

# ENDANGERED CHIROPTERA OF THE SOUTHEASTERN UNITED STATES

by

MICHAEL J. HARVEY

Ecological Research Center, Department of Biology  
Memphis State University, Memphis, Tennessee 38152

## ABSTRACT

Biologists consider four southeastern United States bat taxa to be endangered (in danger of extinction throughout all or a significant portion of their range). They are *Myotis sodalis* (Indiana bat), *Myotis grisescens* (gray bat), *Plecotus townsendii virginianus* (Virginia big-eared bat), *Plecotus townsendii ingens* (Ozark big-eared bat). Causes of population declines include loss of habitat, direct killing, and disturbances to hibernating and maternity colonies.

## INTRODUCTION

Drastic reductions in populations of North American bats have occurred during the past several years. Mohr (1952, 1953) first reported declines in North American cave bat populations based on data gathered from bat banders. Since that early warning a considerable amount of information has been accumulated concerning population declines of various bat species and reasons for these declines. Much of this information was summarized by Mohr (1972).

Foremost among causes of population declines are loss of habitat and direct killing (Greenhall, 1973; Mohr, 1972). In addition, disturbances by spelunkers and bat researchers themselves often cause hibernating bats to arouse to an active state, thus greatly increasing the drain on their energy reserves (Mohr, 1972). Unnatural arousal from hibernation, especially if it occurs several times during the hibernation period, may therefore be a major cause of bat mortality. Because of this the U. S. Fish and Wildlife Service, in 1972, placed a moratorium on the issuing of bat bands, either to new bat banders or for new banding projects. In addition, the National Speleological Society has placed a moratorium on visits by their membership to certain caves inhabited by endangered and threatened bat species and has organized a task force to deal with bat conservation problems.

On 25-27 September 1974 a workshop on Endangered Vertebrates of the Southeast, sponsored by the Southeastern Section of The Wildlife Society, the Southern Division of the American Fisheries Society, and Tall Timbers Research Station, was held at Tallahassee, Florida. Ninety-two biologists, representing various colleges and universities, state conservation departments, federal agencies, private conservation agencies, and private industries, attended the workshop. After considerable discussion by participants in the mammal section of the workshop, it was agreed that 15 mammalian taxa should be listed as "endangered" (in danger of extinction throughout all or a significant portion of their range) and 23 as "threatened" (likely to become endangered in the foreseeable future throughout all or a significant portion of their range). An additional 32 taxa were listed in the category "special concern" (thought to be approaching the threatened category or the exploitation of which might pose a threat to other species in danger) and/or "status undetermined" (usually applied to rare species about which insufficient information is available to classify as to status).

Seven southeastern taxa of Chiroptera were placed on the list. *Myotis sodalis* (Indiana bat), *Plecotus townsendii virginianus* (Virginia big-eared bat), and *Plecotus townsendii ingens* (Ozark big-eared bat) were considered to be endangered. *Myotis grisescens* (gray bat) was considered threatened. However, *M. grisescens* has since been placed in the category endangered (Hillestad, H. O., 25 July 1975, personal communication). *Myotis leibii* (small-footed bat), *Plecotus rafinesquii* (eastern big-eared bat), and *Eumops glaucinus* (Wagner's mastiff bat) were listed in the category special concern. Only those four taxa considered to be endangered are covered in this paper. The following accounts include information concerning status and distribution, estimated numbers, habitat requirements, reasons for decline, and protective measures taken or proposed. For more detailed information concerning the biology of these bats, along with descriptions and color photographs, see Barbour and Davis (1969).

Several persons have aided in the accumulation of data presented in this paper. M. L. Kennedy, J. W. Hardin, and numerous students were involved in field work. H. O. Hillestad, M. D. Tuttle, S. R. Humphrey, C. E. Mohr, R. W. Barbour, W. H. Davis, J. S. Hall, and several others provided information through personal communications during the past several years.

## SPECIES ACCOUNTS

### *Myotis sodalis* Miller and Allen, Indiana Bat — Endangered.

The range of *M. sodalis* is in the eastern United States from Oklahoma, Iowa, and Wisconsin east to Vermont and south to northwestern Florida (Barbour and Davis, 1969). Distribution is associated with major cave regions and areas north of cave regions (Hall, 1962). It is known primarily from the caves in which it hibernates; summers are probably spent singly or in small groups in hollow trees or beneath loose bark, although relatively little is actually known concerning summer habitat and distribution (Barbour and Davis, 1969). The present population is estimated to be approximately 500,000, of which 90% hibernate in two caves in Kentucky and a cave and a mine in Missouri (Greenhall, 1973).

Indiana bats hibernate in tight clusters of up to several thousand individuals in sections of the hibernaculum where temperatures average 3-6° C and with relative humidities of 66-95% (Barbour and Davis, 1969). Most suitable areas within hibernacula are relatively close to the entrance, and this, plus the fact that a large percentage of the entire population hibernates in only a few caves and mines, renders them very susceptible to such factors as vandalism, flooding, or disturbances of other types (Greenhall, 1973).

The total population of the Indiana bat has declined rapidly during recent years and it is now virtually gone from the northeastern United States (Mohr, 1972). Loss of habitat has likely been a factor in this decline. Vandalism has also taken a toll. Several years ago we met a group of Boy Scouts who had been "batting bats" with sticks as the bats flew through passages in Bat Cave, Carter Caves State Park, Kentucky. In that one cave alone thousands of *M. sodalis* have been killed by vandals (Greenhall, 1973). Flooding of hibernacula resulting in the deaths of large numbers of individuals has been reported (Hall, 1962; Griffin, 1953; DeBlase et al., 1965). Repeated unnatural arousal from hibernation may be responsible for marked reductions in several populations, especially in certain caves frequently entered by spelunkers or scientists conducting bat banding or other research (Mohr, 1972). It is possible that pesticide poisoning may also be an important factor in the decline of the Indiana bat. Since the Environmental Protection Agency banned almost all uses of DDT, naturalists at Mammoth Cave National Park have reported an increase in the number of Indiana bats there (Greenhall, 1973). The U. S. Army Corps of Engineers has proposed a dam on the Meramec River in Missouri that, if completed, will inundate several caves that are hibernacula of both Indiana bats and gray bats (Greenhall, 1973).

*M. sodalis* is on the federal list of endangered species and thus has been afforded protection as provided by the Endangered Species Act. The U. S. Fish and Wildlife Service has recently organized an Indiana Bat Recovery Team to develop a recovery plan for this bat. The state of Kentucky has erected chainlink fences across the two entrances of Bat Cave in Carter Caves State Park to protect the large hibernating colony there from human disturbance. Iron gates or chainlink fences have also been installed at entrances to Mammoth Cave National Park caves harboring Indiana bats (Greenhall, 1973).

### *Myotis grisescens* (Howell), Gray Bat — Endangered.

The range of *M. grisescens* is concentrated in the cave region of Missouri, Kentucky, Tennessee, and Alabama, with occasional colonies and individuals in adjacent states (Barbour and Davis, 1969). Gray bats are cave residents throughout the year, although different caves are usually used in summer than in winter; few have been found roosting outside of caves (Barbour and Davis, 1969). The present population is estimated to be approximately 2,275,000 (Tuttle, M. D., 25 July 1975, personal communication).

In summer gray bats form maternity colonies of a few hundred to many thousands of individuals, usually in large caves containing streams; in winter they hibernate primarily in deep pit type caves (Barbour and Davis, 1969). Approximately 65% of the entire known population hibernates in one cave, and about 90-95% of the population is restricted to only five caves (U. S. Department of the Interior, Fish and Wildlife Service, 1975). Gray bats hibernate in tight clusters of up to several thousand individuals, sometimes several tiers thick (Hall, 1962). They choose hibernation sites where temperatures average 7-10° C, slightly warmer than those chosen by *M. sodalis* (Barbour and Davis, 1969). There is some overlap in the two species however, and *M. grisescens* sometimes hang directly on clusters of *M. sodalis* (Hall, 1962).

Although the total population of *M. grisescens* has declined in recent years, the greatest threat to their survival is the fact that, like *M. sodalis*, a large proportion of the known population is concentrated in only a few caves during hibernation (Mohr, 1972). This is true even though most gray

bat hibernacula are located in rather inaccessible, deep pit type caves. Cave exploring has become increasingly popular in recent years and many spelunkers seek out caves of this nature for their activities. Thus visitation has increased, and along with it, increased unnatural arousal of hibernating bats, resulting in loss of stored energy reserves important for survival. Summer maternity colonies are very intolerant of human disturbance and repeated disturbance may cause gray bats to abandon a cave (Barbour and Davis, 1969). Vandalism has no doubt resulted in the destruction of many gray bats, although it is not as well documented as in the case of the Indiana bat. We recently met a group of boys armed with homemade gasoline bombs (Molotov cocktails) who were on their way to "bomb bats" (*M. grisescens*) in a nearby Tennessee cave. Destruction of habitat has also been a factor in declining gray bat populations. During the past several years a number of *M. grisescens* caves have been lost to commercialization or other human related activities (Mohr, 1972). The proposed dam on the Meramec River in Missouri, as mentioned previously, would destroy considerable habitat of both *M. grisescens* and *M. sodalis* (Greenhall, 1973).

Barbour and Davis (1969) have reported that no cave regularly inhabited by *M. grisescens* is protected. Fortunately, this is no longer true. A large hibernating colony which we discovered a few years ago, and which we recently estimated to number approximately 175,000 individuals, is located on Ozark National Forest land in north-central Arkansas. The Forest Service has recently (1975) gated the cave to protect the colony. In addition, a large summer maternity colony of approximately 150,000 gray bats is now protected from disturbance in southern Missouri at the Ozark Underground Laboratory. Thus a large hibernating colony and a large maternity colony are now protected in the southern Ozark region.

The U. S. Fish and Wildlife Service has recently recommended that the gray bat be added to the federal list of endangered species (U. S. Department of the Interior, Fish and Wildlife Service, 1975).

#### *Plecotus townsendii virginianus* Handley, Virginia Big-eared Bat — Endangered.

The Virginia big-eared bat is found in three separate populations centered in eastern Kentucky, western Virginia, and eastern West Virginia (Barbour and Davis, 1969). This subspecies inhabits caves during both winter and summer, although occasional individuals have been observed in buildings in summer. The total number surviving is estimated to be approximately 2,500 (Harvey, 1976a).

*P. townsendii* hibernate in caves or mines where the temperature is 12° C or less, but generally above freezing (Barbour and Davis, 1969). Some caves are inhabited by Virginia big-eared bats in both summer and winter, although summer colonies are usually smaller, maternity colonies. They are usually found clustered in groups of a few to a hundred or more individuals.

The subspecies appears to be declining in numbers. Rippy and Harvey (1965), reporting on the Kentucky colony, estimated their number to be 1,000 in October 1963 and 850 in March 1964. One year later, in March 1965, I estimated the population to be 1,000. Nine years later, in March 1974, I visited the cave and found less than 500 individuals present. I have received similar reports concerning the Virginia and West Virginia colonies which apparently are also declining.

Both winter and summer colonies are very intolerant of disturbance and, if disturbed, may abandon the site (Barbour and Davis, 1969). Like many other bats, loss of habitat, increased visitation of hibernacula and nursery caves, and vandalism have likely been influential in the demise of the race.

Few protective measures have as yet been taken to protect this bat. However, the National Speleological Society has passed a resolution placing a moratorium on visits to a West Virginia cave which houses a colony of almost 1,000 individuals. The U. S. Forest Service is attempting to obtain the cave (and surrounding land) containing the Kentucky colony. *P. t. virginianus* was listed in the 1973 edition of *Threatened Wildlife of the United States* (U. S. Department of the Interior, Fish and Wildlife Service, 1973).

#### *Plecotus townsendii ingens* Handley, Ozark Big-eared Bat — Endangered.

The Ozark big-eared bat is known only from a few caves in northwestern Arkansas, southwestern Missouri, and eastern Oklahoma (U. S. Department of the Interior, Fish and Wildlife Service, 1973). Habitat requirements of this bat are similar to those of the more eastern race, *P. t. virginianus*, previously discussed. Harvey (1976b) estimated that the race probably numbers less than 100 individuals. The U. S. Department of the Interior, Fish and Wildlife Service (1973), also estimated the total number to be less than 100 and stated that never more than four have ever been found in a cave at one time. During the past 2 years we have attempted to locate specimens by contacting knowledgeable persons and searching caves from which *P. t. ingens* has been reported. In February

1975 we located a hibernating colony of 60 Ozark big-eared bats in a cave in western Arkansas. Thus it is quite possible that the previous estimate of less than 100 surviving individuals may be too low.

Due to the small number known, relatively little information is available concerning this subspecies. However, much is known about the biology of the more abundant western subspecies (Handley, 1959; Barbour and Davis, 1969; Graham, 1966; Dalquest, 1947; Pearson et al., 1952; Twente, 1955), most of which may also apply to *P. t. ingens*. The species is very intolerant of human disturbance and will sometimes vacate a cave if disturbed (Humphrey, 1969; Twente, 1955; Barbour and Davis, 1969). This, and other factors previously mentioned concerning other bats, may have played an important role in limiting population size of this race.

Few protective measures have been taken to protect the subspecies. The location of the colony discovered in February 1975 will be kept relatively secret and hopefully will be afforded some protection by the landowner. *P. t. ingens* was listed in the 1973 edition of Threatened Wildlife of the United States (U. S. Department of the Interior, Fish and Wildlife Service, 1973). Attempts will be made to locate additional colonies so that they can be protected.

#### DISCUSSION

It is generally agreed among bat researchers and other concerned persons that many bat species are declining in numbers throughout the United States. Information gathered from the nation's leading bat researchers indicated that 22 species or subspecies (out of 78 in the United States) were declining in part or all of their ranges (Mohr, 1972). Bats are a very important part of the total ecosystem and, because almost all of our native species are insectivorous, they should be afforded every means of protection possible. While legislation, such as federal and state endangered species acts will no doubt play an important role in bat protection, many bat conservationists feel that a program to educate the public concerning the true nature of bats and their importance as consumers of enormous numbers of insects is urgently needed.

Since it is now generally agreed that repeated disturbances of hibernating bats, causing unnatural arousal from hibernation with the resultant loss of energy reserves needed for survival, may be a major factor in bat mortality, efforts should be made to discourage visitation of caves containing hibernating bats. Spelunkers, scientists, and other cave visitors must be made aware that even the simple act of entering a cave during the hibernation period may be detrimental. Efforts should also be made to discourage visitation of maternity colonies, which are also very susceptible to disturbance.

Scientific investigations concerning status and ecology of many bat species are needed and should be encouraged. However, these studies must be conducted by competent individuals who are aware of proper techniques and the importance of minimizing disturbance to bat colonies. Recovery plans, like that being initiated for the Indiana bat, should be prepared and implemented as soon as possible for all species thought to be in danger of extinction, and if possible for threatened species as well. Population levels of all endangered and threatened bat species should be monitored annually and efforts should be made to locate additional colonies. The ultimate goal should be the removal of these species from the endangered and threatened species lists.

#### LITERATURE CITED

- Barbour, R. W., and W. H. Davis. 1969. Bats of America. Univ. Press of Kentucky, Lexington. 286 p.
- Dalquest, W. W. 1947. Notes on the natural history of the bat *Corynorhinus rafinesquii* in California. J. Mammal. 28:17-30.
- DeBlase, A. B., S. R. Humphrey, and K. S. Drury. 1965. Cave flooding and mortality in bats in Wind Cave, Kentucky. J. Mammal. 46:96.
- Graham, R. E. 1966. Observations on the roosting habits of the big-eared bat, *Plecotus townsendii*, in California limestone caves. Cave Notes 8:17-22.
- Greenhall, A. M. 1973. Indiana bat: a cave-dweller in trouble. Nat. Parks Conserv. Mag. 47(8):14-17.
- Griffin, D. G. 1953. Deluge underground. Bull. Nat. Speleol. Soc. 15:34-37.
- Hall, J. S. 1962. A life history and taxonomic study of the Indiana bat, *Myotis sodalis*. Reading Public Mus. and Art Gallery, Sci. Pub. 12:1-68.
- Handley, C. O., Jr. 1959. A revision of American bats of the genera *Euderma* and *Plecotus*. Proc. U. S. Nat. Mus. 110:95-246.
- Harvey, M. J. 1976a. Virginia big-eared bat. In H. O. Hillestad, ed. Endangered and threatened vertebrates of the southeast. Tall Timbers Res. Sta. Bull. In press.

- Harvey, M. J. 1976b. Ozark big-eared bat. *In* H. O. Hillestad, ed. Endangered and threatened vertebrates of the southeast. Tall Timbers Res. Sta. Bull. In press.
- Humphrey, S. R. 1969. Disturbances and bats. *Oklahoma Underground* 2:42-44.
- Mohr, C. E. 1952. A survey of bat banding in North America, 1932-1951. *Bull. Nat. Speleol. Soc.* 14:3-13.
- Mohr, C. E. 1953. Possible causes of an apparent decline in wintering populations of cave bats. *Nat. Speleol. Soc. News* 11:4-5.
- Mohr, C. E. 1972. The status of threatened species of cave-dwelling bats. *Bull. Nat. Speleol. Soc.* 34:33-47.
- Pearson, O. P., M. R. Koford, and A. K. Pearson. 1952. Reproduction of the lump-nosed bat (*Corynorhinus rafinesquii*) in California. *J. Mammal.* 33:273-320.
- Rippy, C. L., and M. J. Harvey. 1965. Notes on *Plecotus townsendii virginianus* in Kentucky. *J. Mammal.* 46:499.
- Twente, J. W. 1955. Aspects of a population study of cavern-dwelling bats. *J. Mammal.* 36:379-390.
- U. S. Department of the Interior, Fish and Wildlife Service, 1973. Threatened wildlife of the United States. U. S. Dep. Interior, Resource Pub. 114. 280 p.
- U. S. Department of the Interior, Fish and Wildlife Service. 1975. Endangered and threatened wildlife. *Fed. Regist.* 40:17590-17591.

## OBSERVATIONS AND SUGGESTED MANAGEMENT PRACTICES FOR THE ENDANGERED DELMARVA FOX SQUIRREL

*by*

LOREN W. LUSTIG AND VAGN FLYGER

Inland Environmental Laboratory

Center for Environmental and Estuarine Studies

University of Maryland, College Park, Maryland

### ABSTRACT

The Delmarva fox squirrel (*Sciurus niger cinereus*) and the gray squirrel (*Sciurus carolinensis*) occupied nest boxes placed in four separate woodlots on Maryland's Eastern Shore. During each season, a large proportion (42%-58%) of the boxes were not occupied, indicating that a lack of nesting sites is not limiting the abundance of Delmarva fox squirrels. The status of the Delmarva fox squirrel at all four sites is precarious. Management of the Delmarva fox squirrel must be based on the best available knowledge. Data pertaining to this squirrel are limited because of its scarcity and, until recently, a lack of interest in the animal by management agencies. Information concerning litters, nest box utilization, and habitat relationships is the basis for a discussion of management strategies. These include reduction of underbrush by light burning or cattle grazing and selective removal of gray squirrels to reduce interspecific competition.

### INTRODUCTION

The range of the Delmarva fox squirrel has progressively decreased in recent years. Within historic times this squirrel was found throughout the Eastern Shore of Maryland (Mansueti 1952; Paradiso 1969) as well as Southeastern Pennsylvania (Rhoads 1903; Poole 1944) Delaware (Mansueti 1952; Barkalow 1956) possibly New Jersey (Abbott 1890; Rhoads 1903) and the Virginia section of the Delmarva Peninsula (Handley and Patton 1947; Taylor 1973; Taylor and Flyger 1974). However, its present distribution (Figure 1) is limited to portions of only four counties on the Eastern Shore of Maryland (Taylor and Flyger 1974). In 1964, the United States Bureau of Sport Fisheries and Wildlife evaluated the animal's status as precarious (U. S. Bureau of Sport Fisheries and Wildlife 1964) and placed the species on its first published list of endangered fauna (U. S. Bureau of Sport Fisheries and Wildlife 1966). Pursuant to the passage of the Endangered Species Preservation Act of 1966 (80 Stat. 926), the species was placed on the first official "Endangered Species List" (Federal Register 1967). It has continued to appear on all subsequent federal endangered species lists. The state of Maryland has forbidden the hunting of the animal since 1971.