

Gray Bat (*Myotis grisescens*) Scott Crozier¹ and Michael T. Mengak²

Introduction

The gray bat (*Myotis grisescens*) is one of the largest species of the genus *Myotis* found in North America. It is distinguishable by its uniformly colored pelage with hair shafts that are uniformly gray from base to tip (Figure 1). The wing membrane attaches at the ankle instead of at the base of the toes as in most other *Myotis* species. Gray bat populations have declined significantly over the past decades. Much of this decline is caused by human disturbance in caves, natural flooding, impoundment of rivers, and contamination from pesticides. Gray bats are especially vulnerable to human activities in caves because they hibernate in dense clusters. This high degree of aggregation, lead researchers to petition for federal endangered status of the gray bat in 1975. It was listed as an endangered species in 1976. Today gray bat populations have recovered in many areas. However, human disturbance continues to be the main reason for declines of gray bats in unprotected caves. Cave protection is critical to the future recovery of this species.



Figure 1. Gray bat. **Photo Credit:** Adam Mann, Environmental Solutions and Innovations

Taxonomy

Family: Vespertilionidae

Subfamily: Vespertilioninae

Genus: *Myotis*

species: *grisescens*

There are nearly 80 species in the *Myotis* genus. *Myotis grisescens* is related to several other species such as, the Chilean myotis (*M. chiloensis*), Cave myotis (*M. velifer*), and Arizona myotis (*M. occultus*). *Myotis grisescens* is a monotypic species. The earliest fossil record

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of gray bats dates from the early to middle Pleistocene. The fossils were found in Cumberland Cave, Alleghany County, Maryland. The gray bat likely originated likely in a cool to temperate climate, but was unable to adjust warming temperatures. Today, most gray bats in northern Florida migrate every autumn to colder hibernation caves in Alabama.

Status

Multiple factors have contributed to the decline of gray bats, including human disturbance of caves, natural cave flooding, impoundment of rivers to create lakes and reservoirs, and contamination from pesticides. The gray bat was listed as endangered in 1976, and a recovery plan was created in 1982. Though gray bats are affected by pesticide poisoning through the food chain their populations have been most affected by human disturbance and vandalism to colonies in caves. They are reported to be highly selective in their use of particular caves typically using only a very small proportion of available cave space and a limited number of sites within the cave. This high degree of aggregation makes them vulnerable to human activities. They hibernate in clusters of up to 500 or more. Numbers of gray bats at 20 caves in Kentucky have declined from an estimated past summer abundance of over 500,000 to just 61,000 by 1979. Much of this decline was attributed to frequency and intensity of disturbance by cavers and other recreation activities. Another reduction in gray bats at summer roosts occurred in Alabama and Tennessee where grays declined from nearly 1.2 million bats in the recent past to 294,000 by a 1976 survey. Bat survival based on banding studies was consistent with declines in counts at some sites. Deliberate destruction of entire colonies from misguided fears about rabies has also occurred.

Following protection under the Federal Endangered Species Act of 1973 and subsequent Recovery Plan, the gray bat has recovered in many areas and the rangewide estimate continues to increase. When the gray bat was listed as endangered, the estimated population was approximately 1.6 million. Populations increased slowly between 1982 and 2007 to about 1.8 million. Some of the recovery objectives listed in the 1982 recovery plan have been achieved. All but one high priority hibernacula cave have been protected. Almost 75% of the most important caves have been protected and a third of these caves have shown a stable or increasing population. Wide population fluctuations of gray bats have been documented at many maternity sites across their range. In general, there have been significant population increases in some of the major hibernacula. However, white-nose syndrome (see Warnell publication WMS-12-12) now poses new threats to all cave bats, including the gray bat.

Distribution

The primary range of the gray bat is concentrated in the cave regions of Alabama, Arkansas, Kentucky, Missouri, and Tennessee. Smaller populations are found in Florida, Georgia, Illinois, Indiana, Kansas, Oklahoma, and Virginia. Confirmed sightings have occurred also in Mississippi and West Virginia. Some biologists noted recently that an estimated 95% of known individuals were confined to only nine caves during hibernation.

Description

The gray bat is one of the largest species of the genus *Myotis* in eastern North America. Typical body measurements are: forearm lengths of 1.57-1.85 inches (40-47 mm) long, a wingspan of 10.8-11.8 inches (275-300 mm) and weights ranging between 0.5-1.0 ounces (7-16 g). The gray bat can be distinguished from other species in the genus *Myotis* by the uniform color of its dorsal fur in which hair shafts are gray from base to tip. Other distinguishing features are a wing membrane that attaches at the ankle of the foot instead of at the base of the toes, and a notch in the claws of the hind feet. The calcar (spur on inner ankle) on gray bats is not keeled and the skull has a distinct sagittal crest.

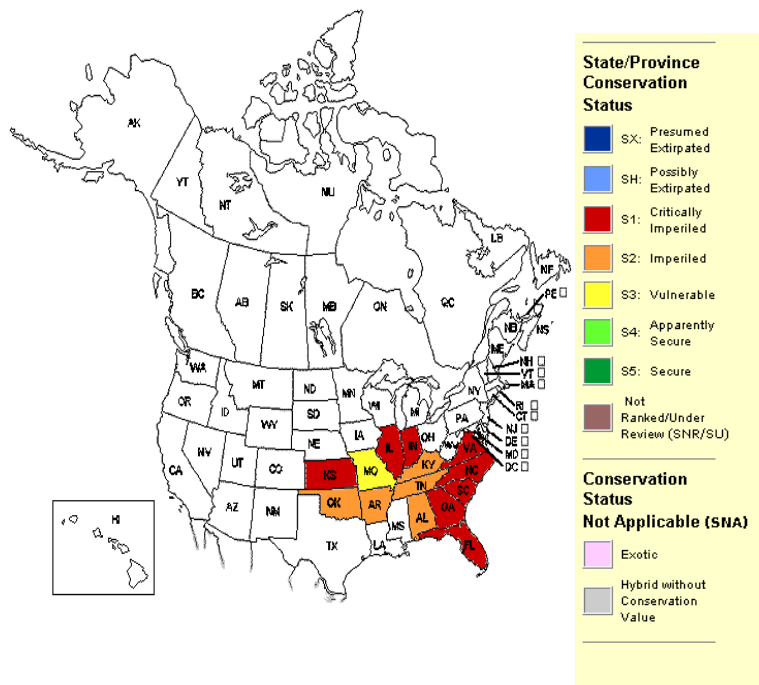


Figure 2. Current distribution of the gray bat by state. **Photo credit:** <http://www.natureserve.org/explorer/servlet/NatureServe>

Biology and Ecology

Reproduction: Courtship and mating of gray bats occurs in the fall when individuals arrive at hibernacula. Male gray bats arrive at hibernacula first and aggressively compete for females. Females enter hibernation first (usually during September and October) immediately following copulation but do not become pregnant until they emerge from hibernation in late March or early April. Males may remain active until November before entering hibernation. Gray bats, like other bats, store sperm in a process called delayed fertilization. Average gestation is approximately 64 days and a single pup is born in late May or early June. Females typically do not give birth until they are two years old. Newborn young are approximately one-third of their mother's weight and can fly within 21 to 33 days.

During the summer, female gray bats form maternity colonies of a few hundred to many thousands of individuals. Nursery colonies typically form on domed ceilings of caves which trap the combined body heat from clustered individuals. Typically these caves are warm with temperatures ranging between 57°F and 77°F (14° and 25°C).

Feeding: In summer, gray bats forage for insects over open water of rivers, streams, lakes or reservoirs. Although the species may travel up to 21 miles (35 km) between prime feeding areas and occupied caves, most maternity colonies are usually located between 0.5 and 2.5 miles (1-4 km) from foraging locations. At foraging sites, gray bats forage within three meters of the water's surface. Gray bats are highly dependent on aquatic insects, especially mayflies,

caddisflies, and stoneflies. The species is an opportunistic forager, however, and also consumes beetles and moths.

Behavior: Gray bats, like many other species of bats, can influence the temperature of the roost site (a behavior known as behavioral thermoregulation) in maternity roosts during the lactation period (28 May to 28 June). The colony carefully selects roost sites, increases colony size, clusters, and remains active as long as non-flying young are present. These bats tend to cluster in summer caves. A square foot of cave ceiling can hold up to 200 individuals (1,828 individuals per square meter), depending on the roughness of the cave surface and ambient temperature. Unless they are in torpor, gray bats maintain their roost temperature at an average of 50°F (10°C) above ambient temperature.

They tend to use the same roost caves from year to year (high roost philopatry). Because of their highly specific roost and habitat requirements, only about 5% of available caves are suitable for use by gray bats. At all seasons, males and yearling females seem less restricted to specific cave and roost types. Bachelor males segregate into separate aggregations within a colony home range. This usually includes several caves that may extend up to 45 miles (70 km) along a particular river valley. Gray bat hibernacula are often made-up of individuals from large areas of their summer range. Researchers have found that the home range of one colony of gray bats included five caves and covered an area approximately 35 miles long by 3 miles wide (50 X 4 km). Newly volant gray bats travel up to 4 miles (6.5 km) between roost caves and foraging areas. Based on band recovery data, a gray bat hibernaculum in Edmonson County, Kentucky attracted individuals from an area encompassing 10,500 square mile (27,195 km²). Gray bats have been documented to regularly migrate from 10 to 263 miles (17 to 437 km) between summer maternity sites and winter hibernacula. Some individuals moving as much as 428 to 481 miles (689 to 775 km)!

Habitat: The optimal foraging habitat of gray bats is in riparian (streamside) areas where they often fly over bodies of water and in the protection of the forest canopy. A study of bats over the Merrimac River in eastern Missouri suggested that gray bats competitively exclude Indiana bats (*Myotis sodalis*) from the river area. This forces the Indiana bats to forage away from the water. Such behavior reduces competition but scatters the predators (bats) over a large area. With a few exceptions, gray bats are one of the few species of bats in North America that inhabit caves year-round. The species occupies cold hibernating caves or mines in winter and warmer caves during summer. In winter, gray bats hibernate in deep vertical caves that trap large volumes of cold air and the species typically forms large clusters with some aggregations numbering in the hundreds of thousands of individuals. The species chooses hibernation sites where there are multiple entrances, good air flow and where temperatures are approximately 41° to 48° F (5° to 9° C), though 34° to 38° F (1° to 4° C) appears to be preferred.

Predators: Screech owls (*Megascops asio*) have been observed preying on gray bats emerging from a roost. A black rat snake (*Pantherophis alleghaniensis*) was found preying on a gray bat in total darkness 93 yards (85 m) inside a cave in Camden Co., Missouri. Raccoons and opossums have been reported to scavenge on juvenile bats that dropped from a cave ceiling in Tennessee. Crayfish (*Cambarus laevis*) were also observed to feed on 32 dead young gray bats in a summer colony in Jessamine Co., Kentucky.

Lifespan: Recorded longevity for gray bat is approximately 14-17 years, but may be longer.

Disease and Parasites

Ectoparasites found on gray bats include the one species of mite, for which the gray bat is the only known host, fleas, chiggers, and the bat fly. Internal parasites include six species of nematodes and one cestode.

In February 2006, an unknown fungus was documented on a number of hibernating little brown bats at Howes Cave near Albany, New York. The unknown growth was named white-nose syndrome (WNS) due to the presence of a visually striking whitish covering on the muzzles (Figure 3), ears, or wing membranes of affected bats. Although the exact origin of the condition was unknown, many affected bats exhibited unusual behavior at hibernacula (e.g., emergence during cold periods, erratic flying, etc.) and the ailment has apparently been responsible for the mortality of thousands of bats. After a concerted effort by numerous researchers, biologists, and bat ecologists, the fungus associated with WNS has been identified as a cold loving fungus already known in Europe: *Geomyces destructans*.

To date, mortality attributed to WNS involves six species of bats: little brown bat (*Myotis lucifugus*), big brown bat (*Eptesicus fuscus*), northern bat (*Myotis septentrionalis*), eastern small-footed bat (*Myotis leibii*), tri-colored bat (formerly eastern pipestrelle) (*Perimyotis subflavus*), and the federally endangered Indiana bat (*Myotis sodalis*). As of January 17, 2012, the U.S. Fish and Wildlife Service reported that WNS had been confirmed in 19 states and 4 Canadian provinces. Although WNS has not yet been documented in any population of *Myotis grisescens*, the condition has been recently discovered in Hancock Cave, Virginia, approximately 11 miles from a bachelor colony of approximately 2000 gray bats. Additionally, it is located approximately 307 miles from the closest major gray bat hibernacula in south-central Kentucky. Since its initial discovery in New York in 2006, WNS has spread approximately 900 miles.



Figure 3. Image of little brown bats (*Myotis lucifugus*) affected by white-nose syndrome. **Photo credit:** Al Hicks, New York Department of Conservation

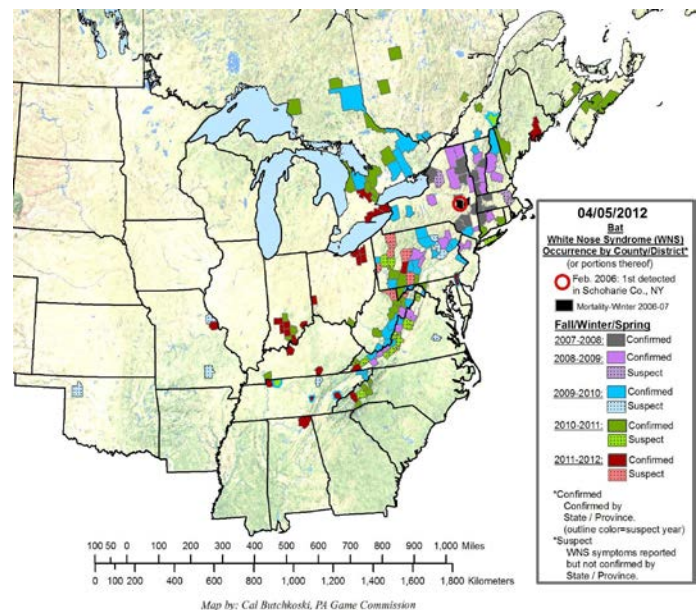


Figure 4. Distribution of White-nose syndrome in US and Canadian caves. **Photo credit:** Cal Butchkoski, PA Game Commission

There is an risk of gray bats coming in contact with bats infected with WNS. There are two primary reasons for this increased risk. First, *Myotis grisescens* has been documented to regularly migrate from 10 to 272 miles (17 to 437 km) between summer maternity sites and

winter hibernacula, with some individuals moving as much as 428 to 481 miles (689 to 775 km). Second, the species often co-occurs at roosts with other species which also migrate considerable distances between winter hibernacula and summer maternity sites. The potential spread of WNS to gray bats would likely be catastrophic. Such losses in gray bats would surely result in an immediate reversal in the recovery that has been so slowly achieved across the range of the species.

Economic Value

Gray bats have no commercial value. Their economic value is as an insect predator. There is some evidence that cave over-utilization for commercial, scientific, or educational purposes have adversely impacted gray bat populations. Marvel Cave, Missouri was commercialized and became a part of Silver Dollar City in 1960. Although numbers at the site varied widely, as at other locations, the population decreased to only 900 individuals in 1993. Some other gray bat caves have ongoing problems with human disturbance associated with commercial cave tours or archaeological looters. Reports by several researchers and data provided by state personnel within the range of the gray bat suggest that human disturbance associated with recreational caving may also negatively impact the species.

Medicinal Value

No medicinal value has been reported for the species.

Legal Aspects

The gray bat is protected in every region in which it occurs as a federally endangered species. Maximum criminal penalties for unlawful taking of a gray bat are one year imprisonment and \$100,000 fine per occurrence. Maximum civil penalties are about half the criminal penalty. Endangered species are rigorously protected and violations are taken very seriously by law enforcement personnel.

Control to Reduce

There are currently no efforts to reduce population numbers of this species. Research and management is focused on efforts to restore and enhance the species.

Major Threats

Despite its recovery in many areas, human disturbance is the main reason for the continued decline of gray bats in unprotected caves. The breaching of locked gates and fences has been noted at multiple caves. Several studies have shown that monitoring and maintenance of protection measures (i.e., gates) and vigilant patrols by various agency law enforcement personnel are essential to prevent human intrusion at gray bat sites. Several bat experts have acknowledged that cave protection measures at some gray bat sites are insufficient to prevent

declines associated with human disturbance. Due to the large number of caves potentially used by gray bats and budget shortfalls of many state and federal agencies, it will be increasingly difficult for law enforcement personnel to monitor some protected sites. Voluntary compliance with cave closure orders is critically important to recover efforts.

Although human disturbance remains the primary reason for the continued decline of some populations of gray bat, natural and man-made flooding remains a secondary threat at some gray bat sites. Flash flooding in caves can also adversely affect gray bats by damaging gates at cave entrances that were constructed to protect roosting bats. Additionally, if white-nose syndrome (WNS) spreads to populations of gray bats and results in mortality rates similar to those reported for other bat species in the northeastern U.S., this disease could become the primary reason for additional declines.

Management to Enhance

The gray bat recovery plan outlines numerous priority actions that should be undertaken. A critical management activity includes continued monitoring of the spread of WNS. Other needed activities are continued efforts to prevent human disturbance to roosting gray bats by placement of various protective measures at maternity sites. Reestablishment of natural air flow at sites where improperly installed cave gates or other structures have impeded air circulation and adversely impacted sensitive roosting temperatures is also necessary. Continued monitoring of gray bat populations at high priority hibernacula, and selected maternity sites is an additional concern. Finally, at sites where cave protection is not possible through the use of gates, fences, or signs, continued efforts are required to prevent human intrusion through the use of conservation easements, safe harbor agreements, private landowner agreements, or other mechanisms. Public education and outreach to the cave community (cavers), landowners, and the general public is necessary to change public perceptions about bats and to instill respect for this important resource.

Human Use

Native Americans: The Native American people recognized that the bat was highly sensitive to their surroundings and so therefore was considered a symbol of intuition, dreaming and vision. This made the bat a powerful symbol for Native American shamans and medicine people. Often the spirit of the bat would be invoked when special energy was needed, like "night-sight" which is the ability to see through illusion or ambiguity and dive straight to the truth of matters. It is also a symbol of communication because the Native Americans observed the bat to be a highly social creature.

Colonists: There are no known uses by colonists.

Further Readings

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