

WINTERING POPULATIONS OF BATS IN INDIANA, WITH EMPHASIS ON THE ENDANGERED INDIANA MYOTIS, *MYOTIS SODALIS*

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ABSTRACT. Between 1981 and 2003, 269 visits were made to 72 caves in Indiana to count hibernating bats. Nearly 2,000,000 bats of seven species were counted: Indiana myotis (*Myotis sodalis*), little brown myotis (*M. lucifugus*), northern myotis (*M. septentrionalis*), gray myotis (*M. grisescens*), eastern pipistrelle (*Pipistrellus subflavus*), big brown bat (*Eptesicus fuscus*), and silver-haired bat (*Lasionycteris noctivagans*). Indiana myotis were found on 214 (80%) visits and in 30 (42%) caves. The statewide winter population of Indiana myotis found in 1981 (148,890) declined to a low of 99,202 in 1985 before reaching a record high of 185,899 bats in 1999. At least 50,000 Indiana myotis were found in Ray's Cave and in Twin Domes Cave; 10,000–50,000 each in Wyandotte, Jug Hole, Batwing, Coon, and Grotto caves; 1000–10,000 bats in Parker's Pit Cave; 100–1000 in each of 12 caves, and <100 bats in 10 other caves. The number of Indiana myotis in Twin Domes and Batwing caves, the largest populations in 1981, decreased >50% during the last 23 years. Declines in these two hibernacula were more than offset by gains at Rays, Wyandotte, Jug Hole, Coon, and Grotto caves. Little brown myotis were found during 226 (84%) visits in 49 (68%) caves; wintering populations in Indiana appear to be increasing. Big brown bats were found in 40 caves (56%) during 156 (58%) visits. The eastern pipistrelle was found in more caves ($n = 61$; 85%) and during more surveys ($n = 234$; 87%) than any other species. Northern myotis, gray myotis, and silver-haired bats were encountered infrequently.

Keywords: Bats, caves, hibernacula, Indiana, Indiana myotis, *Myotis sodalis*

While few species of bats from temperate regions use caves in summer (e.g., the gray myotis, *Myotis grisescens*, and Townsend's big-eared bat, *Corynorhinus townsendii*), use of caves as winter hibernacula is more common. Further, the winter range of several species, including the Indiana myotis (*Myotis sodalis*), is restricted to regions of well-developed limestone caverns or man-made mines. Most caves contain only a few hibernating bats but caves suitable for hibernation may contain large populations of several species.

Indiana has a significant cave resource (Powell 1966). Documented use of caves by bats is, however, often sporadic; and searches for new populations of bats are not a priority. Surveys are time consuming, difficult and sometimes dangerous, and there may be a misconception that known populations remain static over time.

Blatchley (1899) reported "tens of thousands" of little brown myotis, *Vespertilio subulatus*, (probably Indiana myotis) in Wyandotte Cave. Hall (1962) noted Indiana myotis in seven caves in southern Indiana, but considered only four (Wyandotte, Ray's, Coon, and Grotto) to contain significant populations. In 1976 and 1977, previously unknown concentrations of 100,000 and 50,000 Indiana myotis were found in two caves (Richter et al. 1978). Summarizing information from across the range of the Indiana bat, Humphrey (1978) reported 104,824 Indiana myotis in seven caves in Indiana, of which about 100,000 were in one cave. Humphrey & Cope (1976) reported wintering populations of little brown myotis (*Myotis lucifugus*) in 27 caves, 6 of which had sufficient numbers to warrant further studies. Mumford (1974) visited 12 caves

in or near the Hoosier National Forest in Harrison, Lawrence, Martin, Monroe, and Orange Counties. No Indiana myotis were found, but occasional occurrences of little brown myotis, big brown bats (*Eptesicus fuscus*), and eastern pipistrelles (*Pipistrellus subflavus*) were noted. Mumford (1974) also listed 19 known hibernacula of the Indiana myotis statewide, but numbers of bats were not provided. Mumford & Whitaker (1982) summarized known information, including use of caves by species in Indiana. However, their intent was an overview of species rather than detailed enumeration of caves surveyed and bats found.

During the winters of 1981–1983, Brack (1983) made 37 visits to 27 caves to document all species of bats encountered. Brack et al. (1984) summarized these and previous data for the Indiana myotis in the state. However, few data have since been provided to document this unique resource, although Whitaker & Brack (2002) detailed the distribution, including winter populations, of Indiana myotis in Indiana; and Whitaker et al. (2002) reported possible statewide declines of bats. Johnson et al. (2002) described cave management efforts for wintering colonies of Indiana myotis.

Our purpose is to report results of biennial surveys, over a 23-year period, of hibernacula in Indiana that contained known concentrations of Indiana myotis. We also include results of surveys to document new wintering populations of Indiana myotis and counts of winter concentrations of other cave-dwelling bats.

METHODS

Between 1981 and 2003, 269 visits were made to 72 caves to count hibernating bats. To compare populations over time, data from 1981 and 1982 were composited to provide a more complete baseline, referred to as the 1981 estimate. Similarly, surveys in 1983 and 1985 were less complete than subsequent surveys, so statewide totals for Indiana myotis in those years were extrapolated for some smaller hibernacula. Extrapolations are included only in estimates of statewide populations. Numbers of bats in individual caves, and in individual or grouped surveys, do not include extrapolated numbers.

Caves surveyed were those known to have populations of Indiana myotis, reported by caving organizations to have concentrations of

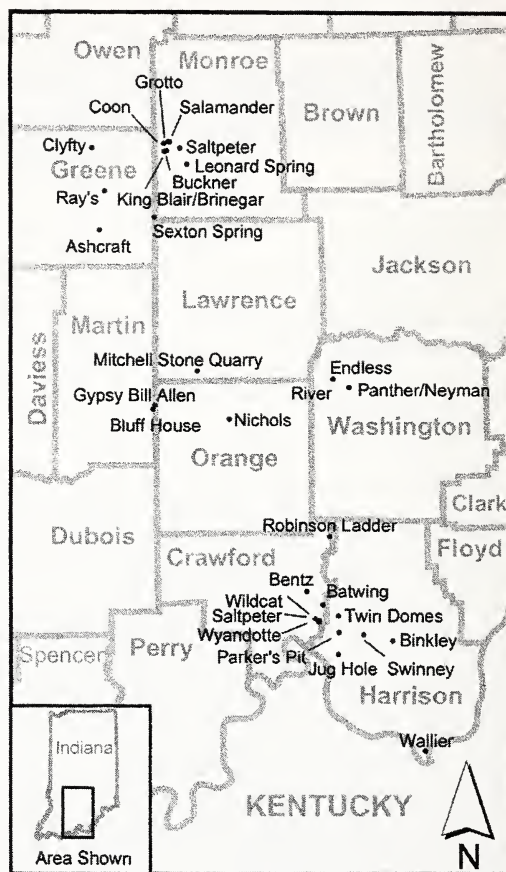


Figure 1.—Caves in Indiana in which populations of Indiana myotis were found during winter hibernacula surveys, 1981–2003.

bats, or were likely to provide suitable habitat because of size, morphology, or airflow. Caves containing >100 Indiana myotis were visited every second year. Surveys were typically completed between mid-January and late February.

Bats were tallied by species and location in the cave. Individuals and small clusters of Indiana myotis were counted directly. When possible, larger clusters were measured with a tape measure or engineer's rule. Sizes of inaccessible clusters were initially estimated using visual-spatial associations, but laser calipers (i.e., two laser pointers bracketed to produce parallel beams 15.2 cm [6 inches] apart) were employed since 1997. Binoculars and a 1,250,000 candlepower spotlight (Collins Dynamics "Magnum" model search light) were used to count bats on high ceilings.

Cluster densities were usually estimated at 300 bats per 0.09 m² (1 ft²; LaVal & LaVal 1980). When available, cave maps were used to locate clusters of bats and temperatures within the cave. Species of bats other than Indiana myotis were counted directly. Within caves, surveys were often terminated when few bats were encountered or warmer temperatures reduced the probability of encountering concentrations of bats.

Temperatures were taken outside entrances, in the twilight area, near Indiana myotis and concentrations of other species, and at intervals throughout the caves. Originally, a Schultheis quick-recording mercury thermometer was used exclusively. A Digi-Sense Model 8528-30 (J) thermocouple thermometer and 8116-40 general purpose probe were used for surveys in 1989 and 1991. Since 1991, most temperatures were taken using an infrared thermometer, speeding data collection and allowing temperatures to be obtained from inaccessible roost sites. Three Raytek models were used: ST2, Raynger® MiniTemp MT4, and Raynger® ST20.

RESULTS

During this 23-year period, nearly 2,000,000 bats of seven species were found during 269 visits to 72 caves (Appendix 1). Caves were visited 1–13 times. The number of bats found per visit ranged from 0 to 98,250 (\bar{x} = 7,314; SD = 16,973). Our surveys produced an average of 3.3 species (SD = 1.1) per cave. The number of caves visited, by county, was: Clark (n = 1), Crawford (n = 20), Greene (n = 4), Harrison (n = 9), Lawrence (n = 10), Martin (n = 4), Monroe (n = 10), Orange (n = 9), Owen (n = 1), and Washington (n = 4).

Indiana myotis.—Indiana myotis were found on 214 visits (80%) in 30 caves (42%; Fig. 1). Mean population size was 7081 bats (SD = 16,988), with the largest being 98,250 in Twin Domes Cave in 1981. At least 50,000 Indiana myotis were documented in Ray's Cave and in Twin Domes Cave; Wyandotte, Jug Hole, Batwing, Coon, and Grotto caves each contained 10,000–50,000 Indiana myotis; Parker's Pit Cave contained 1000–10,000 bats; and Buckner, Saltpeter (Crawford County), Saltpeter (Monroe County), Clyft, Endless, Leonard Springs, Robinson Ladder, Sexton Springs, Wallier, King Blair/Brinegar,

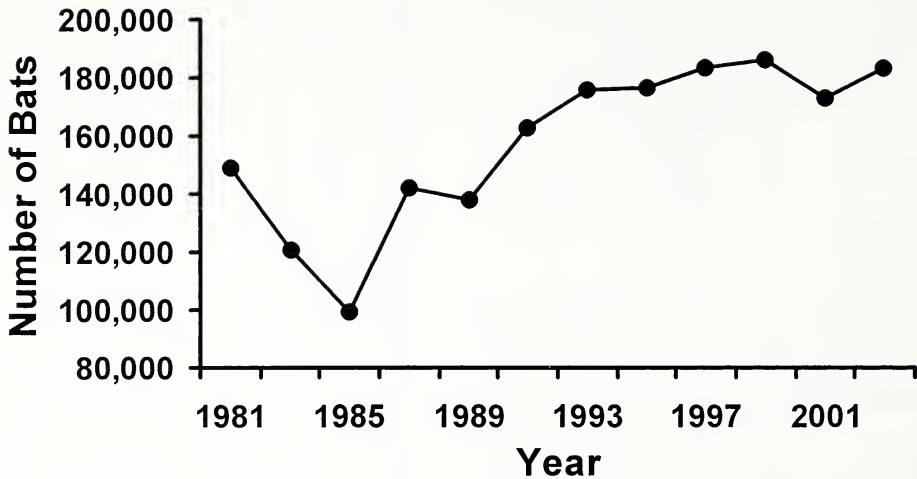
Panther/Neyman, and Gypsy Bill Allen caves each contained 100–1000 bats. Ten caves each had <100 Indiana myotis: Wildcat, River, Salamander, Ashcraft, Bentz, Mitchell Crushed Stone Quarry, Binkley, Swinney, Nichols, and Bluff House caves.

The number of Indiana myotis hibernating in the state has varied over time. In 1981, the known population was 148,890 (Fig. 2). By 1985, the total had decreased 33% to a low of 99,202 bats. Statewide winter populations in Indiana increased through 1999 to a high of 185,899 bats. Increases at Ray's and Wyandotte caves were largely responsible for the observed increase; but newly discovered hibernacula, most notably Jug Hole Cave (19,240 bats in 2003), contributed to the increase. The 2001 survey, which tallied 173,076 Indiana myotis, was the smallest total in nearly 10 years. The 2003 survey tallied 183,298 bats (Fig. 2).

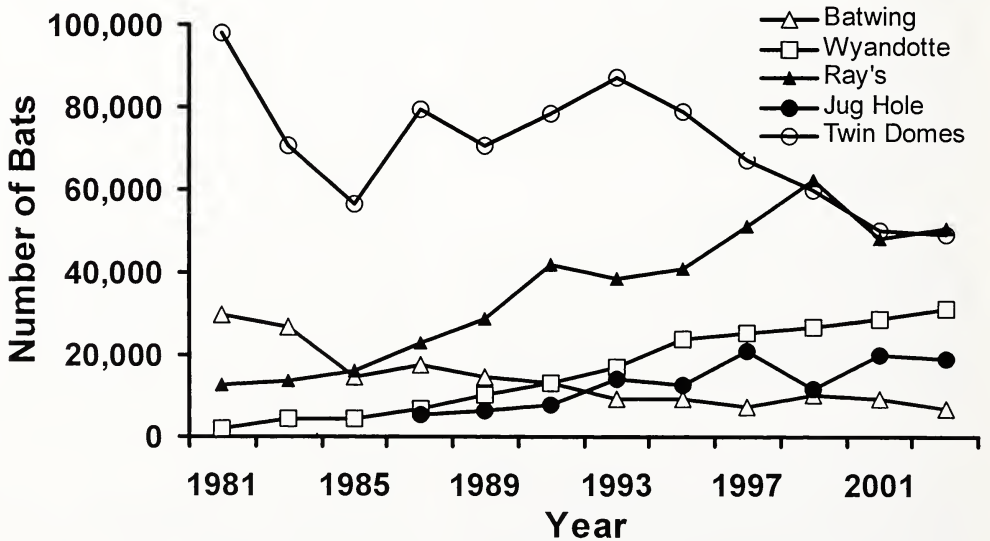
Numbers of Indiana myotis using specific hibernacula have changed over time (Fig. 3). In 1981, there were two known major hibernacula in Indiana, Twin Domes and Batwing caves, which collectively held an estimated 128,210 Indiana myotis. 86% of the statewide total. Ray's Cave contained the next largest population, 12,500 bats, and Wyandotte Cave, with 2152 Indiana myotis, the fourth largest population. Jug Hole Cave, first surveyed in 1987, held an estimated 5535 Indiana myotis. Between 1981 and 2003, the combined estimated population of Twin Domes and Batwing caves decreased to 56,250 bats, 31% of statewide total. In 2003, Ray's, Wyandotte, and Jug Hole caves collectively held 101,398 bats, 55% of statewide total.

In 1981, small populations of Indiana myotis were known from 11 other caves, with a collective population of only 6028 bats (\bar{x} = 553; SD = 942), or 4% of the population of Indiana myotis in the state. This included 1190 bats in Coon and 3190 bats in Grotto. Between 1981 and 2003, 14 additional caves with small populations of bats were documented. By 2003, we found 10,675 bats in Coon Cave and 10,338 bats in Grotto Cave; and the collective populations in 22 of 25 small hibernacula contained 25,650 Indiana myotis (\bar{x} = 1165; SD = 3033), or 14% of the state's total. Zero to three Indiana myotis were found in the most recent visits of the remaining three hibernacula.

2



3



Figures 2, 3.—Numbers of Indiana myotis observed during winter hibernacula surveys in Indiana, 1981–2003 in all hibernacula (Fig. 2), and in each of the five largest hibernacula (Fig. 3).

In addition to changes in wintering populations in specific caves, portions of hibernacula used by Indiana myotis have changed over time. To illustrate, in Wyandotte Cave, three areas, each progressively deeper in the cave (i.e., warmer) received the most use: entrance, Washington Avenue, and Rugged Mountain. Through 2001, from <1% to 7.1% used the entrance area, 68.8–87.0% used Washington Avenue, and 7.6–25.1% used Rugged Mountain. Between 1995 and 2001, numbers of Indiana myotis in Rugged Mountain increased

from an estimated 1897 (7.9%) to 7167 bats (25.1%). During the 2003 survey, the first since winter cave tours were discontinued, 4368 bats (14.0%) hibernated in Bats Lodge, a portion of the cave unused during the preceding 22 years. Bats Lodge is an area with a low ceiling through which tours passed. The use of Bats Lodge was associated with a decrease in the number of bats in Washington Avenue, where 19,087 bats, or only 61.1% of the population, was found. The proportions of bats in the entrance area (3.1%; 962 bats) and

Rugged Mountain (21.0%; 6570 bats) were within the range of past use.

Little brown myotis.—Little brown myotis were found during 226 (84%) visits (\bar{x} = 237; SD = 420) in 49 (68%) caves, and in every county where surveys were completed except Clark (Appendix 1). The largest population was 3380 in Ray's Cave in 1981. Concentrations ≥ 1000 little brown myotis were found only in Ray's Cave (\bar{x} = 1051; SD = 928), Grotto Cave (\bar{x} = 962; SD = 800), and Endless Cave (\bar{x} = 750; SD = 435). From 500–1000 little brown myotis were found in Wildcat (\bar{x} = 388; SD = 103), Parker's Pit (\bar{x} = 234; SD = 174), Coon (\bar{x} = 277; SD = 186), River (\bar{x} = 301; SD = 137), Batwing (\bar{x} = 181; SD = 254), and King Blair/Brinegar (\bar{x} = 353; SD = 159) caves. Eight additional caves contained ≥ 250 little brown myotis.

Numbers of little brown myotis counted ranged from 1406 in 1985 to 8025 in 2001 (Fig. 4), while the mean number of bats per cave ranged from 106 (1989) to 968 (1983). Both totals and averages suggest wintering populations have been increasing since the mid- to late 1980's, concurrent with increases of the Indiana myotis. Consistent increases were noted at Coon, Grotto, and Endless caves, and erratic increases were noted at Saltpeter (Crawford County) and Parkers Pit caves. In contrast, numbers of little brown myotis in Ray's and Panther/Neyman caves decreased and an erratic decrease occurred in King Blair/Brinegar Cave.

Northern myotis.—Northern myotis (*Myotis septentrionalis*) were widespread but found in low numbers. Usually only one to several individuals were found during any year of cave visits. Occurrence was not restricted to any cave or region of the state. For example, northern myotis were found more frequently in 2003 than in most winters, and 25 individuals were found in 11 of 28 caves visited. Ten individuals, a record high, were found in Endless Cave. Bats of this species hibernated individually, often in cracks or other tight spots, and may be overlooked.

Gray myotis.—Gray myotis were rarely found. One or two gray myotis were found on four surveys in Twin Domes and Wyandotte caves, at the northern periphery of this species range. Most recently, a single gray myotis was found in Twin Domes Cave in 2003.

Big brown bat.—Big brown bats were

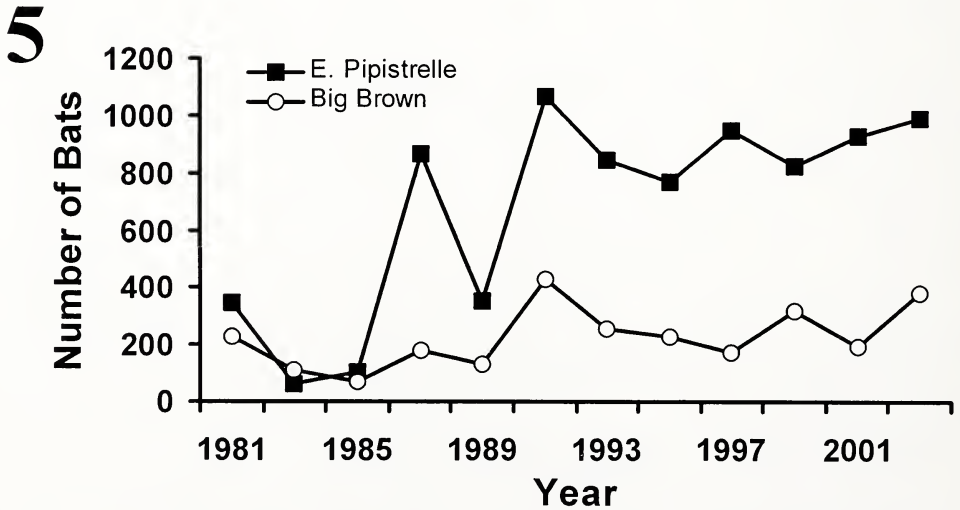
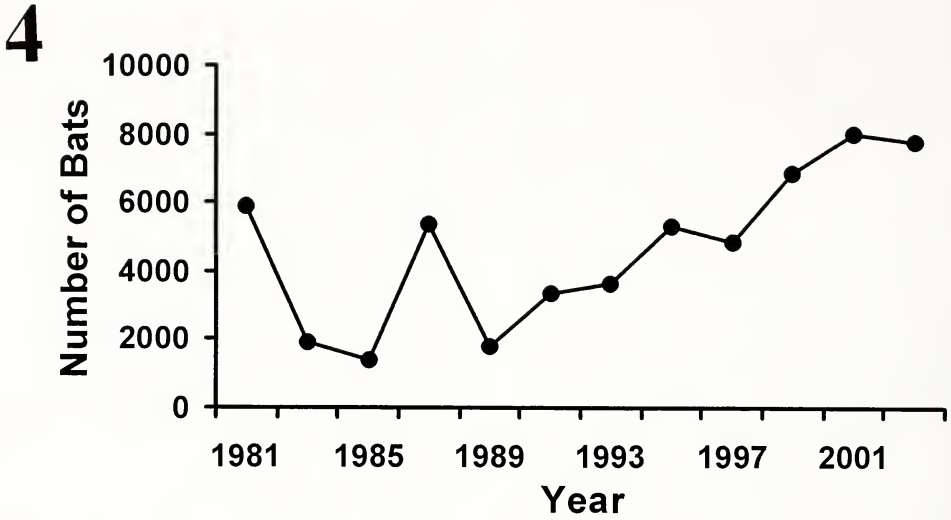
found in 40 caves (56%) during 156 (58%) visits (Appendix 1). They were found in every county where surveys were completed except Clark. Mean number per cave was 11 bats (SD = 26). The largest concentration was 224 in Mitchell Crushed Stone Quarry Cave in 1991. One additional cave, Ray's, has held at least 100 big brown bats (1993 and 1995). In 1995, 53 big brown bats hibernated in Wyandotte Cave, the only hibernaculum and only survey in which 50–100 individuals were found. Neither annual totals (134–431), nor mean number of bats per cave (8–55), suggest a change in numbers of big brown bats hibernating in caves of Indiana (Fig. 5). Further, no individual cave has an increasing or decreasing population of big brown bats.

Eastern pipistrelle.—The eastern pipistrelle, the most common species, was found in 61 caves (85%) during 234 (87%) visits (Appendix 1). Numbers of bats per cave were variable, as were numbers of bats per visit (\bar{x} = 35; SD = 48). The largest number (278) was found in Coon Cave in 1991. Populations >200 eastern pipistrelles were also found in Clyfty (1997) and King Blair/Brinegar (1987 and 1995) caves. River Cave had 153 eastern pipistrelles in 1991 and Grotto Cave had 100 in 1997. Thirteen additional caves contained at least 50 individuals during one or more surveys. Neither annual totals (62–1071) nor mean number of bats per cave (15–54) indicate that numbers of eastern pipistrelles hibernating in Indiana caves are increasing or decreasing (Fig. 5). Similarly, there are no individual caves showing a consistent change over time. Indeed, numbers of eastern pipistrelles in many caves varied widely among visits.

Silver-haired bat.—The silver-haired bat (*Lasiurus noctivagus*) was the species least frequently encountered during cave visits. One individual was found hibernating in Wyandotte Cave in 1989, and two individuals were found in approximately the same location in 1991.

DISCUSSION

The Indiana myotis has been known from hibernacula of the state for over 100 years. Because the species was listed as endangered by the U.S. Fish and Wildlife Service, documentation of this resource, numbers of bats and location of hibernacula, and changes over time, are important for management of the



Figures 4, 5.—Numbers of little brown myotis (Fig. 4), and eastern pipistrelle and big brown bats (Fig. 5) observed during winter hibernacula surveys in Indiana, 1981–2003.

species. Measures to prevent human disturbance, maintain a suitable thermal regime, and forestall natural disasters can be implemented (Johnson et al. 2002).

Increases of Indiana myotis were most notable at hibernacula that had smaller populations both historically and when our surveys began in 1981 (e.g., Ray’s, Wyandotte, Coon, and Grotto caves). Conversely, caves that contained the largest concentrations 23 years ago (i.e., Twin Domes and Batwing caves) have sustained large declines. In addition, hibernacula unknown in the early 1980’s, such as

Jug Hole, Leonard Spring, Robinson Ladder, Sexton Spring, Wallier, and Gypsy Bill Allen caves, were found and in some cases, particularly Jug Hole Cave, experienced significant increases. Finally, caves such as Endless and King Blair/Brinegar, which did not previously contain Indiana myotis, now support important populations. Statewide, increases have more than offset losses and inter-cave movements do not explain all changes, which indicates a true increase in the numbers of Indiana myotis hibernating in Indiana during the last 23 years.

Changes in hibernacula use, for whatever reasons, question our knowledge of hibernacula suitability for this species. Management standards are based on limited data obtained 25 years ago from a few hibernacula, many of which have since experienced marked declines. In many cases, changes were unrelated to disturbance: protected hibernacula experienced the greatest losses while some hibernacula gaining bats had little or no protection (Johnson et al. 2002). Documenting the physical environment, most notably hibernacula temperatures, may help elucidate reasons for shifts in use. Our understanding of needs of the species and development of management practices may be based on initial observations of populations in suboptimal conditions.

Changes in populations among hibernacula and intra-cave variability in hibernation sites suggest the species is adaptable and seeks roost sites that provide specific conditions for winter hibernation. For example, numbers and locations of bats in portions of Wyandotte Cave varied since bats were first reported from the cave. Blatchley (1899) reported “tens of thousands” *Vespertilio subulatus*, (i.e., Indiana myotis) in Odd Fellows’ Hall. Since then, this cave has endured extensive alterations. The entrance was enlarged during commercialization of the cave early in the 1950’s, and a rock wall was placed across the entrance. This wall was replaced in 1978 with a partial wall and a flat-iron gate, and again in 1991 with an angle-iron bat gate. Many areas were dug out to explore and commercialize the cave. One large alteration was ‘opening’ of the new section in 1941, which undoubtedly altered airflow. No Indiana myotis have been found in the Odd Fellows’ Hall area since opening of the new section.

In 1955, only 500 Indiana myotis were estimated to hibernate in Wyandotte Cave, all in the Washington Avenue area. In 1981, 2151 Indiana myotis were tallied in the cave (Brack et al. 1984), and the population has steadily grown to 31,217 individuals in 2003. Further, the location and size of clusters in Washington Avenue varied among surveys; bats also now hibernate in the entrance, Rugged Mountain, and Bats Lodge areas (Whitaker et al. 2003). Use of Rugged Mountain appears to be increasing, and substantial use of Bats Lodge was first documented in 2003.

Only about 500 Indiana myotis used Ray’s

Cave in 1960 (Hall 1962), and 2700 were found in 1975 (Brack et al. 1984). In 1981, Ray’s Cave harbored 12,500 bats, and the population increased to a recorded high of 62,464 in 1999. The most recent survey, in 2003, totaled 50,941 individuals.

Only nine Indiana myotis were in Coon Cave in 1960 (Hall 1962), and 24 were found in 1975 (Humphrey 1978). In 1982, 550 Indiana myotis were found (Brack et al. 1984), but by 2003, the population was tallied at 10,675 individuals. Similarly, numbers of Indiana myotis using Grotto Cave were about 200 in 1960 and 1975, while the 2003 survey produced 10,338 bats. In contrast, numbers of Indiana myotis in nearby Buckner’s Cave decreased from 345 in 1975 (Humphrey 1978) to a single individual in 2001. Much of this decline was attributable to human disturbance. An increase to 40 Indiana myotis in 2003 may be attributable to reduced disturbance.

Richter et al. (1978) reported >100,000 Indiana myotis in Twin Domes Cave in 1976 and 50,000 bats ($\pm 20\%$) in Batwing Cave in 1977. Populations in both caves have steadily declined. In 2003, there were 49,350 Indiana myotis in Twin Domes Cave, about a 50% decline since the population was discovered. Only 6900 Indiana myotis were found in Batwing Cave in 2003, an 86% decline.

Our data suggest wintering populations of little brown myotis have increased in the past 20 years. In contrast, Whitaker et al. (2002) presented evidence, based largely on summer occurrences, of a decline of this species in the state. Numbers of hibernating little brown myotis increased during the same period when the Indiana myotis increased. Perhaps similar factors, such as less disturbance in hibernacula or elements in summer habitats, affected both species similarly. Because our surveys emphasized Indiana myotis, some little brown myotis were likely not found. However, concentrations of little brown myotis, like Indiana myotis, are generally found in cold, anterior portions of caves, where survey was likely. Nevertheless, individuals and small numbers of little brown myotis are found in almost any part of a cave, including warmer areas.

Similarly, our emphasis on Indiana myotis likely underestimated wintering populations of eastern pipistrelles and big brown bats. The eastern pipistrelle, often found in warmer caves and in parts of caves that do not cool

sufficiently for other species, is more widely distributed than Indiana myotis. Big brown bats are often found near cave entrances, but they sometimes hibernate deeper within the cave. Big brown bats frequently hibernate in houses and outbuildings (Whitaker 1997; Whitaker & Gummer 1992, 2000), further limiting interpretation of wintering populations in caves. Our data do not indicate any appreciable change in numbers of big brown bats and eastern pipistrelles hibernating in Indiana caves. Whitaker et al. (2002) presented evidence, again based largely on summer occurrences, of increases of both species in the state.

It is likely that most caves in Indiana that support relatively large concentrations of bats have been found in the last 23 years. Nevertheless, efforts should continue to monitor changes in existing populations and to identify new hibernacula. Populations that are currently insignificant may increase, and new populations may become established. For example, nearly 10,000 Indiana myotis and 20,000 little brown myotis were found in 1995 in a limestone mine in southwest Ohio (VB unpubl. data). This mine ceased operation only about 15 years before the bats were found.

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LITERATURE CITED

- Blatchley, W.S. 1899. Gleanings from nature: Ten Indiana caves and the animals which inhabit

- them. Reprinted by Indiana Karst Conservancy, Myotis Press Special Publication 4:1–71.
- Brack, V., Jr. 1983. The Nonhibernating Ecology of Bats in Indiana with Emphasis on the Endangered Indiana bat, *Myotis sodalis*. Ph.D. dissertation, Purdue University, West Lafayette, Indiana. 280 pp.
- Brack, V., Jr., A.M. Wilkinson & R.E. Mumford. 1984. Hibernacula of the endangered Indiana bat in Indiana. Proceedings of the Indiana Academy of Science 93:463–468.
- Hall, J.S. 1962. A life history and taxonomic study of the Indiana bat, *Myotis sodalis*. Reading Public Museum Publication 12:1–68.
- Humphrey, S.R. 1978. Status, winter habitat, and management of the endangered Indiana bat, *Myotis sodalis*. Florida Scientist 41:65–76.
- Humphrey, S.R. & J.B. Cope. 1976. Population ecology of the little brown bat, *Myotis lucifugus*, in Indiana and north-central Kentucky. American Society of Mammalogists Special Publication 4: 1–80.
- Johnson, S.A., V. Brack, Jr. & R.K. Dunlap. 2002. Management of hibernacula in the state of Indiana. Pp. 106–115, *In* The Indiana bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.
- LaVal, R.K. & M.L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Missouri Department of Conservation Terrestrial Series 8:1–53.
- Mumford, R.E. 1974. The status of the Indiana bat (*Myotis sodalis*) and the eastern woodrat (*Neotoma floridana*) on the Wayne-Hoosier National Forest, Indiana. Unpubl. report to USDI, Hoosier National Forest. 17 pp.
- Mumford, R.E. & J.O. Whitaker, Jr. 1982. Mammals of Indiana. Bloomington University Press, Indiana. 537 pp.
- Powell, R.L. 1966. Caves. Pp. 116–130, *In* Natural Features of Indiana (A. Lindsey, ed.). Indiana Academy of Sciences, Indianapolis, Indiana.
- Richter, A.R., J.B. Seerley, J.B. Cope & J.H. Keith. 1978. A newly discovered concentration of hibernating Indiana bats, *Myotis sodalis*, in southern Indiana. Journal of Mammalogy 59:191.
- Whitaker, J.O., Jr. 1997. Notes on a winter colony of big brown bats at Williamsport, Warren County, Indiana. Proceedings of the Indiana Academy of Science 106:319–325.
- Whitaker, J.O., Jr. & V. Brack, Jr. 2002. *Myotis sodalis* in Indiana. Pp. 53–59, *In* The Indiana bat: Biology and Management of an Endangered Species (A. Kurta & J. Kennedy, eds.). Bat Conservation International, Austin, Texas.
- Whitaker, J.O., Jr., V. Brack, Jr. & J.B. Cope. 2002.

Are bats in Indiana declining? Proceedings of the Indiana Academy of Science 111:95–106.

Whitaker, J.O., Jr., J.B. Cope & V. Brack, Jr. 2003. Bats of Wyandotte Cave, Crawford County, Indiana. Proceedings of the Indiana Academy of Science 112:00-000.

Whitaker, J.O., Jr. & S.L. Gummer. 1992. Hibernation of the big brown bat, *Eptesicus fuscus*, in buildings. Proceedings of the Indiana Academy of Science 102:133–137.

Whitaker, J.O., Jr. & S.L. Gummer. 2000. Population structure and dynamics of big brown bats, *Eptesicus fuscus*, hibernating in buildings in Indiana. American Midland Naturalist 143:389–396.

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Appendix 1.—Numbers of bats of four species observed during winter hibernacula surveys in Indiana, 1981–2003.

Cave	Year	<i>Myotis sodalis</i>	<i>Myotis lucifugus</i>	<i>Eptesicus fuscus</i>	<i>Pipistrellus subflavus</i>
Clark County					
Indian	1985	0	0	0	0
Crawford County					
Across The Valley	2002	0	0	0	2
Batwing	1981	29,960	1	0	11
	1983	26,650			
	1985	14,750			
	1987	17,450			
	1989	14,500			
	1991	13,150			
	1993	9,350			
	1995	9,300			
	1997	7,400			
	1999	10,125			
	2001	9,350			
	2003	6,900	360	0	16
B-B Hole	1999	0	156	0	9
Bentz	1982	0	16	8	24
	1989	3	86	2	32
	2001	0	124	2	56
Big Circle	2002	0	0	0	5
Big Windy (Bauer's Blowhole)	1997	0	24	0	1
Easter Pit	1995	0	108	0	7
Hermit	2002	0	2	0	0
Little Jug Hole	1995	0	1	0	7
Little Mellet Pit	1989	0	0	0	0
Mellet Pit	1989	0	0	0	1
Mesmore Springs	2002	0	112	1	91
Pavey	2002	0	1	1	3
Robinson Ladder	1989	95	14	0	7
	1991	388	8	0	26
	1993	376	8	0	28
	1995	219	182	0	3
	1997	326	0	0	0
	1999	223	119	0	0
	2001	366	58	2	2
	2003	204	164	0	0
Saltpeper	1982	352	114	8	7

Appendix 1.—Continued.

Cave	Year	<i>Myotis sodalis</i>	<i>Myotis lucifugus</i>	<i>Eptesicus fuscus</i>	<i>Pipi- strellus subflavus</i>
Sentinel Rock Treasure Westerhoff Wildcat	1987	427	198	7	25
	1989	295	28	0	7
	1991	508	154	12	60
	1993	375	76	7	15
	1995	647	182	7	39
	1997	577	302	11	68
	1999	800	204	4	10
	2001	849	301	1	29
	2003	681	250	3	32
	2002	0	0	0	0
	2002	0	0	0	0
	1989	0	0	0	3
	1982	29	332	0	30
	1987	0	520	0	63
	1991	31	310	0	33
	1993	61	314	0	19
	1995	34	582	0	45
	1997	48	359	0	49
	1999	19	344	0	18
Wyandotte	2001	35	446	0	28
	2003	17	289	0	13
	1981	2,152	6	11	2
	1983	4,550			
	1985	4,627	21	2	1
	1987	6,681	275	12	2
	1989	10,344	8	32	14
	1991	12,994	15	11	21
	1993	17,304	12	38	4
	1995	23,878	30	53	18
	1997	25,424	70	24	32
	1999	26,854	268	17	13
	2001	28,584	272	10	16
Greene County Ashcraft	2003	31,217	15	14	16
	1993	20	190	4	6
	1995	28	170	0	14
	1999	3	29	0	0
Clyfty	1982	66	298	10	46
	1987	198	295	17	124
	1989	412	233	9	73
	1991	357	334	15	106
	1993	307	176	1	53
	1995	299	141	1	93
	1997	369	268	6	212
	1999	379	272	2	87
	2001	469	394	26	104
	2003	457	329	26	139
Ray's	1981	12,500	3,380	60	14
	1982	11,822	799	95	10
	1983	13,475	1,834	85	14
	1985	16,200	1,044	59	15
	1987	22,990	2,395	74	38
	1989	28,581	671	53	10

Appendix 1.—Continued.

Cave	Year	<i>Myotis sodalis</i>	<i>Myotis lucifugus</i>	<i>Eptesicus fuscus</i>	<i>Pipistrellus subflavus</i>
Sexton Spring	1991	41,854	600	88	94
	1993	38,386	351	118	33
	1995	41,157	677	108	84
	1997	51,365	316	37	58
	1999	62,464	686	59	43
	2001	48,219	644	41	70
	2003	50,941	267	31	53
	1991		1	4	1
	1993	67	196	4	89
	1995	117	64	0	3
	1997	98	7	0	0
	1999	75	17	0	1
	2001	100	87	0	2
	2003	113	21	3	0
Harrison County					
Binkley	1997	84	197	0	17
	2001	9	110	0	25
Borden's Pit	1991	0	13	0	26
Harmon Pit	2003	0	121	1	62
Jug Hole	1987	5,535	9	0	6
	1989	6,424	5	13	9
	1991	7,640	15	16	12
	1993	13,924	9	10	3
	1995	12,463	8	6	10
	1997	20,741	12	11	17
	1999	11,900	10	2	12
	2001	20,151	11	0	8
	2003	19,240	12	9	9
Parker's Pit	1982	500			
	1987	1,803	101	10	18
	1989	1,104	141	5	6
	1991	926	110	9	14
	1993	1,045	209	4	7
	1995	1,276	406	4	4
	1997	1,139	234	2	6
	1999	987	106	5	5
	2001	989	622	3	4
	2003	447	181	3	5
Penny Well Swinney	1995	0	0	0	2
	1997	11	0	0	0
	1999	29	3	13	1
	2001	39	2	5	1
	2003	184	0	7	0
Twin Domes	1981	98,250	0	0	0
	1983	70,750			
	1985	56,650			
	1987	79,650			
	1989	70,800			
	1991	78,500			
	1993	87,350			
	1995	78,875			
	1997	67,100			
	1999	59,775			

Appendix 1.—Continued.

Cave	Year	<i>Myotis sodalis</i>	<i>Myotis lucifugus</i>	<i>Eptesicus fuscus</i>	<i>Pipi- stellus subflavus</i>
Wallier	2001	50,325			
	2003	49,350	1	0	4
	1991	36	7	23	7
	1993	72	1	25	18
	1995	465	1	15	9
	1997	409	3	48	18
	1999	381	4	7	6
	2001	310	9	4	8
	2003	541	8	24	19
Lawrence County					
Bronson's	1982	0	0	0	3
Dixon Pit	1993	0	133	5	75
Doghill-Donnehue	1982	0	98	6	2
	1989	0	119	11	14
Donaldson's	1982	0	0	25	3
Hamer	1982	0	1	10	1
King	1987	0	0	0	0
	1989	0	0	4	0
Mitchell Crushed Stone Quarry	1991	9	178	224	41
	1999	31	380	162	63
	2003	38	280	175	65
Salts	1982	0	33	6	12
	1993	0	102	25	48
Sullivan	1982	0	0	0	0
Twin	1982	0	0	1	0
Martin County					
Aunt Liz	1989	0	1	0	41
Bluff House	2002	1	0	0	7
	2003	0	2	2	4
Granny's	1989	0	1	0	14
Gypsy Bill Allen	2001	134	44	15	34
	2003	250	24	11	21
Monroe County					
Brinegar	1987	12	363	0	205
King Blair/Brinegar	1993	442	427	0	101
	1995	514	673	0	275
	1997	663	295	0	106
	1999	453	247	0	72
	2001	263	220	0	57
	2003	190	248	0	89
Buckner	1982	488	32	2	27
	1985	301	21	9	0
	1987	336	29	0	12
	1989	24	16	0	9
	1991	51	16	0	9
	1993	25	23	2	3
	1995	41	35	3	8
	1997	15	15	2	8
	1999	6	41	2	10
	2001	1	54	0	6
	2003	40	46	4	5
Coon	1981	1,190	31	0	6

Appendix 1.—Continued.

Cave	Year	<i>Myotis sodalis</i>	<i>Myotis lucifugus</i>	<i>Eptesicus fuscus</i>	<i>Pipi- strellus subflavus</i>
Eller's Grotto	1982	550	12	1	5
	1985	777	20	2	5
	1987	2950	152	3	166
	1989	2103	176	5	103
	1991	3696	394	4	278
	1993	4451	392	7	208
	1995	4455	423	1	200
	1997	4786	380	3	188
	1999	6341	376	2	189
	2001	6395	443	0	147
	2003	10,675	525	2	135
	1987	0	0	0	3
	1981	3,190	589	0	2
	1982	2,692	1,090	0	44
	1985	4,198	291	0	8
	1987	3,778	311	0	1
	1989	2,985	213	0	0
	1991	1,996	178	1	5
	1993	1,568	338	2	8
	1995	2,018	937	4	32
Leonard Spring	1997	2,435	1,143	5	44
	1999	4,361	1,811	9	100
	2001	5,419	2,276	1	57
	2003	10,338	2,363	1	85
	1989	135	94	0	17
	1991	112	176	0	68
	1993	92	121	2	81
	1995	82	260	0	96
	1997	92	195	0	35
	1999	81	198	0	61
Patton Ranard School Salamander	2001	25	231	0	48
	2003	138	164	1	38
	2002	0	1	4	3
	1982	0	0	8	0
	1982	74	130	0	21
Saltpeter	1987	0	138	1	79
	1991	0	124	0	50
	1997	1	8	0	0
	2003	0	19	0	4
	1982	83	19	46	0
	1987	19	0	33	1
	1991	221	68	14	12
	1993	245	79	16	20
	1995	175	65	21	17
	1997	136	38	5	5
Orange County	1999	40	29	4	9
	2001	24	41	8	15
	2003	96	51	14	15
Diggers Delight Dillon Duggins Springs Elrod	2002	0	0	0	3
	2002	0	2	1	51
	2002	0	0	0	6
	2001	0	0	2	93

Appendix 1.—Continued.

Cave	Year	<i>Myotis sodalis</i>	<i>Myotis lucifugus</i>	<i>Eptesicus fuscus</i>	<i>Pipi- strellus subflavus</i>
	2002	0	0	0	98
Nichols	2003	39	26	4	18
Red Berry	2002	0	16	0	6
Spring Springs	2002	0	0	0	7
Tucker Lake Springs	2002	0	0	3	8
Wesley Chapel Gulf	2002	0	1	0	7
Owen County					
Boone's	1987	0	1	10	18
	2001	0	4	20	24
Washington County					
Endless	1982	2	163	17	26
	1987	1	330	11	29
	1991	134	460	9	55
	1993	335	602	9	74
	1995	450	772	9	74
	1997	404	665	10	68
	1999	403	993	25	44
	2001	800	1,486	46	89
	2003	863	1,275	33	60
Mill	1985	0	9	0	74
Panther/Neyman	1995	86	277	0	5
	1997	156	249	7	10
	1999	167	246	3	5
	2001	220	146	5	5
	2003	337	239	15	5
River	1982	104	170	4	65
	1987	5	242	2	75
	1991	1	216	1	153
	1999	2	368	2	65
	2003	2	509	4	81