of other bat species in big-eared bat maternity colonies	1.1	2	2 mos.	5	SE	Contract	$2000			
R1	Monitor status of populations in maternity colonies	1.2	1	1-14 days per year	2	SE	ODWC Contract	$900	900	900	Conduct four consecutive annual surveys.
					3	SE	MDC	$300	300	300	Funding may have to be increased if new colonies are found.
					4	SE	AGFC KDFWR	$900	900	900	
					5	SE	WVDNR VCGIF	$3000 300	3000 300	3000 300	
R1	Survey all hibernacula once every two years	1.3	2	1-3 days per year	2	SE	ODWC Contract	$600		600	Funding may have to be increased if new colonies are found.
					3	SE	MDC	$300		300	
					4	SE	AGFC KDFWR	$900 300		900 300	
					5	SE	WVDNR VCGIF	$1800		1800	

Part III Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency FWS Region	Responsible Agency FWS Program	Responsible Agency Other	Estimated Fiscal Year Costs FY 1	FY 2	FY 3	Comments/Notes
R1	Search for maternity colonies	2.1	1	up to 1 month per year	2	SE	ODWC Contract	$2000	2000	2000	
			1		3	SE	MDC	$4000	4000	4000	
			2 1		4	SE	AGFC KDFWR	$2000 4000	2000 4000	2000 4000	Funding for AR search (2000) Funding for KY search (4000)
			3 1		5	SE	WVDNR VCGIF	$1500 3000	1500 2000	1500 2000	
R1	Search for hibernacula	2.2	1	up to 1 month per year	2	SE	ODWC	$2000	2000	2000	
			1		3	SE	MDC	$4000	4000	4000	
			2 2		4	SE	AGFC KDFWR	$2000 2000	2000 2000	2000 2000	Funding for AR search (2000) Funding for KY search (2000)
			1 1		5	SE	WVDNR VCGIF	$4000	4000	4000	
R1	Caves providing habitat for solitary big-eared bats.	2.3	3	continu-ous	2,3,4,5	SE	ODWC MDC AGFC KDFWR WVDNR VCGIF	-	-	-	This information should be generated as a result of funding Task 2.1 and 2.2. This task will require compilation of data on such caves found during the conduct of Task 2.1 and 2.2.
A1-7	Obtain long-term authority to manage and protect colony sites.	3.1	1	3 years	2,3,4,5	SE	ODWC MDC AGFC KDFWR WVDNR VCGIF	-	-	-	Utilize existing program funding.
M3	Reassess all existing habitat protection measures	3.1.1	1	3 years	5	SE	WVDNR	-	-	-	

Part III Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency FWS Region	FWS Program	Other	Estimated Fiscal Year Costs FY 1	FY 2	FY 3	Comments/Notes
R3	Determine impact of human disturbance on colony population trends.	3.2	1	6 days	2	SE	ODWC Contract	2000	2000	2000	
				3 days	3	SE	MDC	500	500	500	
				6 days 6 days	4	SE	KDFWR AGFC	2600 2000	2600 2000	2600 2000	
				15 days	5	SE	WVDNR VCGIF	4900	4900	4900	
R4	Determine long-term impact of existing gates on maternity colony populations.	3.3.1	1		5	SE		-	-	-	Utilize existing program funding. Involves organization of data from Tasks 1.2 and 3.2 and report preparation.
R4	Gather information on behavior, predation, and environmental problems resulting from gates on maternity colonies.	3.3.2	1	Continuous	2,3,4,5	SE	ODWC MDC AGFC KDFWR WVDNR VCGIF	-	-	-	Information to be gathered concurrent with Tasks 1.2, 1.3 and PWRC endangered bat cave gating study.
M3	Modify or remove any problem-causing gates.	3.3.3	1	Continuous	2,5	SE	ODWC WVDNR	-	-	-	Cost undetermined.
R4	Design and test gates to alleviate problems revealed in Tasks 3.3.1 and 3.3.2	3.3.4	1	Undetermined	PWRC 4,5	SE		-	-	-	This task should be incorporated into the ongoing PWRC cave gating study. All actions under this task should be coordinated with the Task 8 coordinator.
M3	Revise recovery plan position on gating maternity colonies.	3.3.5	1	1 month	3	SE		-	-	-	Utilize existing program funding.

Part III Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency FWS Region	FWS Program	Other	Estimated Fiscal Year Costs FY 1	FY 2	FY 3	Comments/Notes
I4	Gather information on any existing gates on hibernacula of non-endangered big-eared bats.	3.3.6.1	2	up to 1 month	3	SE	BLM	-	-	-	Utilize existing program funding.
R4	Gate one hibernaculum.	3.3.6.2	2	up to 1 month	3	SE					Cost undetermined.
M3	Maintain fences and gates	3.3.7	1	Continuous	5	SE		2300	2300	2300	
M3	Place warning/interpretive signs at cave entrances.	3.4	3	up to 1 week	2,3,4, 5	SE	ODWC MDC AGFC KDFWR WVDNR VCGIF	-	-	-	Cost undetermined.
O2	Utilize law enforcement agencies to protect colony sites.	3.5	2	Continuous	2,3,4, 5	SE	ODWC MDC AGFC KDFWR WVDNR VCGIF				Utilize existing program funding. In some cases additional funding may be necessary.
M3	Protection of caves providing habitat for solitary big-eared bats.	4	3	Continuous	2,3,4, 5	SE	ODWC MDC AGFC KDFWR WVDNR VCGIF	—	—	—	
M3	Prevent adverse modifications to the subsurface, including entrances.	5.1	3	Continuous	2,3,4 5	SE	ODWC MDC AGFC KDFWR WVDNR VCGIF	-	-	-	

Part III Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency FWS Region	Responsible Agency FWS Program	Responsible Agency Other	Estimated Fiscal Year Costs FY 1	FY 2	FY 3	Comments/Notes
R3	Conduct pilot study to select and test the most appropriate means of obtaining information required in Task 5.2 (information on habitat use).	5.2.1	2	4-6 mos.	DWRC 4,5	SE	Contract	40,000			The investigation into use of back scatter tags and portable tagged material detectors could be jointly funded by the animal damage control program migratory bird program and endangered species program.
R3	Conduct a study to obtain information required in Task 5.2.	5.2.2	2	2-3 years	2,3,4, 5	SE	Contract	-	-	-	Cost undetermined.
I3	Identify essential surface habitat for each colony site.	5.3	2	Undetermined.	2,3,4, 5	SE	Contract	-	-	-	Cost undetermined.
M3	Protect essential surface habitat.	5.4	2	Continuous	2,3,4, 5	SE	ODWC MDC AGFC KDFWR WVDNR VCGIF	-	-	-	Utilize existing program funding.
M3	Include surface and subsurface habitat in Section 7 consultation process.	5.5	2	Continuous	2,3,4, 5	SE		-	-	-	Utilize existing program funding.
M3	Make locations of important roost sites and surface habitat available to agencies able to assist in protection	5.6	2	Continuous	2,3,4, 5	SE		-	-	-	Utilize existing program funding.
I12	Gather data on toxic substances used in big-eared bat habitat.	5.7.1	3	Continuous	2,3,4 5	SE		-	-	-	Utilize existing program funding.

Part III Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency: FWS Region	Responsible Agency: FWS Program	Responsible Agency: Other	Estimated Fiscal Year Costs: FY 1	Estimated Fiscal Year Costs: FY 2	Estimated Fiscal Year Costs: FY 3	Comments/Notes
R12	Gather baseline data on current toxic substance exposure of big-eared bats.	5.7.2	3	See note	2,3,4,5 PWRC	SE	ODWC MDC AGFC KDFWR WVDNR VCGIF	3575			Collection of samples will require a few days. The chemical analysis will require a longer time period.
R3	Study prey species.	5.8	3	2 years	2,4,5	SE	Contract	5000	5000		
01	Develop and maintain landowner support.	6.1	1	Continuous	2	SE	ODWC	500	500	500	Cost includes chemical analysis for organochlorines and heavy metals, and does not include travel costs for sample collection.
					3	SE	MDC	300	300	300	
					4	SE	KDFWR AGFC	300 300	300 300	300 300	
					5	SE	VCGIF WVDNR	1000	1000	1000	
01	Develop and maintain public support.	6.2	3	Continuous	2	SE	OTRD	-	-	-	Utilize existing funding to interpret value of endangered bats. USFS may incorporate endangered bats into nature talks at Seneca Rocks Visitor Center, West Virginia and at Blanchard Spring Caverns in Arkansas with the guidance of appropriate SE personnel. Talks must not include cave locations. NPS (at Shenandoah National Park and Blue Ridge Parkway) should incorporate discussion of endangered bats into nature talks on wildlife of the Appalachians with guidance of SE personnel.
					3	SE	MDPHP	-	-	-	
					4	SE	ADPT USFS	-	-	-	
					5	SE	USFS NPS	-	-	-	

Part III Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency FWS Region	Responsible Agency FWS Program	Other	Estimated Fiscal Year Costs FY 1	FY 2	FY 3	Comments/Notes
01	Develop and maintain caver support.	6.3	2	Continuous	2,3,4,5			-	-	-	Utilize existing program funding.
M3	Prepare and maintain a management profile for each colony site.	7	3	Undetermined	2,3,4,5			-	-	-	Utilize existing program funding.
04	Appoint a coordinator for all recovery efforts	8	2	Continuous	OES			-	-	-	Utilize existing program funding.
											Note: The hibernaculum at Black Rock Cliff Cave, North Carolina, was reported after the final draft of this plan was completed. The recovery tasks do not therefore mention this colony specifically or the need for surveys and protection of P. townsendii in North Carolina. Appropriate funding for each task should be provided to insure protection of P. townsendii in North Carolina.

APPENDIX 1: LIST OF CAVES PROVIDING HABITAT FOR SOLITARY BIG-EARED BATS

Table A. Caves providing habitat for solitary Ozark big-eared bats in Oklahoma

County	Cave	Maximum Past Population	Date	Maximum Recent Population	Date	Source
Adair	AD-2	2	August 7, 1980	1	May 23, 1983	W.L. Puckette
Adair	AD-6	1	October 30, 1982	1	Nov. 5, 1983	W.L. Puckette
Adair	AD-7	1-2	NA	NA	NA	W.L. Puckette
Adair	AD-8 (gate regrilled 3/82)	1	1960's	0	Dec. 22, 1983	Don Russell/ W.L. Puckette
Adair	AD-12	1	August 14, 1980	1	July 3, 1982	W.L. Puckette
Adair	AD-15	3	August 28, 1957	1 2	July 15, 1982 Dec. 29, 1983	W.L. Puckette
Adair	AD-17 (probable alternate maternity site for AD-18)	formerly of significant size	1960's & 1970's	1	Summer, 1981 and 1982	W.L. Puckette
Adair	AD-25	NA	NA	1	May 28, 1983	W.L. Puckette
Adair	AD-29	NA	NA	1	July 9, 1982	W.L. Puckette
Adair	AD-30	NA	NA	1	July 10, 1982	W.L. Puckette
Adair	AD-49	NA	NA	5	Summer 1983	W.L. Puckette

Table A. Caves providing habitat for solitary Ozark big-eared bats in Oklahoma (contd)

County	Cave	Maximum Past Population	Date	Maximum Recent Population	Date	Source
Cherokee	CZ-9	NA	1980	0	June 23, 1982	W.L. Puckette
Cherokee	CZ-10	20-25	Early spring, 1968	0	March 14, 1981 July 20, 1982	W.L. Puckette
Cherokee	CZ-11	5-10	Early spring, 1968	0	March 14, 1981 July 20, 1982	W.L. Puckette
Delaware	DL-4	Reports vary from 0 to several hundred	1960-1972	1	March 20, 1981 January 2, 1982 Dec. 21, 1983	W.L. Puckette
Delaware	DL-21	10-20	1965-1972	1 2	Feb. 19, 1983 Dec. 21, 1983	W.L. Puckette
Sequoyah	SQ-2	2	1927	NA	NA	W.L. Puckette

Table B. Caves providing habitat for solitary Ozark big-eared bats in Arkansas

A Marion County mine, 1 individual, February 1974., M. Harvey

Hewlitt Cave, at least 1 individual, December, 1950
12 miles west of Fayetteville, Washington County, John Sealander

Basset Cave, near Hicks, Washington County, number of individuals unknown, November 1951. Arkansas Academy of Science, Sealander and Young, 1955, Vol 7:21-31

Table C. Caves providing habitat for solitary Ozark big-eared bats in Missouri

Dillo Cave, Stone County, late 1960's, a few, undocumented

Meade Cave, Stone County, Dec. 31, 1957, one female and 3 others unsexed. personal communication Dick Myers and Rick Clawson.

Sullivan Cave, Stone County, Dec. 31, 1957, two females and 2 males, personal communication Dick Myers and Rick Clawson.

Chimney Rock Cave, Barry County, Jan. 1, 1958, 3 unsexed, personal communication Dick Myers and Rick Clawson.

Note: Summer, 1981, these caves were revisited but no big-eared bats were observed (personal communication Dick Myers and Rick Clawson).

Table D. Caves providing habitat for solitary Virginia big-eared bats in Kentucky

County	Cave	Maximum Past Population	Date	Maximum Recent Population	Date	Source
Lee	Cave Hollow Pit	5	March 25, 1979	1	March 23, 1983	J. MacGregor
Lee	Cave Hollow	1	December 29, 1979	0	March 23, 1983	J. MacGregor
Lee	Cathedral Domain	2	October 24, 1964	0	Dec. 28, 1980	M. Harvey and J. MacGregor
Lee	Armine Branch	2	NA	3	March 23, 1983	J. MacGregor
Lee	Winding Stair	1	May 15, 1964	1	NA	M. Harvey and J. MacGregor
Powell	Natural Bridge	1	NA	0	March 23, 1983	J. MacGregor
Powell	Cave Branch (= Ace Bowen Cave)	NA	NA	2	November 1980	J. MacGregor
Jackson	Johnson	6	March, 1977	1	March 24, 1983	J. MacGregor
Jackson	Bowman Saltpeter	2	January 12, 1979	3	March 24, 1983	J. MacGregor
Rockcastle	Goochland	NA	NA	1	Feb. 15, 1981	J. MacGregor
Lee	Pinnacle	1	May 15, 1964	1	Oct. 24, 1964	M. Harvey
Lee	Spruce Pine	2	October 24, 1964	0	Dec. 28, 1980	M. Harvey
Menifee	Murder	NA	NA	4 1	Winter 1982 January 1984	L. Meade J. MacGregor
Morgan	No name	NA	NA	3	January 1984	J. MacGregor

Table E. Caves providing habitat for solitary Virginia big-eared bats in Virginia

Better Forgotten Cave, Highland County, single individual, Conrad, 1961.

Breathing Cave, Bath County, single individual, Conrad, 1961.

Dove Cave, Shenandoah County, single individual, Mumaw, pers. comm. 1967.

Varner's Cave, Highland County, single individual, Robinson, pers. comm. 1978.

Steele's Cave, Tazewell County, single individual, Ed Kinser, pers. comm. 1983.

Table F. Caves providing habitat for solitary Virginia big-eared bats in West Virginia

Flute Cave, Pendleton County, 6-10 individuals, September 7, 1981 J. Hall and A. Moser. 0 individuals, February 14, 1984, A. Moser, K. Knight, J. Hall and L. Walker

Mill Run Cave, Pendleton County, several individuals, October 17, 1981, F. Grady, 1 individual, July 20, 1982, 1 adult, July 26, 1983, K. Knight and John Hall. 0 individuals, February 15, 1984, A. Moser, K. Knight, J. Hall and L. Walker

New Trout Cave, Pendleton County, 1 individual, January 13, 1982 J. Hall and A. Moser

Klines Gap, Grant County, 5 individuals, January 18, 1982, J. Hall and A. Moser. 0 individuals, February 13, 1984, K. Knight, J. Hall and L. Walker

Keys Cave, Pendleton County, 1 individual, October 17, 1981 F. Grady

Sinks of Gandy, Randolph County, single individual, October 1982
Judy Jacobs

Trout Cave, Pendleton County, occasional hibernator, winter, 1981-82
J. Hall

Bowden Cave, Randolph County, 2 or 3 hibernators, winter, 1981-82
J. Hall

Cedar Hill Cave, Grant County, 1 individual hibernator, 1970's
J. Hall

Bickle Run Cave, Randolph County, 2 individuals, October 9, 1983
John Hall and K. Knight

Dyers Cave, Hardy County, 1 individual, February 17, 1976
Tom Dotson

Green Hollow Cave, Hardy County, 1 individual, February 10, 1976
Tom Dotson, 6 individuals, February 1984, A. Moser, K. Knight, L. Walker

Harper Trail Cave, Randolph County, 2 individuals, November 28, 1983
K. Knight and Harry Mahoney

Hill's Cave, Tucker County, 1 individual, November 18, 1983
L. Walker and K. Knight

Mill Run Cave, Tucker County, 12 individuals, February 18, 1981
John Delfino

New Trout Cave, Pendleton County, 1 individual, February 26, 1983
Virginia Tipton

Note: Handley, 1959, lists other caves in Kentucky, Virginia, and West Virginia with probable sightings.

APPENDIX 2. THEORIES ON THE CURRENT DISTRIBUTION OF THE OZARK AND VIRGINIA BIG-EARED BATS

According to Handley (1959), the present distribution of the endangered subspecies may be related to glacial disturbances during the Pleistocene. This epoch was characterized by an alternation of periods of warm and cold. During the warm interglacial ages, forms such as Plecotus could have been distributed across the continent from coast to coast, provided trees or caves were present. During glacial times, distribution patterns were shifted southward, contracted, and may have been split into isolated segments as ice caps moved southward.

During the Illinoian glaciation, Handley says the Plecotus forms might have been isolated into southeastern and southwestern forms which differentiated into the ancestors of Plecotus rafinesquii and Plecotus townsendii, respectively. During the following interglacial period (the Sangamon), the southwestern form apparently greatly expanded its range eastward. The two species remained genetically distinct when their ranges again came into contact.

Next, the southward advance of the Wisconsin ice caps and cooling climates again contracted the range of Plecotus and broke the wide continuous distribution of the southwestern form into several isolated segments. According to this theory, remnants of the isolated segments are now represented by the remaining populations of Ozark big-eared bats and Virginia big-eared bats. No explanation is apparent for the failure of the endangered subspecies to expand their ranges following the most recent glaciation.

Humphrey and Kunz (1976) have offered an alternative explanation of the current distribution of P. townsendii. This theory holds that the winter climate during the Wisconsin glacial period was mild, not cold as believed by Handley. P. townsendii spread across North America during this period (rather than during the earlier Sangamon interglacial period as hypothesized by Handley). At the close of the Wisconsin glacial period the climate took on its Recent characteristics and resulted in the isolation of segments of the P. townsendii populations that were able to take refuge in caves.

APPENDIX 3: NOCTURNAL ACTIVITY PATTERNS OF A MATERNITY COLONY

A study of the pattern of emergence and return of Virginia big-eared bats from two maternity colony caves in 1982 (Bagley and Jacobs, in preparation) has revealed that the nocturnal activity pattern varies as the maternity season progresses. During April, the colony emerged from the cave after 2000 hours Eastern Daylight Time (EDT) and returned before 0200 hours EDT (Figure A). By late May and early June, most of the bats emerged as darkness fell and remained outside the cave until dawn (Figure B). During the last ten days of June, a small portion of the colony returned to the cave shortly after the emergence. Many of these bats re-emerged prior to the final return for the evening (Figure C). By the end of June, an emergence of a small portion of the colony just before dawn had been added to this pattern (Figure D). By late July, the activity pattern had changed dramatically as the young began to fly from the cave each night (Figure E). This stage varied considerably from night to night but was characterized by the return of a large proportion of the colony to the cave shortly after the initial emergence. Presumably, the colonies began to break up in August. By September, the numbers of bats emerging from the cave was typically very different from the number returning. This may have indicated that bats were moving about from one cave to another prior to initiating hibernation. However, very little is known about the bats' activity during this time period.

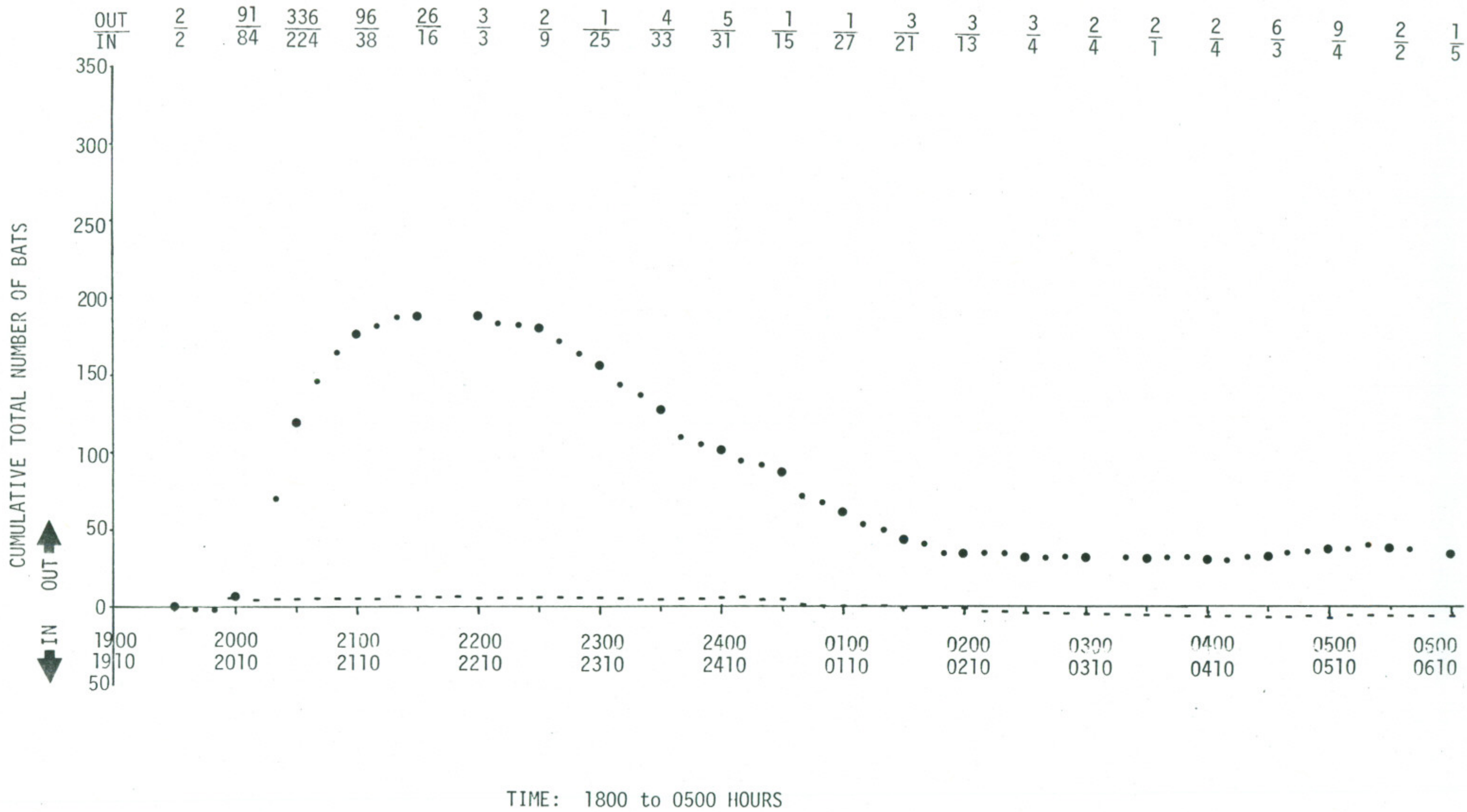


Figure A. Net movement of bats at Mystic Cave on April 23-24, 1982. During April, the colony was observed emerging from the cave after 2000 hours and returning before 0200 hours. Dots represent Virginia big-eared bats. Dashes represent all other bats. The fractions represent the number of bat flights observed going out of the cave and the number of flights observed going into the cave for the previous thirty minutes.

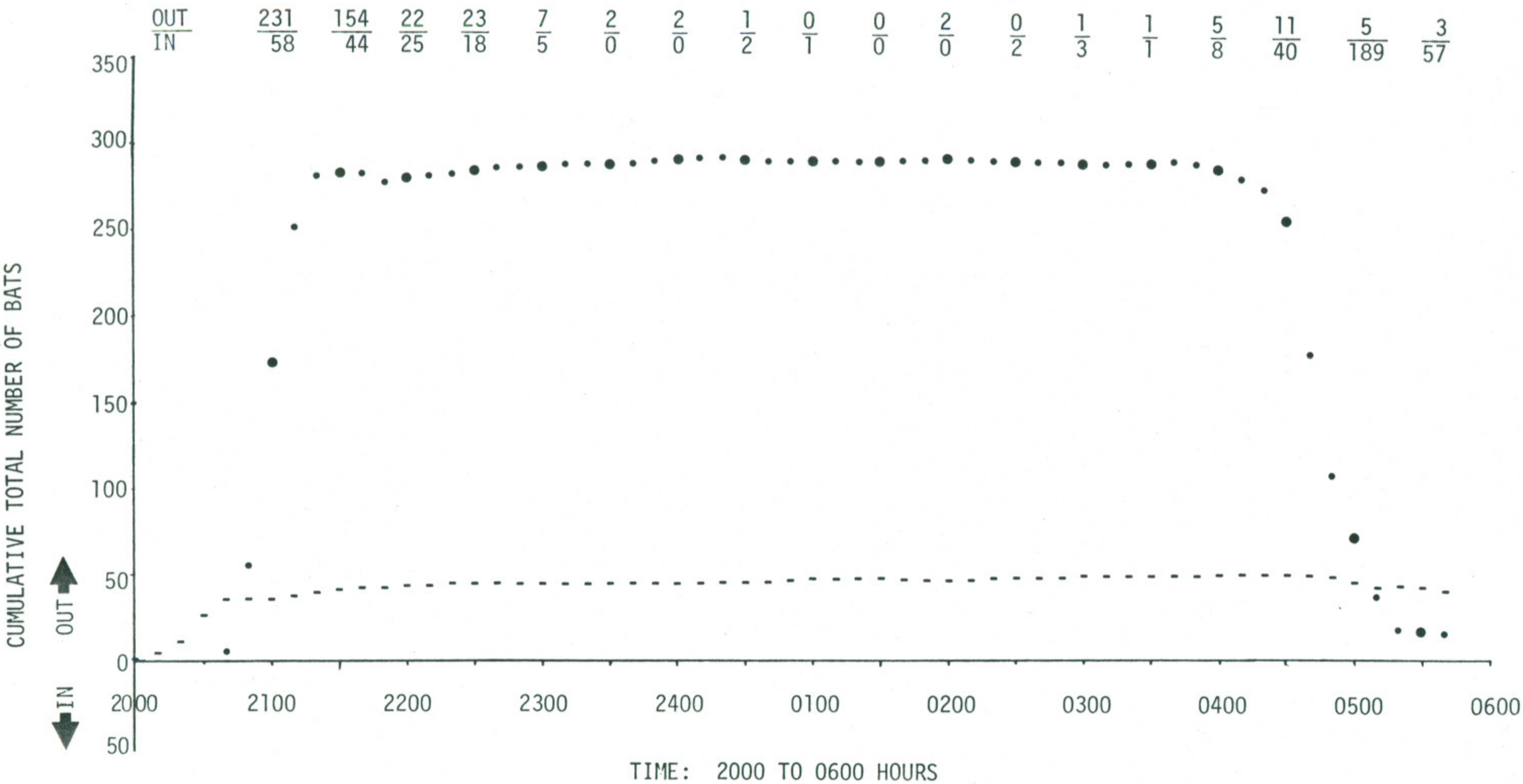


Figure B. Net movement of bats at Mystic Cave on May 22-23, 1982. By late May and early June, most of the big-ears emerged as darkness fell and remained outside the cave until they returned at dawn. Dots represent Virginia big-eared bats. Dashes represent all other bats. The fractions represent the number of bat flights observed going out of the cave and the number of flights observed going into the cave for the previous thirty minutes.

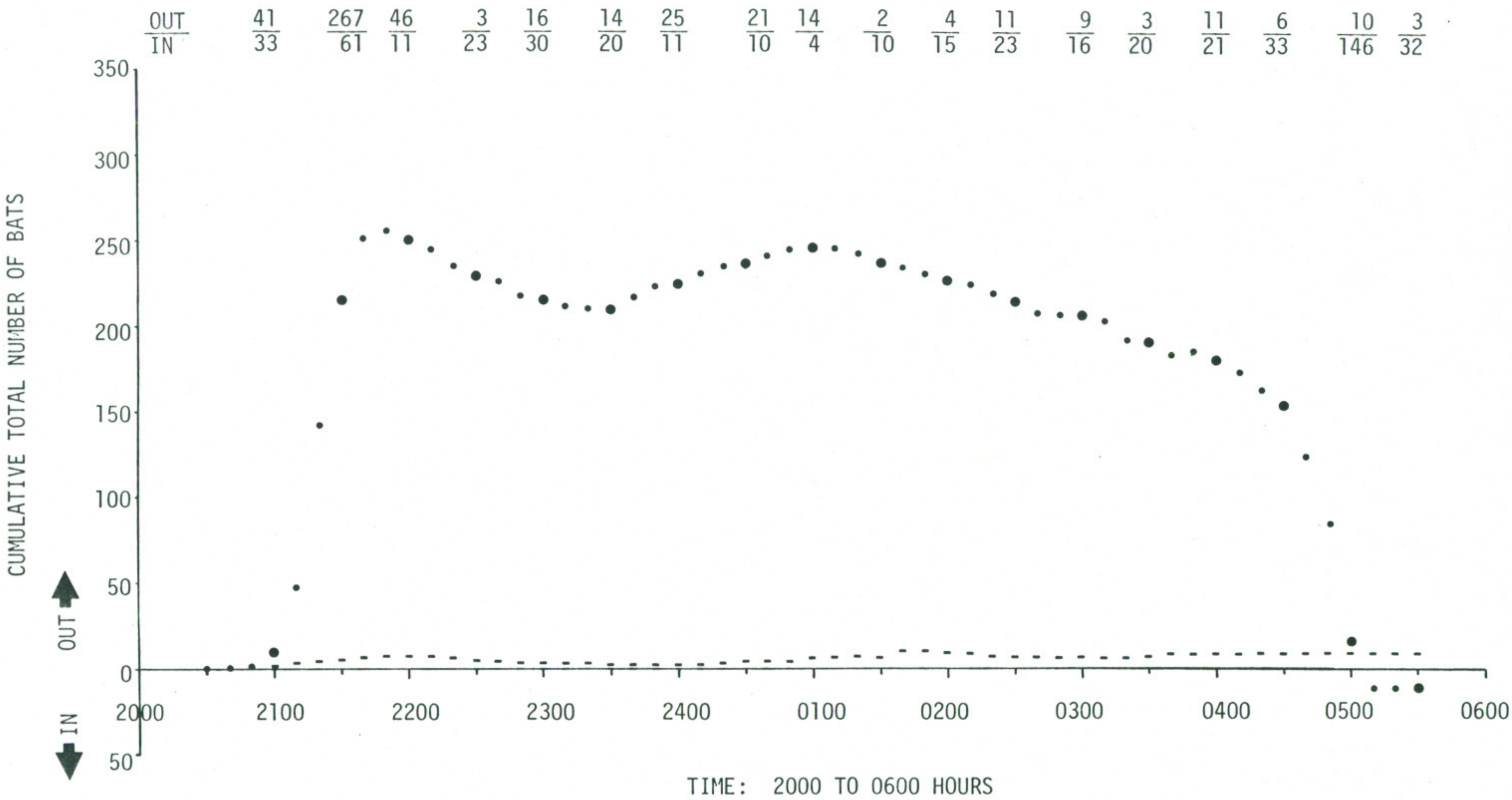


Figure C. Net movement of bats at Mystic Cave on June 24-25, 1982. During the last ten days of June, a small portion of the colony returned to the cave shortly after the emergence. Many of these bats re-emerged prior to the final return of the evening. Dots represent Virginia big-eared bats. Dashes represent all other bats. The fractions represent the number of bat flights observed headed out of the cave and the number of flights observed headed into the cave for the previous thirty minutes.

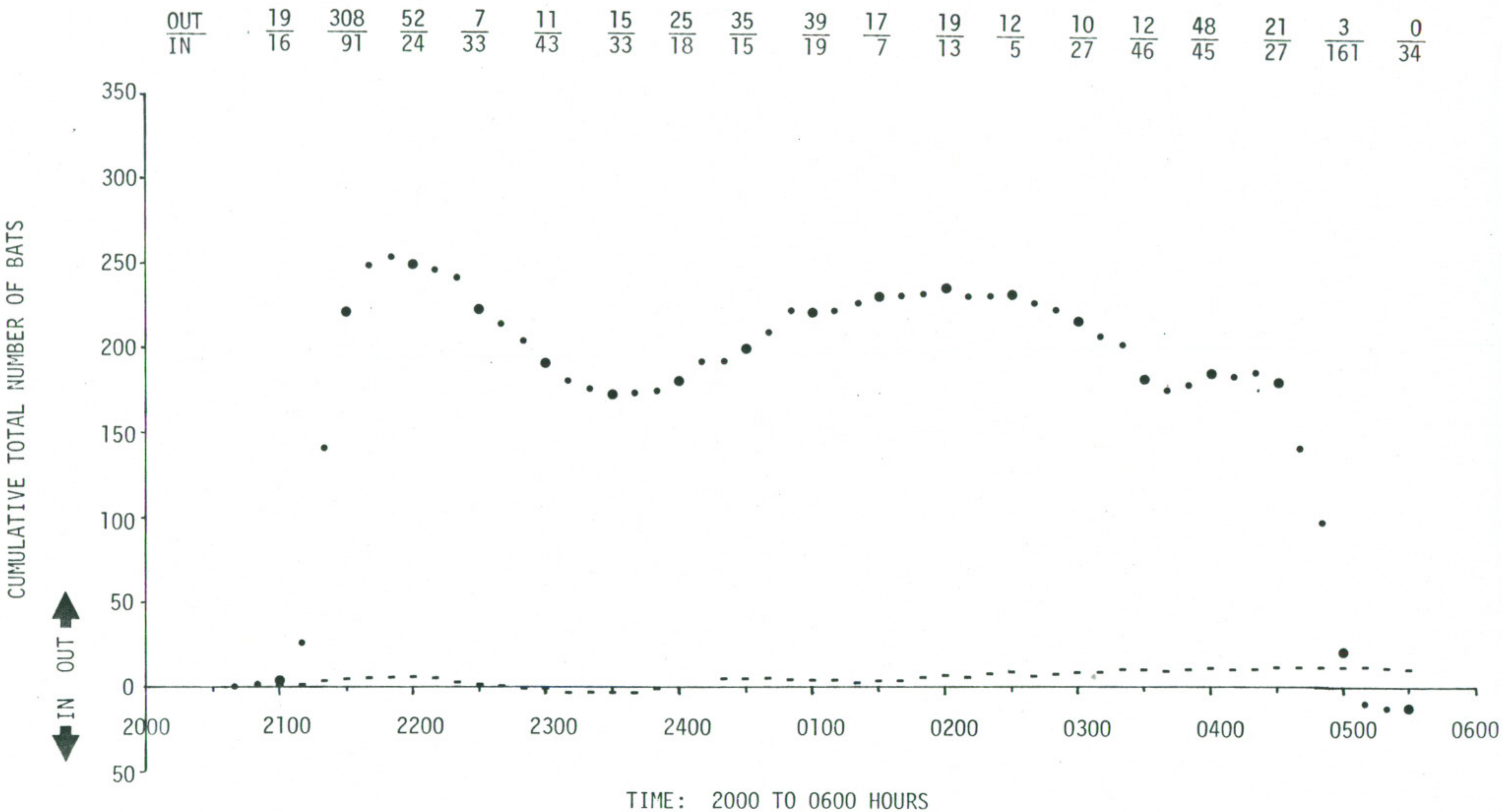


Figure D. Net movement of bats at Mystic Cave on June 28-29, 1982. By the end of June, an emergence of a small portion of the colony just before dawn had been added to the pattern observed in Figure C. Dots represent Virginia big-eared bats. Dashes represent all other bats. The fractions represent the number of bat flights observed headed out of the cave and the number of flights observed headed into the cave for the previous thirty minutes.

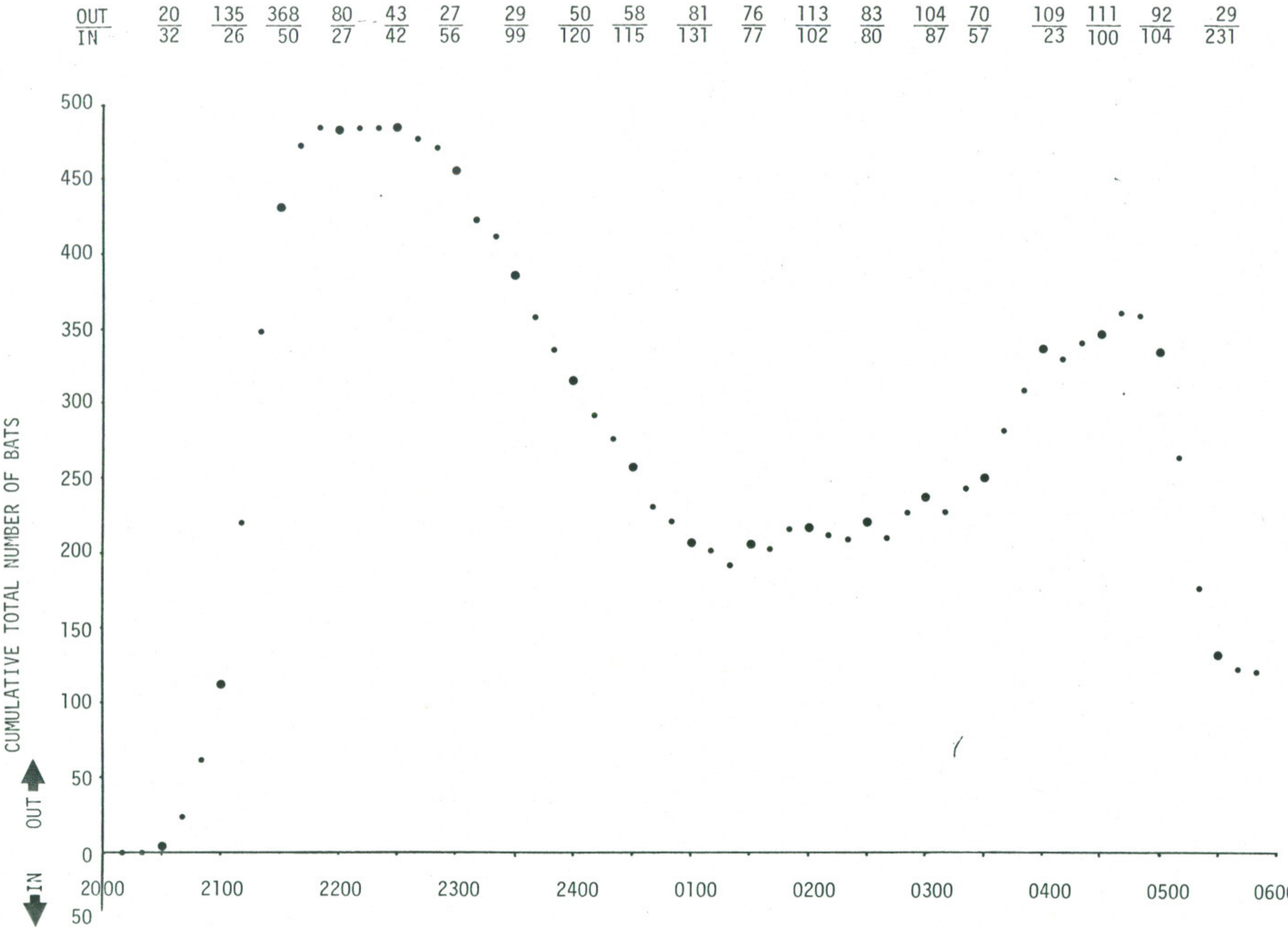


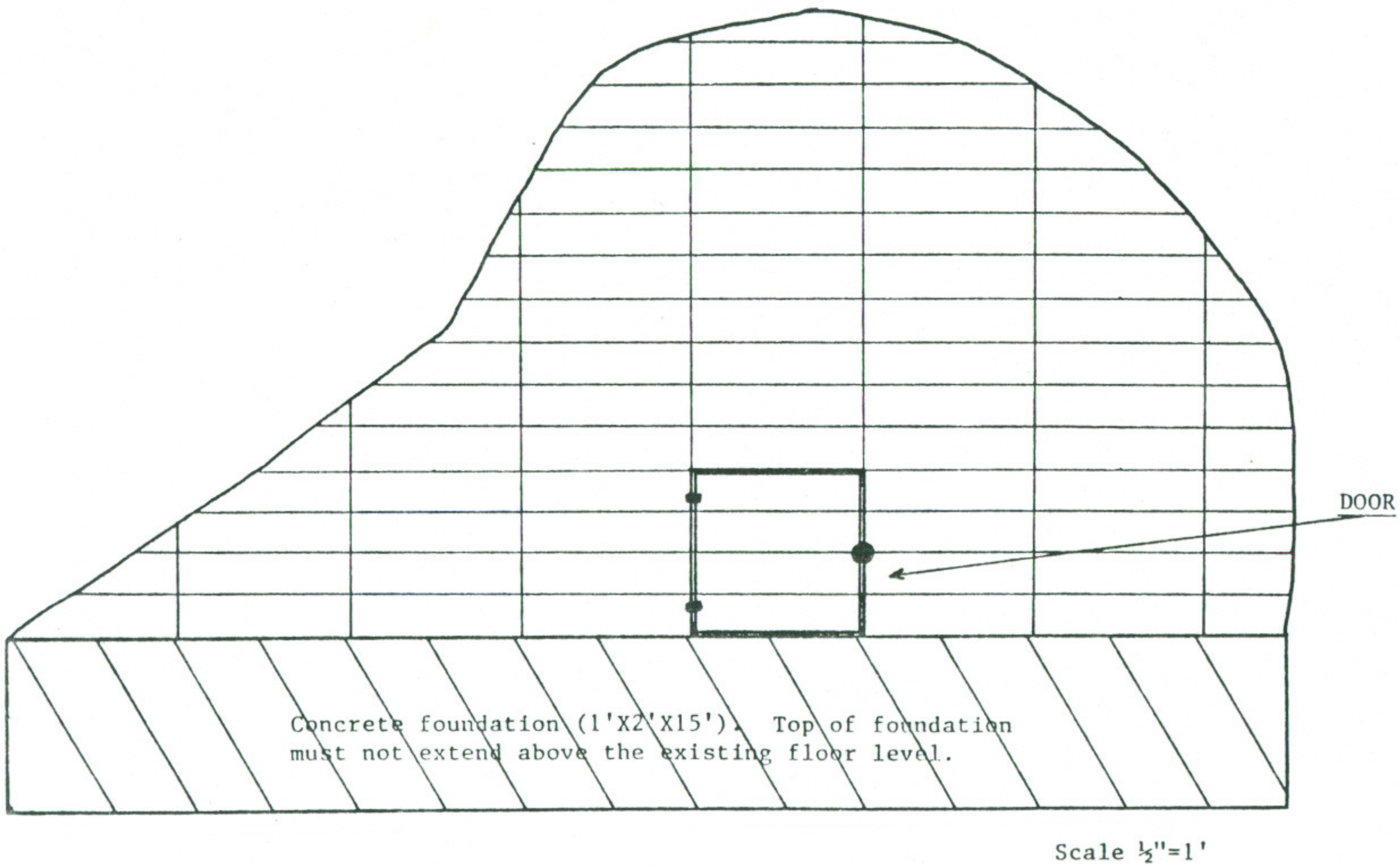
Figure E. Net movement of bats at Mystic Cave on July 22-23, 1982. By late July, the activity pattern of the colony had changed dramatically as the young began to fly from the cave each night. Dots represent Virginia big-eared bats and all others combined. The fractions represent the number of bat flights observed headed out of the cave and the number observed headed into the cave for the previous thirty minutes.

APPENDIX 4: GATE DESIGNS

Prepared by: Robert Currie
Asheville Endangered Species Field Office
Asheville, North Carolina

Bars-- Use 3/4" round steel stock (ASTM 588). Vertical bars spaced 24" edge to edge. Horizontal bars spaced 6" edge to edge. Bars embedded at least 6" into the walls and 12" into the concrete gate foundation. See the attached sheet for details of door construction.

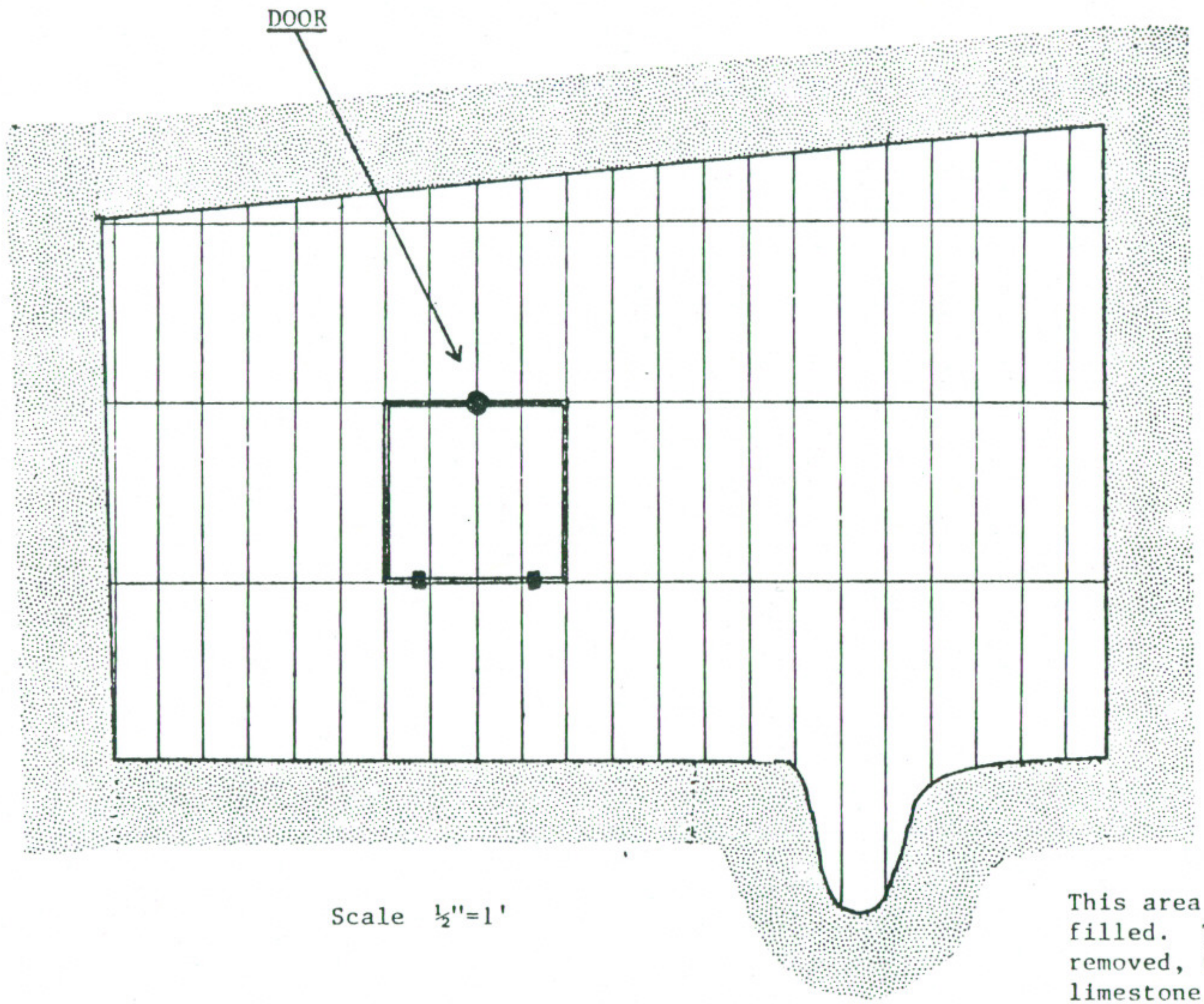
Gate to be constructed four feet inside the innermost portion of the dripline.



SINNIT CAVE GATE PLAN

Figure F.

Bars--Use 3/4" round steel stock (ASTM 588) spaced 24" edge to edge and 6" edge to edge. Bars to be embedded at least 6" into the limestone at each end. All bar intersections to be welded. See attached sheet for details of door construction.



Gate to be installed 8' below ground level at upper(uphill) end and 4' below ground level at the lower end of cave entrance.

This is a horizontal gate.

Scale ½"=1'

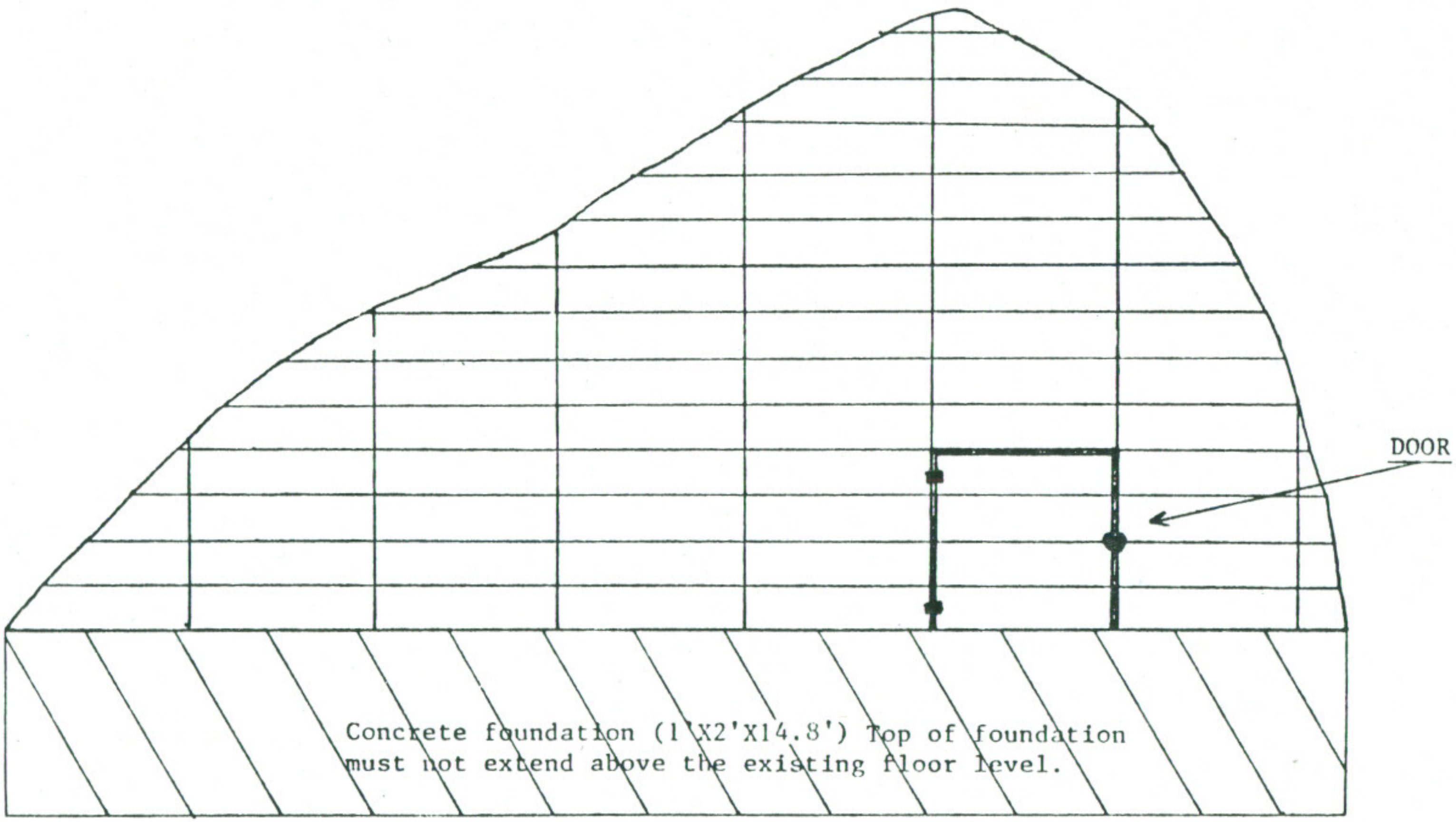
This area is currently dirt filled. The dirt should be removed, the bars embedded in limestone, and the hole filled with concrete.

THORN MOUNTAIN CAVE GATE PLAN

Figure G.

Bars-- Use 3/4" round steel stock (ASTM588). Vertical bars spaced 24" edge to edge. Horizontal bars spaced 6" edge edge. Bars embedded at least 6" into the walls and 12" into the concrete gate foundation. See the attached sheet for details of door construction.

Gate to be installed 18.5' from the stump located just outside the cave entrance.



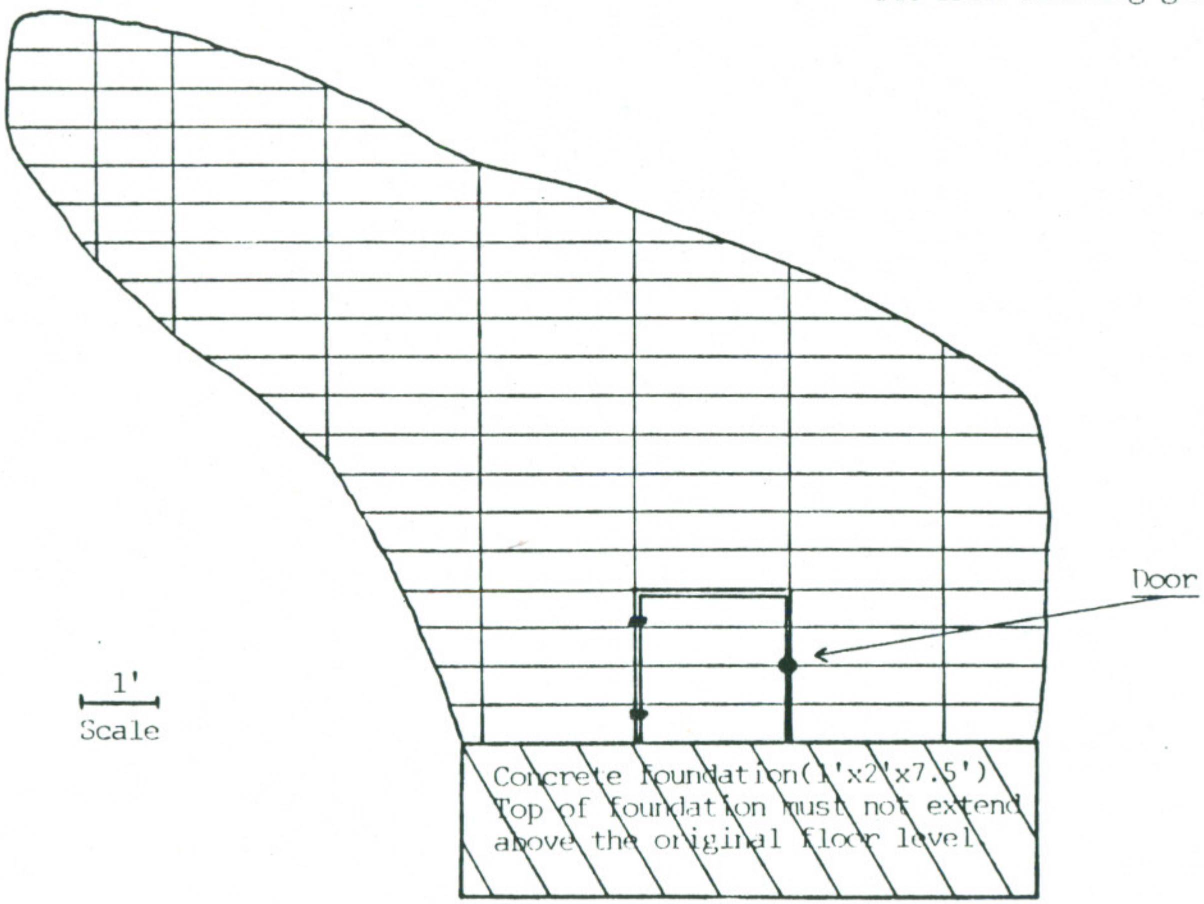
HOFFMAN SCHOOL CAVE GATE PLAN

Scale ½"=1'

Figure H.

Bars-- Use 3/4" round steel stock (ASTM 588). Vertical bars spaced 24" edge to edge (unless otherwise noted on drawing). Horizontal bars spaced 6" edge to edge. Bars embedded at least 6" into the walls and 12" into the concrete gate foundation. See the attached sheet for details of door construction.

Gate to be constructed three feet out from existing gate.

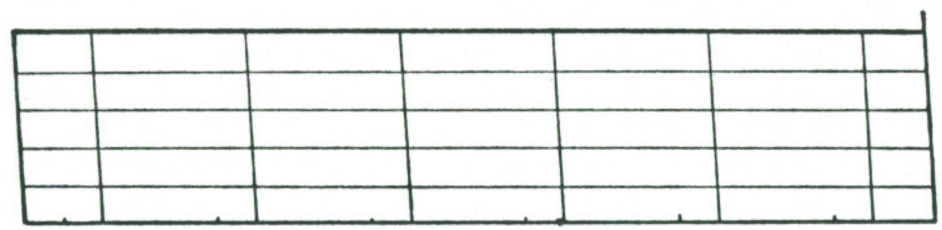


CAVE MOUNTAIN CAVE GATE PLAN
(main upper entrance)

Figure I.

Bars--Use 3/4" round steel stock (ASTM 588). Vertical bars spaced 24" edge to edge (unless otherwise noted on drawing). Horizontal bars spaced 6" edge to edge. Bars embedded at least 6" into the walls.

Gate to be constructed in approximately the same location as the existing gate.



1'

Scale

CAVE MOUNTAIN CAVE GATE PLAN
(small upper entrance)

Figure J.

Bars--Use 3/4" round steel stock (ASTM 588). Vertical bars spaced 24" edge to edge (unless otherwise noted on drawing). Horizontal bars spaced 6" edge to edge. Bars embedded at least 6" into the walls and 12" into the concrete gate foundation. See the attached sheet for details of door construction.

Gate to be constructed three feet behind the existing gate.

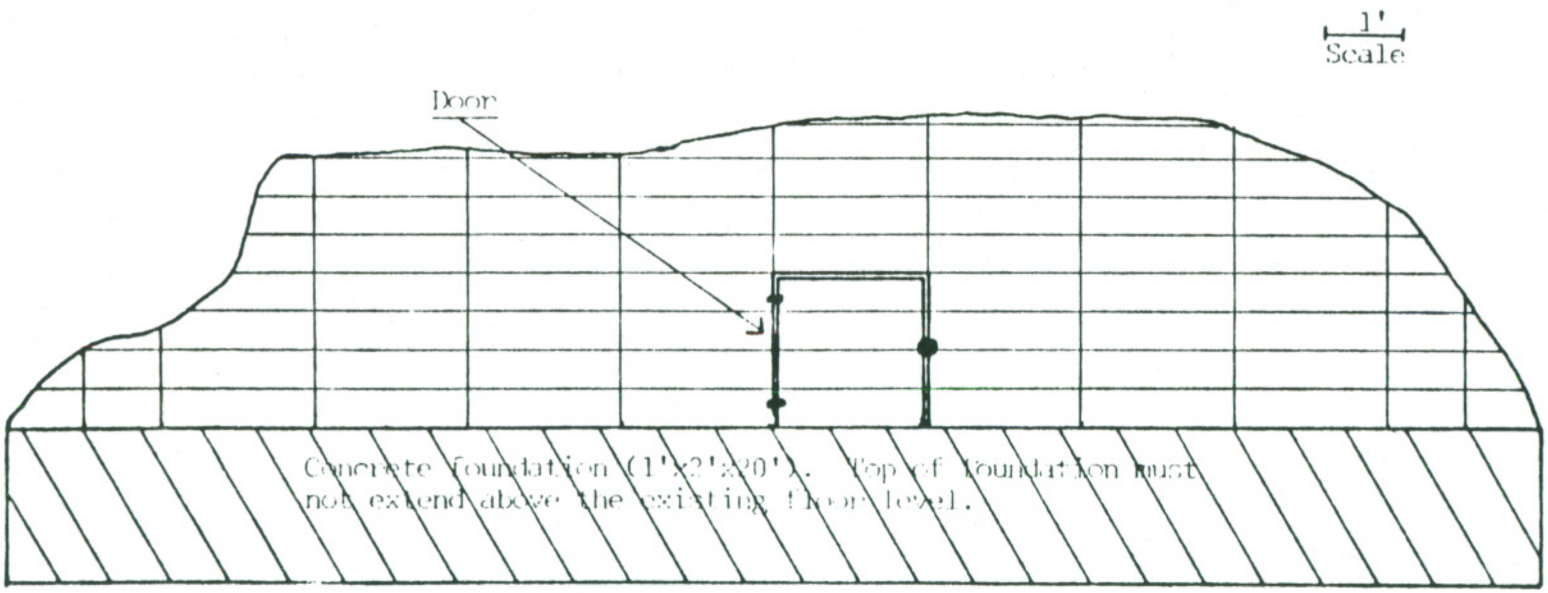
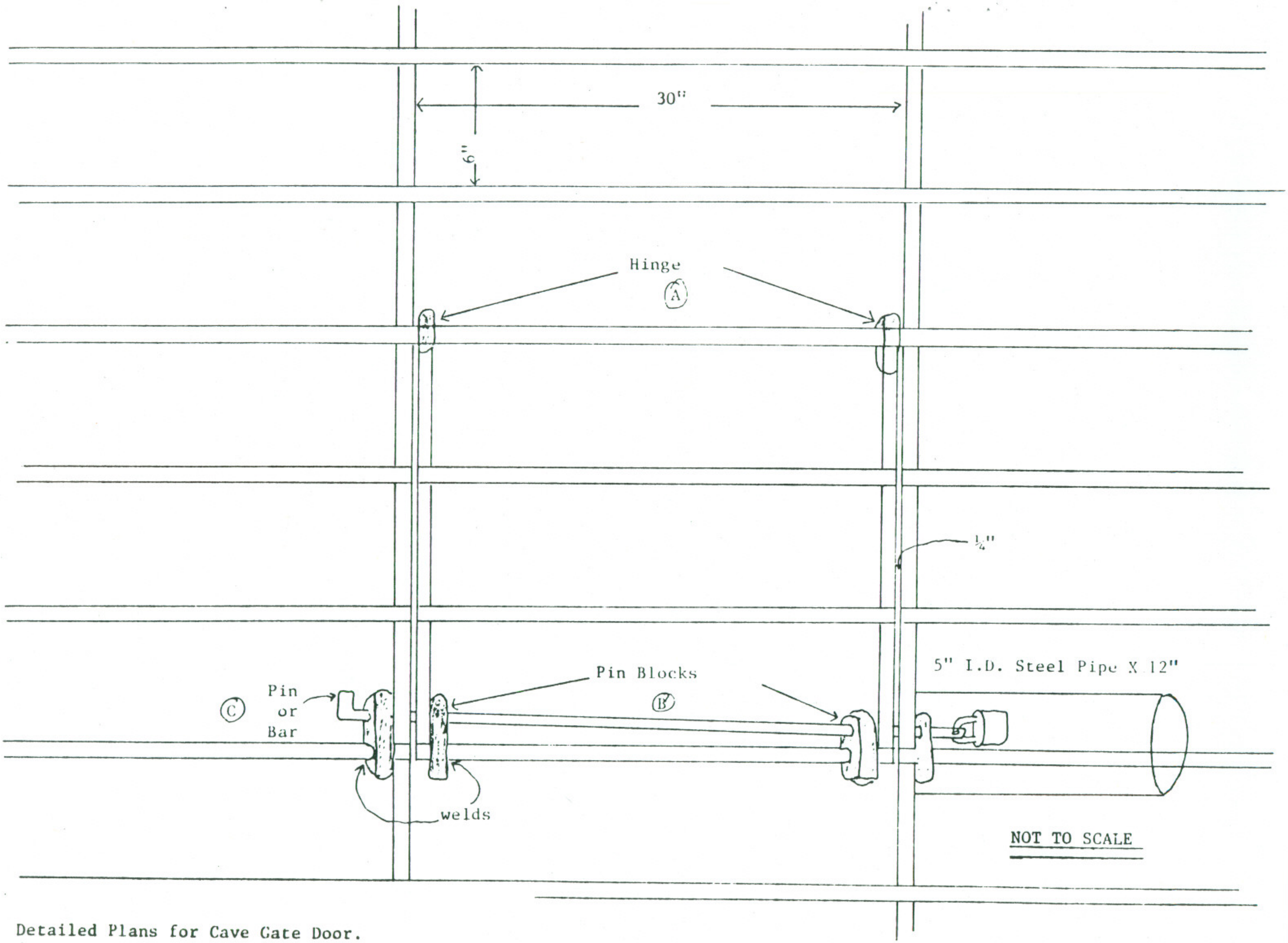


Figure K CAVE MOUNTAIN CAVE GATE PLAN (lower entrance- alternative 2)



Detailed Plans for Cave Gate Door.
(From Len Walker, Elkins, West Virginia)

Figure L.

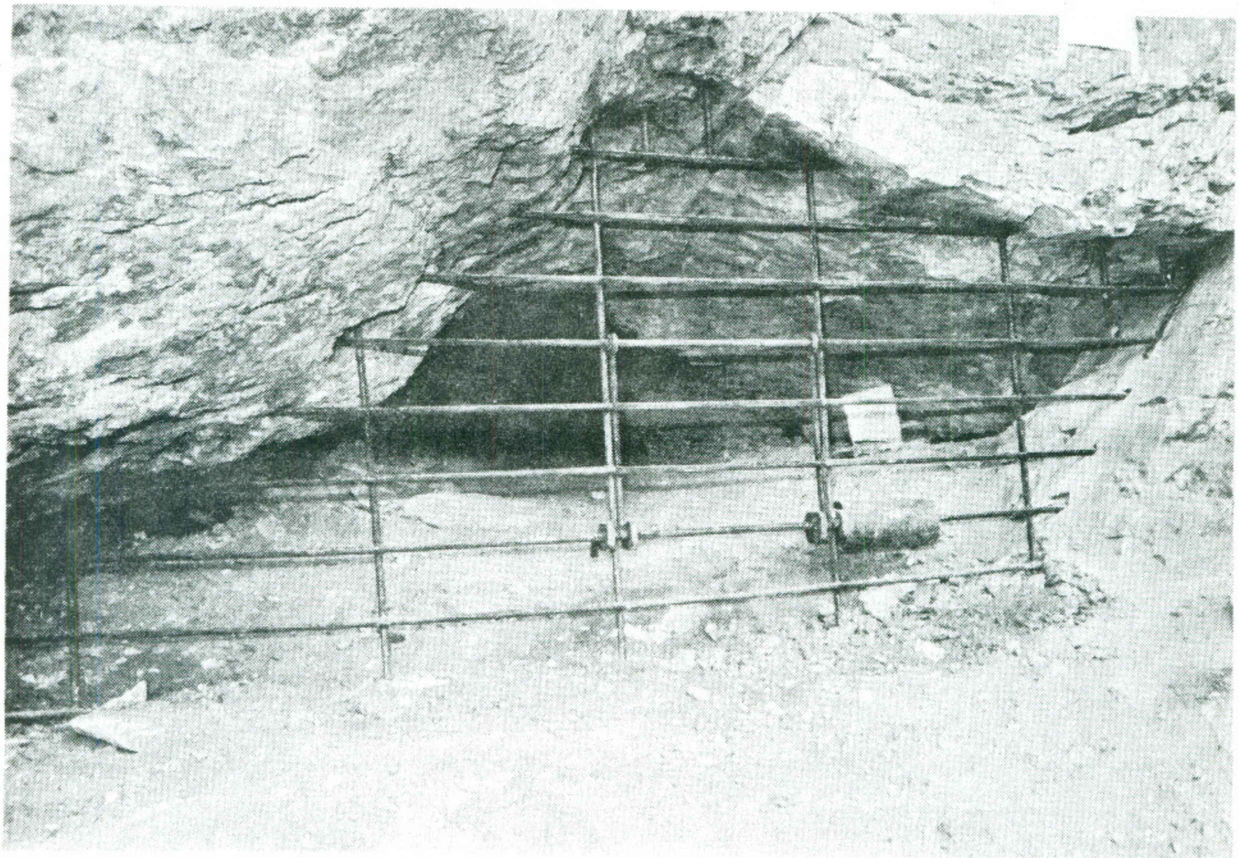


Figure M. Sinnit Cave Gate

APPENDIX 5: EXAMPLE OF COOPERATIVE AGREEMENT

AGREEMENT

This Agreement, made this __________ day of ___________, 1981, by and between ____, Grantor, and the United States of America, Grantee;

WITNESSETH:

The Grantor, in consideration of $1.00 and other consideration, the receipt of which is hereby acknowledged, does hereby agree to permit the U.S. Fish and Wildlife Service to install and maintain a fence or gate around the entrance of _____________ cave, and ______________ cave, which caves are owned by, controlled by, and located on the property of _________________________, the Grantor. It is further agreed that after installation of the fence, the Service shall request permission for the purpose of inspecting and maintaining the fence(s) and gate(s) of the Grantor prior to entering upon the property of the Grantor. The Service shall only have access to the caves while this Agreement is in force. The Agreement commences on the above date and continues until cancelled by either party to the Agreement. Cancellation can be effected by either party by letter delivered certified mail, return receipt requested, stating that said party wishes to withdraw from the Agreement. Cancellation will become effective immediately after receipt of the letter by the other party. Addresses for each party to this Agreement are shown below the signatures of each signator. The location of said cave is specified on the attached survey sketch. The design, specifications, and location of the fence(s) and or gate(s) are attached to the sketch. The duration of the construction period and method of access to the cave entrances is also included in the specifications for construction, which specifications are incorporated herein by reference. The U.S. Fish and Wildlife Service assumes all financial obligation for the construction and maintenance of ______1.______. It is further agreed that the purpose of this Agreement is to protect ______2.______ Virginia big-eared bats from human disturbance in said cave. The Grantor agrees to only permit entrance to the said cave during periods prescribed by the U.S. Fish and Wildlife Service. The prescribed period of closure for these caves will be from ______3.______. The Grantor will not be liable in any manner for any unauthorized entrance into the caves or damage to the gates/fences caused by trespassers.

It is mutually agreed that by this Agreement, the U.S. Fish and Wildlife Service does not obtain any legal claim to or ownership interest in the cave or land. The fence(s) or gate(s) will remain government property and any damage or destruction thereof by trespassers will be grounds for legal action by the United States of America. Legal action will be only against the trespassers with no liability on the part of the Grantor providing there was no collaboration between these two parties to trespass during the above described closure period.

1. either the fence or the gate
2. either the breeding or the hibernating
3. maternity colonies - March 15 to October 31
   hibernacula - August 15 to April 30

IN WITNESS WHEREOF, the Grantor has set his hand and seal on the day and year above written.

Witness:

_____________________________ _____________________________
Grantor

Witness:

_____________________________ _____________________________
Grantee
Regional Director
Fish and Wildlife Service
One Gateway Center
Suite 700
Newton Corner, Mass. 02158
617-965-5100

APPENDIX 6: A NON-INTRUSIVE POPULATION SURVEY TECHNIQUE FOR OZARK AND VIRGINIA BIG-EARED BAT MATERNITY COLONIES

A Non-intrusive Population Survey Technique for Ozark and Virginia Big-eared Bat Maternity Colonies.

This technique was developed to allow determination of population trends at maternity colonies while causing minimal disturbance to the colony. It is a modification of the emergence flight count techniques used on gray bats by Merlin Tuttle (pers. comm.) and little brown bats by Tom Kunz (1982). The technique involves counting big-eared bats as they emerge from the cave entrance. Since these bats emerge after dark, they must be viewed using a night vision scope and infrared lights. Infrared lights may be prepared by sandwiching a Kodak Wratten no. 87 filter between two glass disks and gluing this with plastic rubber onto the outside bezel ring of a Koehler wheat lamp, ensuring that no white light escapes from any part of the lamp. If the lights and the observer are properly placed, it is possible to identify adult big-eared bats by their large ears, size, shape, and flight behavior.

Several lighting schemes have been tested. The preferred scheme involves placement of lights on both sides of the cave entrance and directing them at the opposite cave wall (Figure N). Lights should be adjusted to illuminate bats flying out of the entrance at every level. The number of lights required will be dependent upon the size and shape of the cave entrance. All lights should be on low beam to avoid damaging the infrared filter. The observer should be positioned outside the cave, in line with the emerging bats, viewing at right angles to the light beam. A head cover

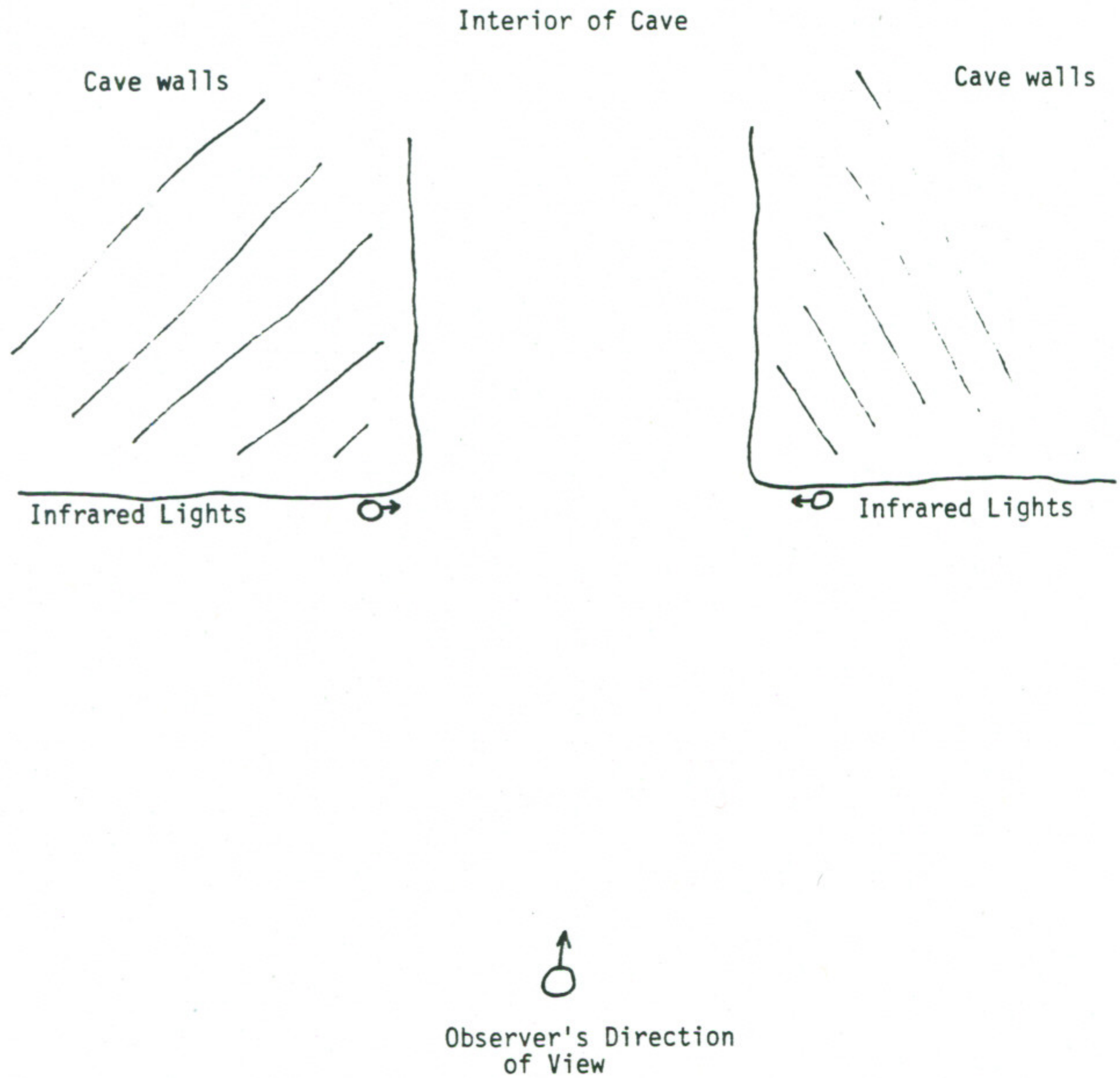


Figure N. Typical placement of lights and observer at cave entrances.

must be used to prevent the night vision scope's light from being detected by the emerging bats. Also, rubber hose of the proper diameter may be cut in short sections and slipped over the lamp to serve as a 'lamp shade'. This may aid in preventing bats from being aware of the infrared lamp until they are adjacent to it. The distance of the observer from the lights will depend upon the size and shape of the entrance, the lens used on the scope and the slope of the terrain from which the observer must view. Data may be recorded on a portable tape recorder or by an assistant.

The time of initiation of the emergence is affected by the stage of the colony and the time of sunset and may range from approximately 2020 to 2115 hours EDST in June and July. Equipment and observers should be in place 30 minutes before the emergence is anticipated to begin.

In the absence of rain, the emergence typically lasts from one to one and a half hours. Rain may increase the number of flights back into the cave and sometimes it can delay the conclusion of the emergence. Observers should ensure that a peak has been reached before stopping their count on a rainy night. If there is a heavy, steady rain throughout the emergence surveyors should, when possible, return to the cave another night to verify their count. After the emergence has ceased, the observer should remove all equipment and depart from the area. Preferably, a flashlight with a visible red filter should be used during the departure.

The ability of an observer to identify big-eared bats may vary with the following factors:

(1) Size and shape of cave entrances - Smaller entrances allow the observer to focus on the area where all bat activity will occur. In contrast, at larger entrances the observer must scan a larger area to ensure that no bats emerge without being noticed. Smaller entrances are also much easier to illuminate properly. At larger entrances the observer is more likely to have difficulty with shadows.

(2) Lighting scheme - The lighting scheme shown in Figure N allows the best view of the bats while minimizing circling resulting from the technique. Shining lights directly into the cave in some cases may provide a slightly better image; however, it will also result in increased circling. The increase in circling will tend to confuse the distinction of big-eared bats and other species.

(3) Lens used on the night vision scope - In general, the observer should choose a lens with a focal length that will allow the largest possible image of the entire cave entrance. It should be remembered that a lens with a longer focal length will provide a larger image of the bat but will also provide a smaller field of vision, resulting in a shorter viewing time of the bat.

(4) Position of the observer - The placement of the observer in line with the emerging bats and at right angles to the light beam (Figure N) provides the most distinct image when lighting from the side. As the observer's angle departs from the perpendicular, the bat's distinguishing characteristics become less obvious.

(5) Presence of a gate - Gates often cause bats to slow their flight and circle before exiting the cave. This behavior may aid in viewing the bats. However, especially at larger colonies, this circling may create additional confusion and also may make it difficult to determine when bats have passed through the gate.

(6) Number of bats of other species in the cave - If there is a large number of bats of other species in the cave, the possibility for confusion with big-eared bats is increased. Therefore, censuses should be scheduled at times in the season when few bats of other species are present in the caves.

(7) Stage of the colony - If the census is conducted after young begin to fly, there is a possibility for confusion of young big-eared bats with bats of other species. This could be avoided by scheduling surveys before the young begin to fly out of the caves.

(8) Experience of the observer - Experience will aid the observer in recognizing the various visual cues of big-eared bats.

Depending on the size and shape of the cave entrance and the physical features surrounding the cave (which influence the observer's choice of viewing position), caves may be generally categorized by the observation conditions they afford, as follows:

(1) Excellent - Each big-eared bat is identified as it emerges and returns to the colony. Our assessment of Category 1 caves includes AD-17, Blue Heaven, Peacock, Sinnit and Minor Rexrode.

(2) Good - Most of the bats in the emergence flight are identified as big-eared bats, however, the identity of some bats is uncertain. Our assessment of Category 2 caves includes AD-10, Arbegast, Mystic, and Schoolhouse.

(3) Minimal - A small portion of the bats are actually seen well enough for positive identification. Our assessment of Category 3 caves includes Hoffman School, Cave Mountain (Lower), Cave Mountain (Upper) and Cassell Farm #2.

Surveys at caves of any of these categories are of value if conducted under proper conditions. Category 1 caves are the ideal, and the observer need only schedule the survey after the adult population of the colony has stabilized and before the young begin to fly. Surveys at category 2 and 3 caves will require more careful scheduling; they should be conducted after most of the bats of other species have departed the caves in late spring and before the young big-eared bats have begun to fly out of the caves.

The number of big-eared bats in the colony is calculated by determining the net number of big-eared bats leaving the cave during each 10-minute period of the emergence, as follows:

(1) $$\frac{\text{No. of flights counted out } (-) \text{ No. of flights counted in}}{\text{Ten minute period}} = X$$

(2) Colony count = sum of the X values for each ten minute period during the emergence period.

The main objective in conducting emergence flight counts is to monitor population trends over a period of years. To do this one must ensure that data are gathered in a consistent manner that will allow comparison of one year's data to another. As mentioned above, surveys should be scheduled when the adult female population at the colony has stabilized and before significant numbers of the young of the year have begun to fly out of the cave. In West Virginia, this time period was identified in 1982 as June 8-28. If surveys are to be scheduled after most of the other bat species have departed the caves and before any of the young have begun to fly out of the caves, this time period must be narrowed further. Based on our two years of data, it appears that in West Virginia, the time period of greatest accuracy for counts is in the 12-day period from June 12-23, with June 19-21 yielding the most accurate counts. Additional data must be obtained to determine how much this time period varies from year to year and from cave to cave.

APPENDIX 7: WARNING/INTERPRETIVE SIGNS

Provided by: Leonard Walker
U.S. Fish and Wildlife Service
Elkins, West Virginia

Note: The dates of closure as given on the adjacent page are not consistent with those given in the text of this plan (see Task 3.0, page 37). The dates given in the plan are those now recommended (i.e., maternity colonies should be closed from March 15 to October 31 and hibernacula should be closed from August 15 to April 30).

PLEASE NOTICE:

DO NOT ENTER THIS CAVE BETWEEN APRIL 1 AND SEPTEMBER 15

The Virginia Big-Eared Bat, an Endangered Species, utilizes this cave for raising young during the summer months and is sensitive to disturbance. If disturbed when newborn flightless young are present, the panicked parents may drop their young which they are unable to recover from the cave floor. The number of Virginia Big-Eared Bats has declined drastically over the past several years and disturbance of nursery colonies has been a contributing factor. All bats in the United States are insect eaters, beneficial to man, and deserve protection.

The gate is to provide seclusion for Virginia Big-Eared Bats during a critical period of the year and is the property of the United States Government. Disturbance of the bats during the above described period of closure, constitutes a violation of the Federal Endangered Species Act and is punishable by fines of up to $20,000 and/or imprisonment for up to one year.

For Information, Call: (304) 636-1767

APPENDIX 8: IMMEDIATE MANAGEMENT NEEDS AND RESPONSIBLE AGENCIES

The recovery plan has provided an outline of the recovery efforts which should be applied to each colony site. This appendix is intended to point out the most urgent management needs of each colony site and to identify the responsible agencies for all recovery actions at colony sites.

West Virginia

Hellhole Cave - meet with quarry industry officials to determine if there are potential conflicts with endangered species needs.

Hoffman School Cave - monitor frequently (at a minimum once a month in May, June, July, August and September) for signs of predation.

Sinnit Cave - remove gate and/or construct predator proof fence. This is the most urgent need for the Virginia big-eared bat.

Mystic Cave - obtain authority to protect habitat.

Arbegast/Cave Hollow - obtain authority to protect habitat, work with USFS to develop protection measures at Cave Hollow.

Schoolhouse - monitor.

Cave Mountain Caves (Upper and Lower) - monitor.

Minor Rexrode Cave - monitor.

Peacock - monitor.

Smokehole - monitor.

Thorn Mountain - monitor.

The responsible agencies for protection of West Virginia _P. t. virginianus_ habitat will be the West Virginia Department of Natural Resources and the U.S. Fish and Wildlife Service.

Kentucky

The maternity colonies for the Stillhouse Cave hibernating population must be located. Authority must be acquired to manage and protect Stillhouse Cave, Wind Cave and other maternity sites. The responsible agencies for protection of Kentucky _P. t. virginianus_ habitat will be the Kentucky Department of Fish and Wildlife Resources, the U.S. Fish and Wildlife Service and The Nature Conservancy.

Virginia

Cassell Farm No. 2 - obtain authority to protect habitat, monitor.

The responsible agencies for protection of the _P. t. virginianus_ habitat in Virginia will be the Commission of Game and Inland Fisheries, the U.S. Fish and Wildlife Service and The Nature Conservancy.

Arkansas

Authority must be acquired to protect Blue Heaven Cave and Marble Falls Cave. At Devil's Den, a means of protecting the colony sites from human disturbance must be developed and implemented. The responsible agencies for protection of Arkansas _P. t. ingens_ habitat will be the Arkansas Game and Fish Commission, Arkansas Department of Parks and Tourism, the U.S. Fish and Wildlife Service and The Nature Conservancy.

Oklahoma

Authority must be acquired to protect Oklahoma's _P. t. ingens_ colonies. Certain land protection efforts for Ozark big-eared bats in Oklahoma may be based on an ecosystem approach. Protection will be provided for caves occurring in close proximity to each other as well as intervening habitat such as woodlands. This approach may be more desirable than protecting individual caves in situations where a small mountain has a number of caves of importance to big-eared bats. The responsible agencies for protection of Oklahoma _P. t. ingens_ habitat will be the Oklahoma Department of Wildlife Conservation and the U.S. Fish and Wildlife Service.

Missouri

Improve landowner relations to allow determination of presence or absence of a big-eared bat colony in Dillo Cave. This must be carefully done to avoid antagonizing the landowner. All such efforts must be carefully coordinated through the Missouri Department of Conservation. Caves in the vicinity of Dillo should be surveyed for maternity and hibernating colonies. The responsible agencies for protection of the Missouri *P. t. ingens* habitat will be the Missouri Department of Conservation and the U.S. Fish and Wildlife Service.

APPENDIX 9: List of Reviewers and Letters of Comment

List of Reviewers of the Ozark Big-Eared Bat and the Virginia Big-Eared Bat Recovery Plan

Larry R. Gale, Director
Missouri Dept. of Conservation
2910 North Ten Mile Drive
Jefferson City, MO 56101

Steven A. Lewis, Director
Oklahoma Dept. of Wildlife Conservation
1801 N. Lincoln
PO Box 53465
Oklahoma City, OK 73152

Steve N. Wilson, Director
Arkansas Game and Fish Commission
State Capitol
Little Rock, Arkansas 72201

Richard Cross, Jr.
Executive Director
VA Cmsn of Game & Inland Fisheries
4010 W. Broad Street, Box 11104
Richmond, VA 23230

Carl E. Kays, Commissioner
KY Dept of Fish & Wildlife Resources
592 E. Main Street
Frankfort, KY 40601

Robert Miles, Chief
WV Div. of Wildlife Resources
1800 Washington St, East
Charleston, WV 25305

Tom Peterson
AK Nature Conservancy
300 Spring Bldg
Suite 415
Little Rock, AK 72201

Michael J. Harvey
Dept. of Biology
Memphis State University
Memphis, TN 38152

Mr. Richard L. Clawson
MO Dept of Conservation
Fish & W/L Research Ctr
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Columbia, MO 65201

Don Wilson
National Fish & Wildlife Laboratory
National Museum of Natural History
Washington, D.C. 20560

Dr. Merlin D. Tuttle
Vertebrate Division, Curator of
Mammals
Milwaukee Public Museum
800 West Wells Street
Milwaukee, WI 53233

Tom Kunz
Department of Biology
Boston University
2 Cummington Street
Boston, MA 02215

John Brady, Leader
Indiana Bat/Gray Bat Recovery Team
U. S. Army Corps of Engineers
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St. Louis, MO 63101

Sam Barkley
Arkansas Game and Fish Commission
#2 Natural Resources Drive
Little Rock, Arkansas 72205

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Richard B. Russell Federal Building
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Endangered Species Coord.
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Athens Field Station
School of Forest Resources, UGA
Athens, GA 30602

Dr. Randy Perry
Director, Endangered Species Research
U. S. Fish and Wildlife Service
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Gainesville, FL 32611

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Radford, VA 24142

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Don Figg
U. S. Fish and Wildlife Service
Stanton, KY 40380

Harry Mahoney
U. S. Fish and Wildlife Service
PO Box 1548
Elkin, West Virginia 26241

OES, Wash. D.C.
Research (AR), Wash. D.C.

Director, National Park Service
Attn: William R. Supernaugh
U. S. Department of the Interior
Washington, D.C. 20240

John E. Crawford, Chief
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Comments on the Ozark Big-Eared Bat and the Virginia Big-Eared Bat Recovery Plan

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