

BATS OF WYANDOTTE CAVE, CRAWFORD COUNTY, INDIANA

John O. Whitaker, Jr.: Department of Life Sciences, Indiana State University, Terre Haute, Indiana 47809 USA

James B. Cope¹: Department of Biology, Earlham College, Richmond, Indiana 47374 USA

Virgil Brack, Jr.: Environmental Solutions and Innovations, 781 Neeb Road, Cincinnati, Ohio 45233 USA

ABSTRACT. Nine of the 12 species of bats known from Indiana have been observed at Wyandotte Cave during mist-netting or trapping at the entrance and by in-cave counts from 1953 to the present. The most abundant bat at Wyandotte Cave is the Indiana myotis, *Myotis sodalis*, and the numbers of bats of that species hibernating in the cave have been increasing steadily over the last two decades. The second most abundant bat is the little brown myotis, *Myotis lucifugus*. At least prior to 1980, little brown myotis outnumbered Indiana myotis during swarming; but that has changed as the hibernating population of Indiana myotis increased. Relatively few eastern pipistrelles (*Pipistrellus subflavus*) or big brown bats (*Eptesicus fuscus*), are found at Wyandotte Cave, and *Myotis septentrionalis* is even less common. One southeastern myotis (*Myotis austroriparius*, now extirpated in Indiana), was seen in hibernation there in February 1966. One gray bat (*Myotis grisescens*) was found in hibernation in the cave in February 1967, and several have been netted at the entrance. Also, a few male gray bats were found inside the cave in summer forming a small bachelor colony. Two silver-haired bats, *Lasiorycteris noctivagans*, were found in hibernation; and two were captured by mist-netting, both in late March. Red bats, *Lasiurus borealis*, are seldom found in caves, but 43 were captured by mist-netting at the entrance.

Keywords: Bats, Chiroptera, hibernation, Wyandotte Cave

Wyandotte Cave has been known since 1798. It is in Crawford County, Indiana, and is located in Harrison-Crawford State Forest. It has 14.8 km of known mapped passages (Fig. 1). Over the years, it has been used as a saltpeter-epsom salt mine, domestic and commercial produce warehouse; and it has long been used as a commercial cave for tourists. The cave has a large, downward sloping entrance and currently has a bat-friendly gate, constructed in 1991, about 100 m into the cave. It has been owned and operated by the Indiana Department of Natural Resources since 1966. It was visited by many people each year, including tours in winter. Johnson et al. (1998) recorded more than 375 tours between mid-September and late April in each of two years. However, the cave has been privately operated since 2002, and winter tours have been terminated.

Henry P. Rothrock apparently purchased the

property containing the cave in 1820 from the U.S. Land Office in Jeffersonville, Indiana. The first good descriptions of the cave entrance were made by Adams (1818) and McMurtrie (1819), after almost a decade of mining. The entrance was about 4–5 m wide, and about 1–1.5 m in height, descending by gradual steps into a large, spacious room. In the first few years a stone wall with a small wooden door was built a few meters inside the drip line. A portion of this wall is still present to the right of the trail leading into the cave. This wall had the effect of shortening the horizontal opening from 4–5 m to perhaps 2.2 m. The cave remained semi-developed for the first 50–70 years as a commercial cave, but few improvements were made since Rothrock desired to keep the cave pristine.

Doors and gates can greatly affect bat movements, and doors and gates were often mentioned in descriptions of Wyandotte Cave. The first cave gate was erected in 1843 (Hov-

¹Deceased.

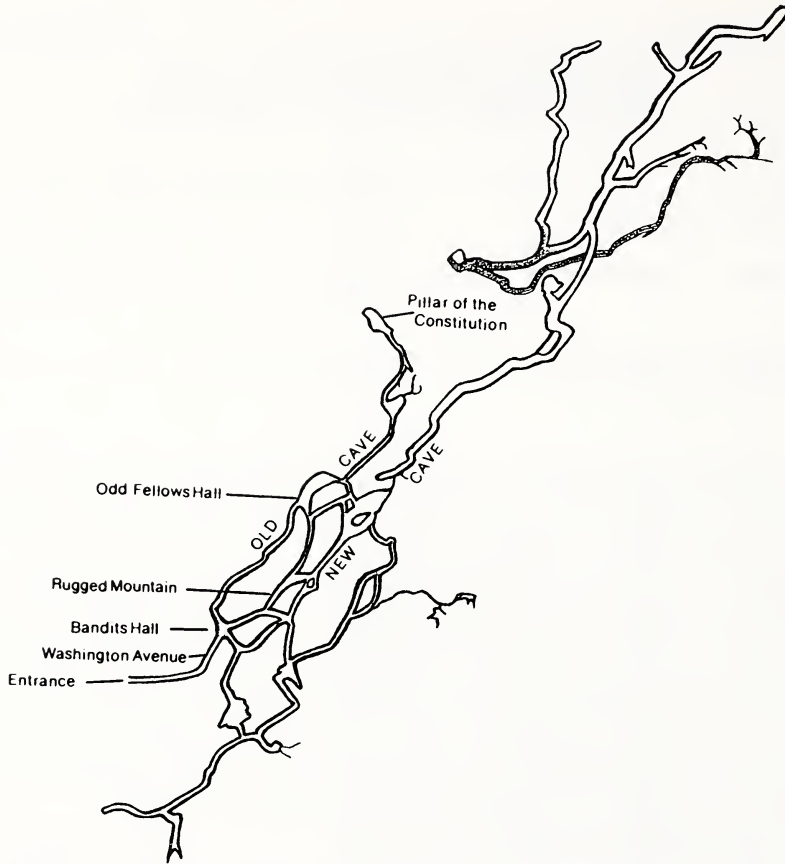


Figure 1.—Map of Wyandotte Cave (not to scale). The distance from end to end of the area shown is approximately 1.4 km.

ey 1880, 1882). It was just a fence in front of the cave entrance to keep out cattle that used the cave to cool off and to lick epsom salts from the rocks. Two doors were mentioned in early descriptions, an outer wooden door at the entrance, and a locked wooden door in the area of the entrance to the “New Cave” (Burnet 1851; Hender 1853). It was apparently removed about 1880 (George 1990). In 1858, a new door was built. Collett (1879) and Hovey (1882) said the outer door was now 6 m wide and nearly 2 m high. Apparently a half-meter of earth had been excavated from the floor and some of the talus removed. In 1970, the fourth gate was installed. It was a modern iron bar gate and was about 25 m into the cave. The last and present gate was constructed in 1991. This latter gate was designed to give bats good access into and out of the cave.

In November of 1850 Norman J. Coleman and party slid down a slope at the end of what

is known as Bandits’ Hall. They followed air flow and removed some rocks and gained entrance to a “New Cave.” With the addition of the New Cave, the known size of the cave had more than doubled and now included very large rooms and prominent formations.

Walsh (1911) reported that when the original outer door was first installed, the cave housed a large colony of bats. There was only one known entrance, and when the door barred their exit “they flew blindly against it and were killed by thousands.” Blatchley (1899) reported that “tens of thousands” of little brown bats, *Vespertilio subulatus*, were found in Odd Fellows’ Hall. It is likely these bats were mostly, or all, Indiana myotis, although no concentration of bats has been found in this portion of the cave in recent years. This conclusion is supported by his description, which said they congregate very closely together. The total population of In-

diana myotis in Wyandotte Cave was estimated at 10,000 in 1953. That is the largest actual number of bats reported earlier (Mumford & Whitaker 1982), although there were claims that clusters of bats as large as a grand piano were once found in the cave. A grand piano on roughly 2.5×1.4 m would be about 3.5 sq. m, which would equate to up to 18,235 bats, using the estimate of Clawson (2002) that Indiana bats can occur at densities up to about 2510 per sq. m.

Although the cave is constantly visited, it presently contains numerous bats, mainly in winter, and is a major hibernaculum for the endangered Indiana myotis, *Myotis sodalis*. Further, the hibernating population of this species has grown; and it is now the third largest population of hibernating Indiana myotis in the state. Only Twin Domes and Ray's Caves have larger populations. We have a great deal of information about the bats that use Wyandotte Cave collected from 1953 to the present, mostly by mist-netting the entrance and by examining hibernating bats inside. The purpose of this paper is to summarize available information on the bats of Wyandotte Cave for use now and in the future.

METHODS

Cope and associates used two methods to study the bats of Wyandotte Cave. They entered the cave 28 times in the months of October through June between 1961–1983 to assess bat populations. They identified all the bats they observed (Table 1). To assess swarming, a mist-net was used to cover the entrance of the cave, and all bats were identified and their sex was determined. Data from 61 of these samples are presented here (Table 2). Mumford and Whitaker (1982) mist-netted the entrance to Wyandotte Cave all night on 23–24 August 1974 to assess the swarming population there. Whitaker, Todd Webb and Konnie Thessin did a similar all-night assessment 20 September 2001, although they used a 4×5 foot (1.2×1.5 m) harp trap rather than a mist-net. Also, second author (VB) netted the entrance in the spring of 1980 (22–23 May).

Brack and Dunlap (pers. comm.) entered Wyandotte Cave during every other winter from 1981 to 2001 to assess bats, particularly Indiana myotis, hibernating there (Table 3). This was part of the population assessment of

the Indiana myotis by the Indiana and Gray Bat recovery team. However, only a small portion of the cave is surveyed for bats during their biannual survey (Fig. 1). Indiana DNR personnel (pers. comm.) indicate that there are rarely, or never, concentrations of bats in winter beyond the area of the cave surveyed.

RESULTS

Nine of the 12 species of bats of Indiana were seen during this work. The only species not included that occur in Indiana were Rafinesque's big-eared bat, *Corynorhinus rafinesquii*, the hoary bat, *Lasiurus cinereus*, and the evening bat, *Nycticeius humeralis*. The big-eared bat is considered accidental in Indiana, the hoary bat very seldom enters caves, and the evening bat has never been taken in caves. The nine species are discussed below.

Bats observed during 28 trips inside Wyandotte Cave between 1953–1981 (Table 1) included all nine species of bats taken there. However, only four species were taken regularly: *Myotis sodalis*, *M. lucifugus*, *Eptesicus fuscus* and *Pipistrellus subflavus*, in order of decreasing abundance. Only 1–3 individuals of the other five species were taken. Some of the trips (Table 1) were at times other than winter, the hibernating season. These trips were in October, April, and June; but, as would be expected, few bats were present at these times, and most were undoubtedly males.

Sixteen of these trips were taken in winter (December–March). *Myotis sodalis* was again the most abundant species, averaging over these times from 20–2141. *Myotis lucifugus* was second, ranging from 0–240. *Eptesicus fuscus* ranged from 0–45 and *Pipistrellus subflavus* from 0–19.

During 78 mist-nettings between 1961–1978 (Table 2), seven species of bats were rather regularly taken by mist-netting the entrance: *Myotis lucifugus*, *M. sodalis*, *Eptesicus fuscus*, *Pipistrellus subflavus*, *Myotis septentrionalis*, *Lasiurus borealis*, and *Myotis grisescens* (13 individuals of this latter species were taken).

The entrance to Wyandotte Cave was mist-netted on 22–23 August 1974 (all night) by Mumford & Whitaker (1982). They caught 399 bats of seven species, including 133 little brown myotis, 100 big brown bats, 91 Indiana myotis, 66 eastern pipistrelles, 6 northern my-

Table 1.—Bats observed on 28 trips on various dates inside Wyandotte Cave, 1953–1981, by Cope and associates. Means can be considered as estimates of the number of bats using the cave during different periods. In addition, some species were taken in much lower numbers as follows: one gray bat (*Myotis grisescens*) was recorded in February 1967/69, one northern myotis (*M. septentrionalis*) on 21 June 1966, two southeastern myotis (*M. austroriparius*) in February 1963/66, one red bat (*Lasiurus borealis*) in February 1970/74, and three silver-haired bats (*Lasionycteris noctivagans*), all in February, two in the 1963–66 period and one in the 1970–74 period.

Date	No. trips	<i>Myotis sodalis</i>	<i>Myotis lucifugus</i>	<i>Eptesicus fuscus</i>	<i>Pipistrellus subflavus</i>
Oct. 1963/1964	2	40	2	3	1
\bar{x}		20	1	1.5	0.5
Dec. 1961/1963	2	2428	450	15	5
\bar{x}		1214	225	7.5	2.5
Dec. 1967	1	638	0	0	0
Feb. 1963/66	2	2343	382	20	4
\bar{x}		1171.5	191	10	2
Feb. 1967–69	3	863	321	89	6
\bar{x}		287.7	160.5	44.5	2
Feb. 1970–74	5	457	22	128	13
\bar{x}		91.4	4.4	25.6	2.6
27 Feb. 1971	1	2141	4	17	2
Feb. 1976–79	2	702	11	19	3
\bar{x}		351	5.5	18.5	1.5
March 1953/1955	2	536	0	0	0
\bar{x}		268	0	0	0
March 1957/1959	2	942	233	0	0
\bar{x}		471	116.5	0	0
March 1961–65	3	2271	718	0	0
\bar{x}		757	239.3	0	0
25 March 1977	1	273	0	0	0
16 April 1966	1	28	31	34	3
21 June 1966	1	1	7	0	0

otis, 2 red bats and 1 gray myotis. However, on 20 September 2001, the picture was very different. Four species of bats, totaling 1245 individuals, were caught, including 843 Indiana myotis, 392 little brown myotis, 9 eastern pipistrelles, and 1 big brown bat. Thus there was an increase in the total number of bats but the number of species decreased from 7 to 4. The greatest increase was in Indiana myotis (from 91 to 843), and the little brown myotis increased (from 133 to 392). The community composition also changed. The Indiana myotis was the third most abundant species in 1974, forming 22.8% of the total catch, but was first in 2001 with 67.7%. The little brown myotis was the most abundant species in 1974, forming 33.3% of the sample, but dropped to second (392 of 1245, 31.5%) in 2001. In 1974, the sample included four species comprising 16% or more of the sample: the big brown bat (25%) and the eastern

pipistrelle (16.5%), besides the Indiana and little brown myotis. In 2001 only the latter two species formed more than 16% of the sample.

The third author (VB) mist-netted the entrance to Wyandotte Cave on 22–23 May 1980. Unfortunately there was rain during much of the night. Mist-netting occurred from 2100–2300 h, and again from 0335–0500 h. All bats taken (37 individuals) were males, including 28 Indiana myotis, three northern myotis, three big brown bats, one little brown myotis and one eastern pipistrelle. It would appear that these bats were using Wyandotte Cave as bachelor quarters.

Regular bi-yearly counts of bats in hibernation by Brack et al. (1991) began in 1981 and have occurred every year since (Table 3). Six species were observed. *Myotis sodalis* is by far the most abundant species and has continually increased, from 2152 in 1981 to

Table 2.—Mean number of bats captured by mist-netting entrance to Wyandotte Cave 79 times 1961–1978, plus two all-night samples, one on 23 September 1974 and one on 20 September 2001.

Date	No. of samples	<i>Myotis sodalis</i>	<i>Myotis lucifugus</i>	<i>Myotis septentrionalis</i>	<i>Myotis gris-escens</i>	<i>Eptesicus fuscus</i>	<i>Pipistrellus subflavus</i>	<i>Lasiurus borealis</i>
March 1977–78	3	14.3	11.3	3.3	0	21.7	0.3	0.3
April 1963–66	4	31.3	126.5	1.5	0.25	22.3	19.7	0
April 1977/1978	6	48	19	1.80	0	11.2	5	0
May 1962	2	6.5	29.5	0	0	32.5	8.5	0
May 1978	7	10	11.4	0	0.1	12.3	14.4	0
June 1978	1	137	39	2	1	12	22	0
July 1966	4	30.3	66.5	0.25	0	12.3	20.5	0.75
August 1961–1966	23	29.8	277	2	0.3	28.8	58.2	1.1
August 1974–1976	2	50.2	95.5	5.5	0.5	56	47	1
September 1961–1964	21	82.6	193.2	1.1	0.14	5.1	33	0.7
October 1963–1964	3	163	95.3	0.3	0	20	8.7	0
October 1968	1	12	0	0	0	0	0	0
All Night Sampling, 1974 and 2001								
22 August 1974	1	91	133	6	1	100	66	2
20 September 2001	1	843	392	0	0	1	9	0

28,584 in 2001. The other three regularly-occurring species are indicated in decreasing order as *Myotis lucifugus*, *Eptesicus fuscus*, and *Pipistrellus subflavus*, but all of these occur in relatively low numbers. The only other two species observed were *Lasionycteris noctivagans* ($n = 2$) and *Myotis septentrionalis* (1). The total number of bats during these observations increased each year and ranged from 10,344 to 28,584. These can be compared to the 16 earlier trips taken in winter (Table 1). The number of bats observed during these trips ranged from 91 to 2271, with the earlier counts being much lower.

SPECIES ACCOUNTS

Red bat, *Lasiurus borealis*.—The red bat is solitary and lives among the foliage. It is almost never found inside of caves, and none were found inside Wyandotte Cave (Table 1). However, 43 red bats were taken in mist-nets at the entrance to the cave. The fact that none were found inside the cave would seem to indicate that the bats merely swooped into the entrance and then flew back out. In an attempt to determine why red bats were netted at the cave entrance, we separated them by month and sex. If the majority were netted there in autumn (August–October, and perhaps in early

Table 3.—Bats counted during biyearly counts in hibernation in Wyandotte Cave by Brack and Dunlap.

Year	<i>Myotis sodalis</i>	<i>Myotis lucifugus</i>	<i>Eptesicus fuscus</i>	<i>Pipistrellus subflavus</i>	Other species
1981	2,152	6	11	2	0
1983	4,550	0	0	0	0
1985	4,627	21	2	1	0
1987	6,681	275	12	2	0
1989	10,344	8	32	14	<i>L. noctivagans</i> —1
1991	12,994	15	11	21	<i>L. noctivagans</i> —2
1993	17,304	12	38	4	0
1995	23,878	30	53	18	0
1997	25,424	70	24	32	0
1999	26,854	268	17	13	0
2001	28,584	272	10	16	<i>M. septentrionalis</i> —1
Total	163,392	977	210	123	
\bar{x}	14,853	89	19	11	

Table 4.—Locations of Indiana bats *Myotis sodalis* in hibernation in Wyandotte Cave during the past seven regular biyearly counts by Brack and Dunlap.

Year	Entrance		Washington Avenue		Rugged Mountain		Rest of survey area		Total
	No.	%	No.	%	No.	%	No.	%	
1989	23	0.2	8,894	83.1	781	7.6	946	9.1	10,344
1991	12	0.1	11,301	87.0	1,658	12.8	23	0.2	12,994
1993	12	0.1	11,995	69.3	3,719	21.5	1,578	9.1	17,304
1995	84	0.4	20,644	86.5	1,897	7.9	1,253	5.2	23,878
1997	6	0.0	21,994	86.5	3,365	13.2	59	0.2	25,424
1999	1,896	7.1	21,520	80.1	3,222	12.0	216	0.8	26,854
2001	1,531	5.4	19,662	68.8	7,167	25.1	224	0.8	28,584

spring) it could mean they came in search of mates. One male was there in March, but then no red bats were netted until the end of July. Most red bats at the cave entrance were taken in August or September (25 ♂ and 15 ♀). Since this is the time of dispersal and mating, perhaps a few do use the cave entrance as a place for finding mates.

Silver-haired bat, *Lasionycteris noctivagans*.—A few silver-haired bats hibernate in caves in Indiana, but otherwise silver-haired bats are found in Indiana only during spring and fall migrations (March through early June; and late September through November). Six were seen during this work. One male was found in hibernation inside Wyandotte Cave on 24 February 1973, and three were seen during the winter counts, one on 9 February 1989 and two on 1 February 1991, at locations near the entrance. The other two, a female (26 March 1977) and a male (31 March 1978) were taken by mist-net.

Southeastern myotis, *Myotis austroriparius*.—Only one southeastern myotis was found during this work. It was hibernating in Wyandotte Cave on 12 February 1966. Southeastern myotis were regularly found in caves in Lawrence and Greene Counties (especially Donnehue's Cave) through the late 1970's with the last one being found on 4 February 1977. However, there have been no verified records since. This species appears to have become extirpated in the state.

Gray myotis, *Myotis grisescens*.—The only maternity roost(s) of gray myotis known in Indiana is in Clark County where the bats spend the summer in a quarry at Sellersburg. Gray bats were first discovered in Clark County by Cope (unpubl. data) by netting in Mud-

dy Fork Creek just north of Sellersburg in 1980; but the actual roost in the quarry was not discovered until 1982 (Brack et al. 1984), when about 400 gray bats were present. This population near Sellersburg has increased to nearly 4000 bats. Pruitt et al. (1997, 1998) discovered gray myotis at the Charlestown army installation, about 5 km NE from Sellersburg, but the specific site of the Charlestown roost has not been found. These roosts are assumed to be part of a single colony since bats have been documented moving between the two localities.

Only one gray bat was taken inside Wyandotte Cave by Cope and associates (Table 1). It was found on 10 February 1967. However, 12 gray bats (including 4 ♂ and 4 ♀) were mist-netted near the cave in April (1), May (1), June (1), August (6), and September (3). Autumn is the time of dispersal, which probably explains the larger numbers in August and September. These bats could have come from Sellersburg; but it is more likely that they were from colonies from northern Kentucky, which are much closer than those at Sellersburg. In addition, four male gray myotis were found in Wyandotte Cave on 26 July 1989. They were among a sample of 23 bats (the other 19 were male Indiana myotis) from two clusters, totaling an estimated 600 bats near a formation called The Pillar of Constitution (Fig. 1). Another two male gray myotis were captured in April 1991 at Wyandotte Cave during spring emergence. The occurrence of gray bats at Wyandotte Cave is not surprising since Whitaker & Gummer (2001) netted gray myotis at seven sites along the nearby Ohio River between Spencer and Clark Counties.

Eastern pipistrelle, *Pipistrellus subflavus*.—This species hibernates in caves and mines usually not more than 180 km from the summer roost. It enters the hibernaculum early in the autumn and exits in April and May. Forty-four pipistrelles (1.1 per trip) were recorded inside the cave by Cope and associates (Table 1). However, pipistrelles are solitary, and are often found deeper in the cave than are other species. Netting pipistrelles yielded 307 individuals in 19 counts in April (16.1 per netting). Males outnumbered females among exiting pipistrelles. This might indicate that males remained near the entrance longer, and perhaps summered there, whereas females left to establish maternity colonies. Seventy individuals were netted at the cave entrance in June and July, but all were males, probably indicating that this was a bachelor roost for a small number of pipistrelles. Numerous nettings in August and September yielded numerous pipistrelles (mean = 59.6, range of 0–171 in August; mean = 33.3, 1–79, 21 nettings in September). There were many more males than females at this time. These pipistrelles were probably migrating through or returning to the cave for hibernation. In the case of the latter, the females were apparently quickly entering the cave for hibernation. The males were spending more time at the cave, presumably for mating purposes; thus their numbers were higher than those of the females (males: mean of 8.7 per night of mist-netting, females 1.3 per night of mist-netting).

Northern myotis, *Myotis septentrionalis*.—*Myotis septentrionalis* hibernates in caves and is common in Indiana. However, it is seldom found while hibernating. Only one bat of this species was found in Wyandotte Cave by Cope and associates (Table 1) during 30 visits in winter, and only one was recorded by Brack and Dunlap between 1981–2001. The fact that few individuals were seen hibernating in Wyandotte Cave does not mean that this species does not hibernate there. The fact that only 142 individuals were captured during 77 nettings ($n = 1.8$ bats per netting) does indicate that few northern myotis use Wyandotte Cave either for swarming or for hibernation. The largest number seen in any one trip was 10 August 1965 when 10 males were captured. Only six were captured in an all-night netting 22 August 1973, and none were captured in an all-night sampling on 20 September 2001.

Whitaker & Rissler (1993) found numerous bats swarming and much winter activity at Copperhead Cave, a mine in Vermillion County, Indiana; but none were seen in hibernation there. However, Whitaker & Rissler (1992) estimated that about 900 northern myotis hibernate in tiny cracks in this mine.

Big brown bat, *Eptesicus fuscus*.—The big brown bat is the most abundant bat in Indiana, in great part because it has taken advantage of man-made structures other than mines. Most maternity colonies are in buildings or other structures (we know of only two maternity colonies in trees). One maternity colony is in a building in the town of Prairie Creek, Vigo County, Indiana; and before parturition, adults fly 5 km to a 650 ha wooded bottomland area near the confluence of Prairie Creek and the Wabash River. After the young are volant, the bats form a “post-maternity colony” under loose bark of trees at the Prairie Creek site. A few big brown bats hibernate in caves and mines in winter, usually near the entrance in small numbers. We estimate, probably generously, that not more than 15,000 of the state’s 1,200,000 big brown bats hibernate in caves and mines. The rest hibernate in buildings. We recorded only 326 big brown bats (Table 1) hibernating in Wyandotte Cave in the 30 visits (mean = 12.2 bats per visit), although there were undoubtedly more, since Wyandotte Cave is of large size. In caves and mines the big brown bat hibernating population is usually male biased. However, this sample consisted of 161 male and 165 females. At Wyandotte Cave relatively few big brown bats were swarming, totalling only 179 bats in the 77 visits (mean = 2.3 per visit). Likewise, Brack & Dunlap (1999) recorded few big brown bats (0–38) in Wyandotte Cave in the 1981–2001 period.

Indiana myotis, *Myotis sodalis*.—The most abundant hibernating bats in Wyandotte Cave are the Indiana and little brown myotis. However, the numbers of Indiana myotis are consistently larger than those of little brown myotis as indicated by all winter dates (Tables 1, 2). A total of 3955 Indiana myotis was observed at Wyandotte Cave during 77 mist-netting sessions between 1961 and 1978 (Table 1), mean = 51.4 per session (range 0–449). The numbers inside the cave in December through February 1960–1975 ranged from 0–2164 (mean = 615.3).

The population of hibernating Indiana myotis in Wyandotte Cave has increased greatly over the past several years. There were 1372 bats counted in February of 1979, and the numbers have increased every year since the biannual surveys began—from 2152 in 1981 to 28,584 in 2001 (Table 3). Thus, populations remained relatively low until about 1980, when they began to increase dramatically, until Wyandotte Cave currently has the third largest wintering population in the state after Twin Domes and Ray's Caves, and followed by Jughole and Batwing. The largest known population of this species was Pilot Knob Mine, an iron mine in Missouri, which is now too dangerous to enter. It was estimated to hold 139,000 Indiana myotis in 1975–78, but Clawson (pers. commun.) estimates that it has declined by as much as 75% since.

Apparently the reason hibernating populations in Wyandotte Cave of *Myotis sodalis* have changed so over the past 40 years, and have increased over the past 20 years, is because of structural changes at the cave (Richter et al. 1993). A gate was built in 1977 to keep people out at unauthorized times. However, the gate increased cave temperatures, which was detrimental to the bats. A new gate was constructed in July 1991 (Johnson et al., in press). It improved air flow, helped cool the cave, and allowed bats in. The number of bats hibernating in Wyandotte Cave immediately began to increase. It is clear that the early gate was detrimental to Indiana bats and that the new gate favored them.

The Indiana myotis normally hibernates at lower environmental temperatures (2–6° C) than other species, and also does best when temperatures are stable. Wyandotte Cave is very large with stable temperatures of about 10° C. This temperature is more appropriate for other species, yet many Indiana myotis hibernate there. For example, in 1991 the temperature in the entrance area was 5° C, but only 1896 Indiana myotis hibernated there. Most of the bats were in the Washington Avenue area (21,520 bats, temperature 8–9° C) and Rugged Mountain area (3222 bats at 10° C). Fewer bats (216) were counted in area D (the rest of the survey area) where the temperature was 12° C. The temperature further inside the cave from where the Indiana myotis hibernated was 13° C.

The number and percentage of Indiana my-

otis using various portions of the cave have varied over time (Table 4). The Washington Avenue area has always contained the greatest number and percentage, varying from 68.8% (2001) to 87% (1991). The Rugged Mountain area has contained from 7.6% (1989) to 25.1% (2001) of the hibernating population. The entrance usually has had low numbers and less than 1% of the population, but in 1999 and 2001 it contained 1896 and 1531 Indiana myotis (7.1% and 5.4%, respectively, of the population).

Little brown myotis, *Myotis lucifugus*.—The little brown myotis is the second most abundant bat hibernating in Wyandotte Cave, yet its numbers usually are not large. It is most abundant during hibernation in Area D. The mean number hibernating in Wyandotte Cave ranged from 0–225 between 1953–1980. It is noteworthy that, although the numbers of Indiana myotis hibernating in Wyandotte Cave were larger than the numbers of little brown bats from 1953–1980, the number of little brown myotis mist-netted during that period was much larger than that of Indiana myotis. The mean number of little brown myotis in the 77 nettings was 157.5, whereas it was only 51.4 for the Indiana myotis. However, in the last two decades (1980–2001), during the increase in the numbers of the Indiana myotis, numbers of little brown myotis hibernating in Wyandotte Cave were still lower, averaging 88.8 (range 0–275) per visit during biannual counts. It should be mentioned that during the winter hibernating period, individuals and small clusters of little brown myotis are more likely to use portions of the cave beyond those areas surveyed, and therefore may not be found and included in the counts. No mist-netting data are available for the period 1982 through 2000, but on 20 September 2001, the entrance to Wyandotte Cave was mist-netted, and at that time Indiana myotis outnumbered little brown myotis 843 to 392. The only other bats taken that night were nine eastern pipistrelles and one big brown bat.

DISCUSSION

It is not clear why Indiana myotis continue to do so well at Wyandotte Cave when the temperature in the areas where the bats hibernate is about 10° C, whereas their preferred hibernating temperature is about 2–6° (Hall 1962). We have attempted to help protect In-

diana bats by preventing winter visitations to hibernacula so that the bats would not be awakened and use energy that is supposed to see them through the winter. However, the bats themselves (at least *M. lucifugus*, and presumably other species) negate some of our efforts. They arouse periodically from hibernation, about once every two weeks for a few hours. During these arousals, which collectively total about 53 h, the bats expend about 75% of their stored energy (Thomas et al. 1990). During these arousals, the bats often move about, both as individuals and perhaps even in groups.

Disturbance is also an important factor; therefore, it has been general policy that Indiana myotis hibernacula are not visited during the hibernating season except once every other year to assess the bat population. However, Wyandotte Cave has been a major exception to the general policy. Through the winter of 2001–2002 there were guided tours through the cave, and these tours went directly under one of the main areas (Washington Avenue) where the bats hibernate. Thus, data from this cave suggest that the non-visitation policy is not necessary to conserve energy for successful hibernation, as the bats have continued to increase even in the face of regularly occurring visits, often several per day. However, non-visitation does prevent vandalism on hibernating bats.

Brack et al. (1991) reviewed alterations of cave morphology and airflow that have occurred in Wyandotte Cave. Richter et al. (1993) reviewed historical changes in the number of bats hibernating in the cave and related them to man-made changes that affected airflow. More bats apparently hibernate in the cave because of gating changes that improved airflow and are more bat-friendly. The 2001 survey was the fifth since a bat-friendly, angle iron gate was installed in 1991.

Albino bats are rare. However, during recent surveys, one albino Indiana myotis was observed in Ray's Cave during three consecutive biannual surveys (1985, 1987, 1989) (Brack & Johnson 1990). During the 1995 and 1997 surveys, a single white bat was found in Wyandotte Cave. No white bats were observed during more recent surveys.

The numbers and locations of big brown bats, little brown bats, and eastern pipistrelles have varied over the years. Big brown bats are

typically found only near the entrance, and most little brown bats are usually found beyond the Rugged Mountain area.

It appears that the early gate installed at Wyandotte Cave was detrimental to the bats but that the new gate is satisfactory. Since the new gate was installed, the number of hibernating Indiana myotis has continued to increase. However, the number of little brown myotis hibernating there has decreased since that time. The reasons for the decrease in little brown myotis are unknown, but a similar decline was noted at Ray's Cave as the number of Indiana myotis increased.

LITERATURE CITED

- Adams, B. 1818. Interesting Cave. Mammoth Cave of Indiana. The Inquisitor and Cincinnati Advertiser (Cincinnati, Ohio), 21 July 1818, p. 1.
- Blatchley, W.S. 1899. Gleanings from nature: Ten Indiana caves and the animals which inhabit them. Reprinted by Indiana Karst Conservancy. Special Publication No. 4, Myotis Press. 71 pp.
- Brack, V., Jr., R.E. Mumford & V.R. Holmes. 1984. The gray bat (*Myotis grisescens*) in Indiana. American Midland Naturalist 111:205.
- Brack, V., Jr. & S.A. Johnson. 1990. Albino Indiana bat (*Myotis sodalis*). Bat Research News 31:8.
- Brack, V., Jr., K. Tyrell & K. Dunlap. 1991. A 1990–1991 winter cave census of non-Priority 1 hibernacula in Indiana and a search for unreported hibernacula of the Indiana bat. Unpubl. Report to Indiana DNR, Nongame and Endangered Wildlife program, Indianapolis, Indiana. 46 pp.
- Burnet, S. 1851. Magnificent cave. Franklin Examiner (Johnson County, Indiana) 5(47):1. 4 January 1851.
- Clawson, R.L. 2002. Trends in population size and current status. Pp. 2–8. In The Indiana Bat: Biology and Management of an Endangered Species. (A Kurta & J. Kennedy, eds.). Bat Conservation International. Austin Texas.
- Collett, J. 1879. Wyandotte Cave. Pp. 456–489 In Geological Report on Harrison and Crawford Counties, Indiana. Indiana Geological Survey., 8th, 9th & 10th Annual Reports of 1879.
- George, A.I. 1990. Wyandotte Cave Chronology of Historic Events: A Preliminary Assessment. Journal of Spelean History 24(4):14–21.
- Hall, J.S. 1962. A life history and taxonomic study of the Indiana bat, *Myotis sodalis*. Reading Public Museum and Art Gallery. Scientific Publication Number 12. Reading, Pennsylvania. 68 pp.
- Hender, C.K. 1853. Great Indiana or Wyandotte Cave. Gleason's Pictorial Drawing Room Companion 4:206.

- Hovey, H.C. 1880. Eight miles in Indiana caverns. *Scribner's Monthly* 19(6):875-877.
- Hovey, H.C. 1882. Celebrated American Caverns. Robert Clarke & Co., Cincinnati. Pp. 123-153.
- Johnson, S.A., V. Brack, Jr. & R.E. Rolley. 1998. Overwinter weight loss of Indiana bats (*Myotis sodalis*) from hibernacula subject to human visitation. *American Midland Naturalist* 139:255-261.
- Johnson, S.A., V. Brack, Jr. & R.K. Dunlap. 2002. Management of hibernacula in the state of Indiana. Pp. 100-109, *In* The Indiana Bat: Biology and Management of an Endangered Species. (A. Kunta & J.M. Kennedy, eds.). Bat Conservation International. Austin, Texas.
- McMurtrie, H. 1819. Sketches of Louisville. S. Penn, Jr., Louisville, Kentucky.
- Mumford, R.E. & J.O. Whitaker, Jr. 1982. Mammals of Indiana. Indiana Univ. Press. Bloomington, Indiana. 537 pp.
- Pruitt, L. 1997. 1997 bat survey at the Indiana Army Ammunition Plant at Charleston, Clark County, Indiana. USFWS Report. Bloomington. 25 pp. (unpubl. report).
- Pruitt, L. 1998. 1998 bat survey at the Indiana Army Ammunition Plant at Charleston, Clark County, Indiana. USFWS Report. Bloomington. 23 pp. (unpubl. report).
- Richter, A.R., S.R. Humphrey, J.B. Cope & V. Brack, Jr. 1993. Modified cave entrances: Thermal effect on body mass and resulting decline of endangered Indiana bats (*Myotis sodalis*). *Conservation Biology* 7:407-415.
- Thomas, D.W., M. Dorais & J. Bergeron. 1990. Winter energy budgets and cost of arousals for hibernating little brown bats, *Myotis lucifugus*. *Journal of Mammalogy* 71:475-479.
- Walsh, D., Jr. 1911. Huge Sacrificial Altar of Prehistoric Race in an Indiana Cavern. *Courier-Journal* (Louisville, Kentucky), 10 September 1911, Sec. 4, pp. 1, 12.
- Whitaker, J.O. Jr. & S.L. Gummer. 2001. Bats of the Wabash and Ohio River Basins of Southwestern Indiana. *Proceedings of the Indiana Academy of Science* 110:126-140.
- Whitaker, J.O., Jr. & L.J. Rissler. 1992. Seasonal activity of bats at Copperhead Cave. *Proceedings of the Indiana Academy of Science* 101:127-133.
- Whitaker, J.O., Jr. & L.J. Rissler. 1993. Winter activity of bats at a mine entrance in Vermillion County, Indiana. *American Midland Naturalist* 127:52-59.

Manuscript received 8 March 2002, revised 3 March 2003.