Status and Management of Endangered Bats in Arkansas

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Abstract: Three taxa of cave bats in Arkansas are listed as endangered: the gray bat (*Myotis grisescens*), the Indiana bat (*M. sodalis*) and the Ozark big-eared bat (*Corynorhinus townsendii ingens*). All occur primarily in the Ozark Plateau region of the northwestern and northcentral portion of the state. Population monitoring and ecological studies of endangered bats inhabiting important hibernation, summer, and transient caves were conducted annually since 1978. Through the efforts of several federal, state, and private agencies and organizations, as well as numerous private landowners, 14 caves important to bats were gated or fenced to protect colonies of bats from disturbance by humans. Several additional caves were afforded protection by intrusion alarm systems, control of access roads and cooperative management agreements.

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Arkansas is a recognized leader in the protection and management of endangered bats. The Arkansas Game and Fish Commission, with the aid of funding administered by the U.S. Fish and Wildlife Service under Section 6 of the Endangered Species Act of 1973 (PL 93-205) and the Federal Aid in Wildlife Restoration Act (Pittman-Robertson Act), has supported studies involving distribution, status, ecology and management of endangered bats since 1978. Additional funding for these studies was provided by the U.S. Forest Service (Ozark-St. Francis National Forests) and National Park Service (Buffalo National River).

Several federal, state, and private agencies and organizations also are actively involved in the effort to protect bats in Arkansas through acquisition of land, gating and fencing of caves, installation of intrusion alarm systems, construction of artificial cave entrances, and other forms of protection of caves. These include the Arkansas Game and Fish Commission, U.S. Fish and Wildlife Service, U.S. Forest Service (Ozark-St. Francis National Forests), National Park Service (Buffalo National River), The Nature Conservancy, Arkansas Natural Heritage Commission, Arkansas Department of Parks and Tourism, and the U.S. Army Corps of Engineers. Other agencies and organizations that have contributed to the effort to protect endangered bats are the Arkansas Soil and Water Commission, Arkansas Geological Commission, National

Speleological Society, Cave Research Foundation, Association for Arkansas Cave Studies, American Cave Conservation Association, and the Ozark Underground Laboratory. Personnel from several universities as well as numerous other volunteers are involved in the bat protection effort. Private landowners in Arkansas, with rare exception, have been exceptionally helpful throughout many years of research and management efforts.

Eighteen species of bats occur in the eastern United States (i.e., 31 states east of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma and Texas). All but 1 of these 18 species occur west of the line indicated above. Sixteen species of bats occur in Arkansas. Of these, 3 taxa of cave bats are considered endangered (i.e., in danger of extinction throughout all or a significant portion of their range) by both the U.S. Fish and Wildlife Service and the Arkansas Game and Fish Commission. They are the gray bat, Indiana bat, and Ozark big-eared bat. All occur primarily in the Ozark Plateau region of northwestern and northcentral Arkansas, the only area of the state where caves are numerous.

Three additional species of bats in Arkansas are under review for possible listing as endangered or threatened by the U.S. Fish and Wildlife Service. They are the southeastern bat, *Myotis austroriparius,* the eastern small-footed bat, *M. leibii,* and Rafinesque's big-eared bat, *Corynorhinus rafinesquii.*

The U.S. Fish and Wildlife Service has recovery plans for the gray bat (Brady et al. 1982), Indiana bat (Brady et al. 1983), and Ozark big-eared bat (Hensley and Scott 1995). Protective management measures are in effect, as recommended in recovery plans. These include gating or fencing of important caves and placing of warning/interpretive signs at other caves to minimize disturbance of colonies of bats by humans. Signs placed at selected cave entrances tell what endangered species of bats inhabit the cave, the season when they are present, information concerning the beneficial nature of bats, and adverse effects of disturbing colonies of bats. Signs also indicate that entering these caves during restricted times is a violation of the Federal Endangered Species Act, punishable by fines of up to $50,000 for each violation.

Fourteen important caves for endangered bats in Arkansas were gated or fenced to protect colonies of bats from disturbance by humans. Several additional caves are afforded protection by intrusion alarm systems, control of access roads, and cooperative management agreements. To avoid publication of names of caves and their locations, each cave was assigned an alpha-numeric code (e.g., AR-1).

Species Accounts

Gray Bat

The range of the endangered gray bat is concentrated in the cave regions of Arkansas, Missouri, Kentucky, Tennessee, and Alabama, with occasional colonies and individuals found in adjacent states (Barbour and Davis 1969). The present total population is estimated at ca. 1,500,000; however, about 95% hibernate in only 8 caves—2 in Tennessee, 3 in Missouri, and 1 each in Kentucky, Alabama, and Arkan-

sas. Although numbers of gray bats are still relatively high, their total population has decreased significantly during historic times (Harvey 1986, 1992).

Estimating population declines of gray hats during historic times is possible because of the presence of guano deposits and ceiling stain left in caves by roosting bats. Estimates based on guano and ceiling stain indicate an 89% decline in Kentucky (Rabinowitz and Tuttle 1980), a 72% to 81% decline in Missouri (LaVal and LaVal 1980), a 76% decline in Tennessee and Alabama (Tuttle 1979), and a 61% decline in Arkansas (Harvey 1986, 1992).

An estimated 220,000 gray bats are known to inhabit 19 maternity and bachelor caves in Arkansas during summer, while an estimated 310,000 hibernate in 6 caves in Arkansas during winter. Several additional caves serve as transient caves for gray bats. Of the 3 endangered species of bats inhabiting the state, the population of the gray bat appears to be relatively stable or possibly increasing.

Previous banding studies have demonstrated that the difference between the estimated populations in summer and winter (ca. 90,000) results from the fact that many gray bats that hibernate in Arkansas are known to migrate to summer caves in nearby states (Missouri, Oklahoma, and Kansas). Also, some gray bats that hibernate in Missouri are known to summer in Arkansas (Harvey 1994).

It is difficult to accurately assess the total population of gray bats in Arkansas for various reasons. The hibernating population in the major hibernaculum, AR-42 (gated in 1975 by the U.S. Forest Service), is large, and the configuration of the cave makes it difficult to obtain an estimate that is reliable. The usual estimate is 250,000; however, when last checked during February 1994, the hibernating population was estimated at 165,000 (Harvey 1994). Although that number is considerably less than the previous estimates of 250,000, other caves in the vicinity show significant increases, possibly due to movement from AR-42. A small cave (AR-63) located near AR-42 contained an estimated 25,000 hibernating gray bats in February 1995. Prior to winter 1991–92, gray bats were not known to use this cave (Harvey 1994).

Before development as a tourist attraction by the U.S. Forest Service, Blanchard Springs Caverns (AR-41) housed a hibernating colony of gray bats of 5,000 to 7,000 individuals. Construction in the cave began in 1963, and the cave was opened to the public in 1973. By the winter of 1978–79, the hibernating colony decreased to 150 gray bats and reached a low of only 33 bats during winter 1985–86. Since that winter, the U.S. Forest Service has limited disturbance at the roost site, located near the natural entrance, and the population of bats increased. During 10 winters (1985–86 through 1994–95), the population was estimated as follows: 33, 55, 188, 520, 6,200, 8,000, 10,000, 18,000, 20,000, and 58,650. The summer bachelor colony also increased to 42,000 during the summer of 1993.

AR-32, located on Buffalo National River lands, houses hibernating colonies of both gray bats and Indiana bats. The greatest number of gray bats reported to hibernate in this cave prior to winter 1990–91 was 700 in winter 1980–81 (Harvey 1994). During the following winter (1981–82), only 50 gray bats were present. To protect endangered colonies of bats from disturbance, the cave was fenced by the National Park Service during summer 1982 and closed to visitation during the hibernation

Table 1. Summary of population data and protection of important caves of the endangered gray bat (*Myotis grisescens*) in Arkansas.

Cave code	Ownership[a] and/or mgmt. agency	Colony[b] type	Max. prior to 1990	Highest recent (3 years) estimate	Protective measures
AR-3	P	M	18,000	8,540	Coop. agre., sign
AR-4	P	M	13,000	200	Coop. agre., sign
AR-5	P	M	156,000	51,000	Coop. agre., sign
AR-8	P	M	27,000	2,720	Coop. agre., sign, acc. road blocked
AR-9	ANHC/NC	M	22,000	9,330	Fence, sign
AR-10	P	B	28,600	20,400	Fence, coop. agre., sign
AR-15	ANHC/TNC	B	16,500	0	Sign
AR-16	P	M	10,000	8,000	Coop. agre., sign
AR-20	USFWS	M	25,000	20,030	Natl. Wildl. Refuge, sign
AR-23	P	M	54,700	8,500	Coop. agre., sign
AR-27	P	B	10,200	200	Coop. agre., sign
AR-30	P	B	37,800	2,550	Coop. agre., sign
AR-32	BNR	H	700	47,000	Fence, sign
AR-33	BNR	B	7,700	0	Fence, sign
AR-34	BNR	B	12,000	17,000	Fence, sign
AR-36	BNR	B	10,080	19,040	Sign
		H	180	600	
AR-37	BNR	B	10,000	350	Fence, sign
AR-38	BNR	B	21,000	0	Fence, sign
AR-39	ADPT/USACE	B	15,000	1,000	Fence, sign, artificial entrance
AR-41	ONF	B	18,000	34,000	Gate, fence, sign
		H	8,000	58,650	
AR-42	ONF	H	250,000	165,000	Gate, sign, access road blocked
AR-56	BNR	M	12,000	11,900	Sign
AR-62	P	M	8,000	7,800	Coop. agre., sign
AR-63	ONF	H	?	25,000	Sign, access road blocked
AR-68	P	B	?	20,000	Coop. agre., sign
		H	?	42,500	

[a]Ownership/Mgmt. Agency: P = private; ADPT = Arkansas Department of Parks Tourism; BNR = Buffalo National River; ONF = Ozark National Forest; TNC = The Nature Conservancy; USACE = U.S. Army Corps of Engineers; and ANHC = Arkansas Natural Heritage Commission.

[b]Colony Type: B = bachelor; H = hibernation; M = maternity.

period of bats. Since the cave was fenced, the hibernating population of gray bats gradually increased to 47,000 during winter of 1995–96; thus, significant increases at several caves have kept the total hibernating population of gray bats in Arkansas relatively stable over the past several years.

Because of intercave movement in summer, it also is difficult to obtain a reliable estimate of the summer population of gray bats in Arkansas. Because only 1 or 2 maternity caves are monitored each night, movement of bats between caves may result in overestimating or underestimating populations by counting individuals more than once or by missing them altogether. In addition, estimates of the number of bats exiting large maternity or bachelor colonies (sometimes ≥50,000) are difficult to make. The most recent (1996) count at 10 maternity sites was 106,490, down 2,740 from the previous summer count.

Only 3 (of 10) maternity caves of gray bats are currently protected by virtue of being on government lands. AR-20, 1 of 2 priority-1, gray bat maternity caves in Arkansas, was recently designated Logan Cave National Wildlife Refuge, AR-56 is located on Buffalo National River lands, and AR-9 is owned by the Arkansas Natural Heritage Commission and is fenced.

Indiana Bat

The range of the endangered Indiana bat is in the eastern United States from Oklahoma, Iowa, and Wisconsin east to Vermont, and south to northwestern Florida. The distribution is associated with major cave regions and areas north of cave regions (Barbour and Davis 1969). The present total population is estimated at <335,000, with >85% hibernating at only 9 locations—2 caves and a mine in Missouri, 3 caves in Indiana and 3 caves in Kentucky.

Indiana bats usually hibernate in large dense clusters of up to several thousand individuals in sections of the hibernation cave where temperatures average 4–8 C and with relative humidities of 66%–95% (Barbour and Davis 1969). They hibernate from October to April, depending on climatic conditions. Density in tightly packed clusters usually is estimated at 3,200 bats/m^2, although as many as 5,000/m^2 have been reported (Harvey and McDaniel 1986).

Only 6 Arkansas caves are known to house hibernating colonies (i.e., 10 or more individuals) of Indiana bats. The hibernating population in Arkansas declined by 58% during the past 13 years from 6,000 to 2,540. During winter 1980–81 the population of the largest colony, AR-47, was 5,000. It now has <1,200. Thus, this population decreased by over 75% in 15 years. AR-47 was gated by the Arkansas Game and Fish Commission in 1990.

Hibernating colonies of 400 and 350 Indiana bats are located in 2 caves on Ozark National Forest lands (AR-49 and AR-52, respectively). AR-52 is gated and access roads leading to AR-49 are closed. Both populations have remained stable during the past 20 years. An additional hibernating colony of 100 individuals in AR-58 on Buffalo National River lands is gated. A few male Indiana bats occupy caves in Arkansas during summer and it is likely that most females migrate northward to maternity roost sites located to the north of the Ozark Mountains.

Ozark Big-eared Bat

The range of the endangered Ozark big-eared bat includes only a few caves in northwestern and northcentral Arkansas, southwestern Missouri, and eastern Oklahoma (Harvey 1986). The total surviving population of this race is probably <1,700. About 1,400 inhabit a few caves in eastern Oklahoma, while ca. 200 currently survive in Arkansas. They are no longer known to exist in Missouri.

In Arkansas, only 2 caves (a hibernation cave, AR-54, and a nearby maternity cave, AR-53) and few crevice caves in Devil's Den State Park (AR-55) are presently known to be regularly inhabited by colonies of Ozark big-eared bats (Harvey and Barkley 1990). The population in Arkansas is about 200 individuals, down 57% from a high of 470 in 1980.

Table 2. Summary of population data and protection of important caves of the endangered Indiana bat (*Myotis sodalis*) in Arkansas.

Cave code	Ownership[a] and/or mgmt. agency	Max. prior to 1990	Highest recent (3 years) estimate	Protective measures
AR-14	P	240	0	Coop. agre., sign
AR-32	BNR	7,000	300	Fence, sign
AR-36	BNR	450	0	Sign
AR-43	ONF	135	0	Sign, access road blocked
AR-46	ONF	200	0	Sign, access road blocked
AR-47	P/AGFC	5,000	1,450	Gate, coop. agre., sign
AR-48	BNR	39	7	Sign
AR-49	ONF	450	400	Sign, access road blocked
AR-50	ONF	100	3	Sign
AR-51	ONF	130	0	Sign, access road blocked
AR-52	ONF	450	490	Gate, sign, access road blocked
AR-55	ADPT	?	43	Sign
AR-58	BNR	110	98	Gate, sign, access road blocked
AR-64	ONF	100	0	Sign

[a]Ownership/Mgmt. Agency: P = private; ADPT = Arkansas Department of Parks and Tourism; AGFC = Arkansas Game and Fish Commission; BNR = Buffalo National River; ONF = Ozark National Forest.

Table 3. Summary of population data and protection of important caves of the endangered Ozark big-eared bat (*Corynorhinus townsendii ingens*) in Arkansas.

Cave code	Ownership[a] and/or mgmt. agency	Colony[b] type	Max. prior to 1990	Highest recent (3 years) estimate	Protective measures
AR-53	P/AGFC	M	152	154	Gate, sign, coop. agre.
AR-54	ANHC/TNC	H	420	120	Sign, access road blocked
		B	100	40	
AR-55	ADPT	H	60	47	Intrusion alarm system, sign
AR-60	P	B	100	60	Coop. agre., sign
AR-66	ONF	H	?	9	Sign

[a]Ownership/Mgmt Agency: P = private; ADPT = Arkansas Department of Parks and Tourism; AGFC = Arkansas Game and Fish Commission; ANHC = Arkansas Natural Heritage Commission; ONF = Ozaark National Forest; TNC = The Nature Conservancy.

[b]Colony Type: B = bachelor; H = hibernation; M = maternity.

Prior to 1975, Ozark big-eared bats were reported in small numbers from only a few caves in northwestern Arkansas, southwestern Missouri, and eastern Oklahoma (Handley 1959, U.S. Fish and Wildlife Service 1973). The U.S. Fish and Wildlife Service (1973) estimated the total number surviving to be <100 and reported that no more than 4 individuals had ever been found at one time. That was incorrect; Sealander (1951) reported 11 Ozark big-eared bats from a Washington County, Arkansas, cave in 1951. It was not until 24 years later that a number greater than 11 was reported. Harvey (1975) and Harvey et al. (1978) found 60 hibernating Ozark big-eared bats in a Washington County cave (AR-55) in February 1975.

During summer 1978, the first known maternity colony of Ozark big-eared bats

was discovered in AR-53. The colony consisted of 120 females and young (Harvey et al. 1979). During the following winter (March 1979), a hibernating colony of 255 Ozark big-eared bats was discovered in another cave (AR-54), only 6 km from the maternity cave (Harvey et al. 1979).

The hibernating population in AR-55 has fluctuated since 1975, with no more than 63 reported during any one winter. The hibernating population in AR-54 has varied from a high of 420 in 1980 to a low of 8 during February 1996. The maternity population in AR-53 has varied from a high of 301 in 1993 to a low of 34 during the summer of 1995. These 3 sites are the only caves in Arkansas where colonies of Ozark big-eared bats are regularly found, although scattered individuals of small groups are reported from other caves. AR-54 and 83 ha of surrounding land were purchased by the Nature Conservancy and are under the jurisdiction of the Arkansas Natural Heritage Commission. AR-53 was afforded protection through a cooperative agreement with the landowner and by an angle-iron gate constructed in 1987 by the Arkansas Game and Fish Commission. The Devil's Den Crevice caves (AR-55) are located in Devil's Den State Park. A management plan for the cave's exits and a security system is installed.

Management Implications

Populations of gray bats in Arkansas remain relatively stable or increasing since the species was listed as endangered in 1976. Hibernating populations of Indiana bats in Arkansas show a continuous downward trend since the species was listed as endangered in 1967; a 58% decline during the past 13 years. The population of Ozark big-eared bats in Arkansas, listed as endangered in 1979, has declined by 57% since 1980. Hopefully, continued efforts to protect and recover these species will result in increased populations and their removal from the list of endangered species. To accomplish this I recommend continued monitoring of endangered bat populations inhabiting caves, continued efforts to locate additional caves inhabited by endangered bats, and additional studies to delineate essential non-cave habitat utilized by these species, especially foraging habitat and roost sites. Additional important roost caves also should be gated, fenced, or otherwise protected from disturbance by humans. Most importantly, continuing efforts should be made to educate the public concerning the true nature of bats and their importance in the ecosystem.

Literature Cited

Barbour, R. W. and W. H. Davis. 1969. Bats of America. Univ. Press. Ky., Lexington. 286pp.

Brady, J., T. Kunz, M. D. Tuttle, and D. Wilson. 1982. Gray bat recovery plan. Fish and Wildl. Ref. Serv., Denver, Colo. 21pp.

———, R. K. Laval, T. H. Kunz, M. D. Tuttle, D. E. Wilson, and R. L. Clawson. 1983. Recovery plan for the Indiana bat. Fish and Wildl. Ref. Serv., Rockville, Md. 20pp.

Handley, C. O., Jr. 1959. A revision of American bats of the genera *Euderma* and *Plecotus*. Proc. U.S. Natl. Mus. 110:95–246.

Harvey, M. J. 1975. Endangered Chiroptera of the southeastern United States. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 29:429–433.

———. 1986. Arkansas bats: a valuable resource. Ark. Game and Fish Comm., Little Rock, Ark. 48pp.

———. 1992. Bats of the eastern United States. Ark. Game and Fish Comm. Little Rock, Ark. 46pp.

———. 1994. Status of endangered gray bat (*Myotis grisescens*) hibernating populations in Arkansas. Proc. Ark. Acad. Sci. 48:250–251.

——— and S. W. Barkley. 1990. Management of the Ozark big-eared bat, *Plecotus townsendii ingens*, in Arkansas. Proc. Ark. Acad. Sci. 44:131–132.

———, J. J. Cassidy, and G. G. O'Hagan. 1979. Status of the endangered bats *Myotis sodalis, M. grisescens*, and *Plecotus townsendii ingens* in Arkansas. Proc. Ark. Acad. Sci. 33:81.

———, M. L. Kennedy, and V. R. McDaniel. 1978. Status of the endangered Ozark big-eared bat (*Plecotus townsendii ingens*) in Arkansas. Proc. Ark. Acad. Sci. 32:89–90. Sci. 33:81.

——— and V. R. McDaniel. 1986. Population decline of the endangered Indiana bat, *Myotis sodalis*, in Arkansas. Proc. Ark. Acad. Sci. 40:87–88.

Hensley, S. and C. Scott. 1995. Ozark big-eared bat revised recovery plan. Fish and Wildl. Ref. Serv., Bethesda, Md. 50pp.

LaVal, R. K. and M. L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Terrestrial Ser. No. 8, Mo. Dep. Conserv., Jefferson City, Mo. 53pp.

Rabinowitz, A. and M. D. Tuttle. 1980. Status of summer colonies of the endangered gray bat in Kentucky. J. Wildl. Manage. 44:955–959.

Sealander, J. A., Jr. 1951. Lump-nosed bat in Arkansas. J. Mamm. 32:465.

Tuttle, M. D. 1979. Status, causes of decline, and management of endangered gray bats. J. Wildl. Manage. 43:1–17.

U.S. Fish and Wildlife Service. 1973. Threatened wildlife of the United States. U.S. Dep. Int., Resour. Publ. 114. Washington, D.C. 280pp.