Hibernacula of the Endangered Indiana Bat in Indiana

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A total of 37 visits was made to 27 caves (known or potential *Myotis sodalis* hibernacula) during the 3 winters between autumn 1980 and spring 1983. Of the caves visited, 15 were used as hibernacula by *M. sodalis*. The 2 Priority 1 hibernacula, both of which are protected, contained 79% of the state's wintering population. Ray's Cave contained 11% of the population. This population has increased markedly in the past 8 years. One reason for this may be a reduced pressure on the bats by the scientific community. Despite this increase, and also because of it, this cave needs to be protected. Three other caves, Wyandotte, Grotto, and Coon's, have also experienced increases in hibernating populations in the past several years. Wyandotte (the type local) is on state property. As a result of this investigation Grotto and Coon's caves have come under a landowner protection agreement with The Nature Conservancy. Population counts at other caves are provided so that interested groups, public or private, can make decisions on protection, and to provide a data base for analysis of long term trends. Protection of non-Priority 1 hibernacula is encouraged because of the extreme vulnerability of populations at the 2 Priority 1 caves.

Introduction

The Indiana bat, *Myotis sodalis*, was not recognized as a distinct species until Miller and Allen (6) delineated the taxonomy of the related species of *Myotis* with which it was confused. Historically, Wyandotte Cave, the type local, has housed the largest wintering population (7); however, 2 caves recently discovered (9) have larger populations. Ray's Cave has also historically contained a major portion of the known hibernating population in Indiana. Humphrey (4) reported the known populations of *M. sodalis* hibernating in 7 Indiana caves in 1975. He determined that 2 caves contained the majority of the state's population, and the 4 largest hibernacula contained 99.5% of the population.

The clustering behavior of this species makes it extremely vulnerable to natural catastrophe, human disturbance, and vandalism. Hall (3) documented the extirpation, by flooding, of a hibernating colony estimated at 300,000 in Bat Cave, Edmonson County, Kentucky. About 3,200 *M. sodalis* were killed by flooding of their hibernaculum in Wind Cave, Kentucky (2). Vandals killed about 10,000 *M. sodalis* in Bat Cave, Carter County, Kentucky, in 1961 (4). Similarly, vandalism has been reported to us from Ray's Cave in Indiana, and Humphrey (4) reported that "a bushel basket" of bats was killed by vandals in Little Mammoth Cave, Tennessee, in 1970.

In addition to vandalism, human disturbances from cave usage and visitation by biologists has led to precipitous declines at some caves. A 60% decline in the number of bats using Bat cave, Carter County, Kentucky was attributed to past repeated distur-

bance by biologists and cave visitation (4). A 95.5% decline occurred at Coach Cave, Kentucky after one of the cave's entrances was blocked and air flow restricted. Gating at Colossal Cave, Kentucky, and at Wyandotte Cave, Indiana also restricted air flow, and resulted in a decreased population of hibernating bats.

The vulnerability of the species to man-made perturbation and natural catastrophe, as a result of the winter clustering behavior and extreme aggregation in only a few hibernacula, led to its listing as a federal endangered species in 1966. A 28% decline of the population throughout the range occurred in the 15 year period from 1960 to 1975 (4). The Indiana Bat Recovery Team,[1] therefore, has decided that Priority 1 hibernacula (greater than 30,000 bats) should be censused only every other year, and in order to standardize population estimation, all Priority 1 caves will be censused by the same individual beginning during the 1982-1983 season. In addition, federal, state, and private organizations have begun to provide protection to major hibernacula.

Despite these admirable efforts, there is a great deal of benefit that can be accrued at *M. sodalis* caves that are not Priority 1 hibernacula. These hibernacula may be of particular importance should an unforeseen or unavoidable catastrophe occur at one or more of the Priority 1 hibernacula. Since little or no recent data exist on the number of bats utilizing 19 caves reported used by *M. sodalis* in Indiana (7), it was decided that the initial step in determining the importance of secondary hibernacula to the species was to census these hibernacula. This will provide a data base for the Indiana Department of Natural Resources, Natural Heritage Program, and others, for analysis of long-term trends. In addition, the current population numbers at the Priority 1 hibernacula (Twin Domes and Bat Wing caves) were determined in association with and in assistance to the U.S. Fish and Wildlife Service Indiana Bat Recovery Team. Cave temperatures were taken and the numbers of bats of other species were noted while conducting the censuses.

Materials and Methods

During the winters of 1980-1982 through 1982-1983, 27 caves were visited a total of 37 times. Locations of the caves visited can be found in Brack (1), allowing for future checks on non-Priority 1 and unprotected caves, so that long term trends can be observed. Mumford (7) listed 19 caves which have been occupied by *M. sodalis*; all but 2 of these were visited. Bear Cave, Crawford County could not be located. Later research indicated that the correct location may be Orange County. The caretakers of Boone Cave would not allow access to this cave.

The numbers of *M. sodalis* in small clusters were counted directly. In larger clusters, the size of the cluster was measured with a tape measure, and the number of bats was calculated at 300 bats per square foot (5). The numbers of bats of other species were usually counted directly, except that larger groups of *Myotis lucifugus* (little brown bats) were estimated by groups of 10. Temperatures were taken near large clusters of *M. sodalis* with a Schultheis quick recording thermometer. The hibernacula counts were compared to past records, determined from published accounts (4,8) and from unpublished records of Mumford.

Results

Myotis sodalis was found hibernating in 15 caves (Table 1). Two of these, Twin Domes and Bat Wing, are Priority 1 hibernacula on dedicated Indiana State Nature

1 Recovery Team

TABLE 1. *Bat hibernacula counts and cave temperatures.*

Cave	Date	M. sodalis	M. lucifugus	M. keenii	E. fucus	P. subflavus	**Temp. °C	Observer(s)
Twin Domes	27 Feb. 1981	98,250	0	0	0	0	—	JC, VB, AW
	28 Jan. 1983	70,750	—	—	—	—	—	RC, JC, VB
Bat Wing	8 Mar. 1981	29,960	1	0	0	11	4.4°	VB
	28 Jan. 1983	26,650	—	—	—	—		RC, VB, JC
Ray's	*15 Oct. 1980	1,920	—	—	—	—	—	RM, VB
	9 Mar. 1981	12,500	3,380	22	60	14	7.0-8.5°	VB
	13 Jan. 1982	11,822	799	0	95	10	0.6-1.4°	VB, AW
	12 Feb. 1983	13,475	1,834	1	85	14	4.0°	VB
Grotto	21 Feb. 1981	3,190	589	0	0	2	2.0°	VB
	29 Jan. 1982	2,692	1,090	1	0	44	3.6-4.9°	VB, AW
Wyandotte	27 Feb. 1981	2,152	6	0	11	2	—	JC, VB, AW
	29 Jan. 1983	4,550	—	—	—	—	—	RC, VB
Coon's	21 Feb. 1981	1,190	31	0	0	6	1.0-9.5°	VB
	29 Jan. 1982	550	12	0	1	5	6.8°	VB. AW
Buckner's	29 Jan. 1982	488	32	0	2	57	3.0°	VB, AW
Parker's Pit	31 Jan. 1982	400-500	—	—	—	—	—	MW
Saltpeter (Crawford Co.)	20 Jan. 1982	352	114	0	8	7	6.0°	VB, AW
River	12 Feb. 1982	104	170	2	4	65+	7.2°	VB, AW
Saltpeter (Monore Co.)	29 Jan. 1982	83	19	0	46	0	9.1°	VB, AW
Salamander	26 Feb. 1982	74	130+	0	0	21	—	AW
Clyfty	14 Jan. 1982	66	298	0	10	46	6.0°	VB, AW
Wildcat (Sheep)	20 Jan. 1982	29	332	0	0	30	8.1°	VB, AW
Endless	13 Jan. 1982	2	163	0	17	26	10.5°	VB, AW
Bronson's	12 Jan. 1982	0	0	0	0	3	10.5-12°	VB, AW
Twin	12 Jan. 1982	0	0	0	1	0	9°	VB, AW
Hamer	12 Jan. 1982	0	1	0	10	1	—	VB, AW
Donaldson's	12 Jan. 1982	0	0	1	25	3	—	VB, AW
Sullivan's	13 Jan. 1982	0	0	0	0	0	11.8°	VB, AW
(back entrance)	13 Feb. 1982	0	0	0	0	0	—	VB, AW
Donnehue's	*13 Jan. 1982	0	0	0	4	0	1.4-3.8°	VB, AW
	12 Feb. 1982	0	98	0	6	2	—	VB, AW
Bentz	21 Jan. 1982	0	16	0	8	24	5.8-7.4°	VB, AW
Quarry	21 Jan. 1982	0	0	0	0	1	—	VB, AW
Siebert's Well	20 Jan. 1982	0	0	0	0	0	—	VB, AW
Sharp Creek	20 Jan. 1982	0	0	0	0	0	—	VB, AW
Ranard School	13 Feb. 1982	0	0	0	8	0	1.2°	VB, AW
Salt's	26 Feb. 1982	0	33	0	6	12	—	AW

*Searches were cursory

**Temperatures were taken near *M. sodalis* when they were present, and shortly after the photo-zone when they were absent.

RM — Russell Mumford
JC — James Cope
RC — Richard Clawson
VB — Virgil Brack
AW — Anthony Wilkinson
MW — Michele Wright

Preserves. These 2 caves contained 79% of the state's population of hibernating *M. sodalis*. Ray's Cave contained the third largest population, with 11% of the hibernating bats in the state found there. The present population at Ray's Cave is up, as have been the 2 most recent censuses at Wyandotte, Grotto, and Coon's caves (see Table 2 for past populations). Buckner's Cave had a small but significant population of bats. Most other caves containing hibernating *M. sodalis* supported small popula-

TABLE 2. *Past populations and dates of census of caves utilized as hibernacula by* M. sodalis.

Cave	Date	Population	Source
Twin Domes	1976	100,000	Richter *et al.*, 1978
Bat Wing	1977	50,000	Richter *et al.*, 1978
Ray's	1952	2,700	Mumford and Whitaker, 1982
	1955	1,000	(same)
	1960	512	Humphrey, 1978
	1964	960	Mumford and Whitaker, 1982
	1965	3,200	(same)
	1969	600	(same)
	1970	1,300	(same)
	1975	2,000	(same)
		2,700	Humphrey, 1978
Wyandotte	1953	10,000	Mumford and Whitaker, 1982
	1955	500	(same)
	1960	980	(same)
		1,944	Humphrey, 1978
	1965	3,200	Mumford and Whitaker, 1982
	1970	1,000	(same)
	1974	1,900	(same)
Grotto	1960	200	Humphrey, 1978
	1969	80	Mumford, 1974
	1974	50	(same)
	1975	200	Humphrey, 1978
Coon's	1953	150	Mumford, 1974
	1960	9	Humphrey, 1978
	1974	70	Mumford, 1974
	1975	24	Humphrey, 1975
Buckner's	1952	500	Mumford and Whitaker, 1982
	1953	300	Mumford, 1974
	1954	400	Mumford and Whitaker, 1982
	1956	295	(same)
	1960	63	Humphrey, 1978
	1962	160	Mumford, 1974
	1974	300	(same)
	1975	345	Humphrey, 1978
Saltpeter	1953	22	*
(Crawford Co.)	1975	95	Humphrey, 1978
Saltpeter	1952	13	*
(Monore Co.)	1954	18	*
Clyfty	1954	9	*
Wildcat (Sheep)	1950	6	(collected) by L. P. Wood and R. F. Inger*
Bronson's	1948	1	(collected) by R. G. Prasil*
	1953	4	*
Donaldson's	1962	1	*
Sullivan's	1955	15	*
Donnehue's	1969	1	*
	1971	1	*
Bentz	1959	8	*
Boone	1962	1	*

* Unpublished data—R. E. Mumford

tions (Table 1). Parker's Pit Cave was reported to us by Michele Wright to contain 400-500 *M. sodalis*. This was the first reported use of this cave. The smallest number of *M. sodalis* found in any cave was 2, in Endless Cave. In general, caves with larger (400 bats or more) concentrations of bats were colder than caves occupied by few or no bats. Several caves which have had small populations of *M. sodalis* in the past contained no bats during these visits.

The numbers of bats of other species observed were relatively small. *M. lucifugus*

was common in only Ray's Cave. *Myotis keenii* (Keen's bat) was located on only 5 cave visits at 4 caves. *Eptesicus fuscus* (big brown bat) was found in several caves but was most abundant at Ray's Cave. *Pipistrellus subflavus* (eastern pipistrelle bat) was found at more caves than any other species, but was not numerous at any.

Discussion

It is apparent from these population counts that several non-Priority 1 hibernacula in Indiana should receive protection. Ray's Cave contains about 11% of the state's population of hibernating *M. sodalis*, but is not protected from human disturbance. Capture with a bat trap at Ray's Cave during spring and autumn swarming periods also produced large numbers of *M. keenii*, which is on the state's threatened species lists. Because of their secretive hibernating habits, they are only rarely seen during hibernacula visitation. The population of *M. sodalis* at Ray's Cave historically has varied between 1,000 and 3,000 bats (Table 2) while the current population is 3 to 4 times that number. It is felt that this population increase is due to a large reduction in the number of bats removed from the cave for biological research during the last 8 to 9 years. It has been related to us that until recently, hundreds to thousands of bats were removed yearly from Ray's Cave for research. This heavy harvest predates regular bat censusing at the cave. The accuracy of these reports is not verifiable, but it is consistent with and may represent a mechanism for the dramatic increase in recent years. Despite this increase, and also because of it, Ray's Cave should be protected during the season of hibernation (1 September-30 April) from random visitation.

Grotto and Coon's caves also have viable populations which logically should benefit by seasonal protection. As a result of the censusing done during this project, these 2 caves have come under a voluntary landowner agreement with the Indiana Natural Areas Registry (a cooperative undertaking between The Nature Conservancy and the Indiana Department of Natural Resources) to restrict winter visitation. The populations at both Coon's and Grotto caves are up since the last reported censuses of 1975 (4). The reasons for these increases are not known. They may simply be fluctuations of an intrinsic or unknown cause, or federal protection of the bats may be producing a positive effect on population numbers. There has also been a heightened awareness and subsequent modification of potentially disruptive actions by cavers in recent years. Since this group of individuals represents the major volume of human traffice in caves, and thus represents a major potential for disturbance to the bats, it is anticipated that their cooperation in avoiding disturbance to the bats would produce a positive effect. Even if some types of disturbance from uninformed individuals continues, a reduction of vandalism should benefit the bats.

The numbers of *M. sodalis* hibernating at a majority of the other caves visited were relatively small, and were comparable to numbers found there in the past. No *M. sodalis* were found at Bronson's, Donaldson's, Sullivan's, Donnehue's, or Bentz caves, although in the past bats have been found in them. Parker's Pit Cave, with a population of 400-500, is difficult to enter, thus reducing visitation and consequently disturbance. Saltpeter Cave, located on state forest land in Crawford County, has recently experienced some roof destabilization. Therefore, state personnel are recommending against visitation by most individuals. The 2 Priority 1 hibernacula are on state property and unauthorized entry is prohibited by federal law.

Summary

Hibernating *M. sodalis* were found in 15 of 27 caves visited during the period October 1980 to January 1983. The 2 Priority 1 caves housed 79% of the state's hiber-

nating population of *M. sodalis*. Prior to this study, only one non-Priority 1 cave, Wyandotte, was protected. Non-Priority 1 caves should be protected because of the extreme clustering habit of the species. Clustering increases the susceptibility of the species to natural and man-made catastrophes. Should a catastrophe occur at one of the state's Priority 1 hibernacula, a large percentage of the state's population would be lost. As a result of this study, 2 caves, Grotto and Coon's, have been protected by landowner agreement through The Nature Conservancy. The population at Ray's Cave has greatly increased over the past few years, and now harbors 11% of the state's hibernating population of *M. sodalis*. While this ranks as the third largest population in the state, the cave has no protection at this time. The population counts at the other caves will provide information on long term trends at these caves.

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