Myotis septentrionalis Northern Long-Eared Bat

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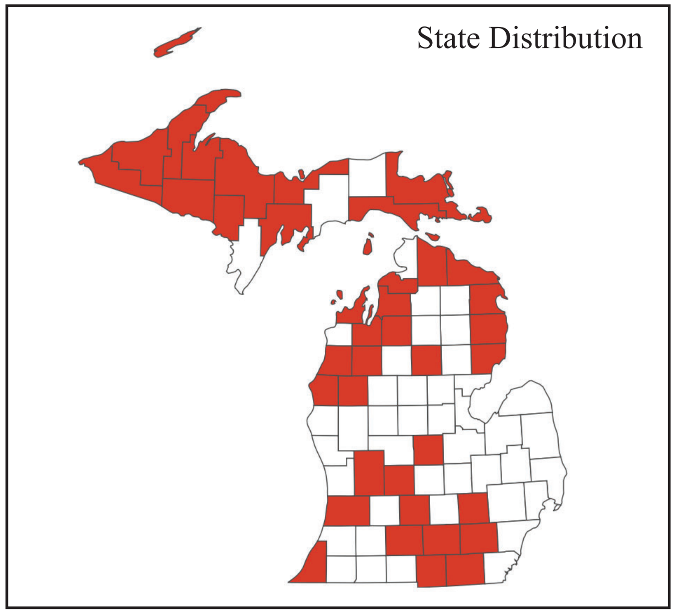
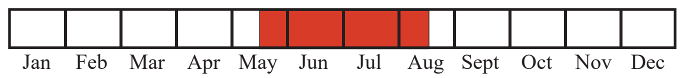


Best Survey Period



Status: Federal endangered, State threatened

Global and State Rank: G2G3/S1

Family: Vespertilionidae (Evening bats)

Synonyms: Before 1990 the northern long-eared bat, also known as the northern *Myotis* and the northern bat, was classified as a subspecies of Keen's bat (*Myotis keenii septentrionalis*) but is now regarded as a distinct species (Wilson and Reeder, 2005; Kurta, 2008). Currently, no subspecies are recognized for *M. septentrionalis* and no genetically distinct subpopulations have been identified (Johnson et al., 2014; NatureServe, 2024).

Total Range: The northern long-eared bat's range and distribution is patchy but includes much of the eastern and north-central United States, as well as all Canadian provinces west to the southern Yukon Territory and eastern British Columbia (Nagorsen and Brigham, 1993; Caceres and Pybus, 1997; Environment Yukon, 2011; USFWS, 2022). Winter and summer geographic ranges of the species appear to be the same. However, the lack of hibernacula and gravid or nursing females in some areas indicates that significant portions of the population may move seasonally (Barbour and Davis, 1969).

State Distribution: The northern long-eared bat occurs throughout the upper and lower peninsulas of Michigan as well as Summer and Mackinac Islands and Isle Royale (Kurta, 2008). The species is less common in southern Michigan and more common in the north, where forests are abundant and potential hibernation sites are reasonably close. The lack of suitable hibernacula in southern Michigan suggests that bats must migrate either south to the karst regions of Indiana and Ohio or north to the abandoned mines of the Upper Peninsula to overwinter (Kurta, 1982). Before white-nose syndrome was detected in Michigan (the winter of 2014), hibernacula were located in Gogebic, Ontonagon, Houghton, Keweenaw, Baraga, Marquette, Dickinson, and Manistee counties (MNFI, 2024). There are currently 74 element occurrences (EOs) within the Michigan Natural Heritage Database, 20 of which are historical (i.e., most recent observation was ≥ 30 years ago) and 54 are ranked extant, however their viability has not been assessed (MNFI, 2024). Most of these data were collected before white-nose syndrome was detected in Michigan. Therefore, more research is needed to better understand the viability of these EOs in the face of this novel disease.

Recognition: *Myotis septentrionalis* is a small bat (average body length 77-95 mm and head-body length 40-46 mm) with average body mass of 5-8 grams (Caceres and Barclay, 2000; Wilson and Mittermeier, 2019; USFWS, 2022). Weight of individual bats varies seasonally, weighing the least in the spring when emerging from hibernation. Females tend to be slightly larger than males (Kurta, 1995; Caceres and Pybus, 1997). Ears are long (14-19 mm; Caceres and Barclay, 2000) for the size of the body and extend 3-5 mm past the tip of the nose when gently laid forward (Kurta, 2008; Morgan et al., 2019). Wingspan is 228-258 mm and forearm length is 34-38 mm (Caceres and Barclay, 2000; Kurta, 2008). Fur ranges in color from medium to dark brown on the back and tawny to pale-brown on the underside (Whitaker and Mumford, 2009; USFWS, 2022). Ears and wing membranes are dark brown, but not black in color and have a long, pointed, narrow tragus around 9 mm in length (Whitaker and Mumford, 2009; USFWS, 2022). The calcar (cartilaginous projection extending from the inner ankle that is used to extend the wing membrane) is occasionally slightly keeled and this can add some uncertainty when identifying the species (Nagorsen and Brigham, 1993). This keel is usually indistinct or absent (Morgan et al., 2019; Wilson and Mittermeier, 2019).

Similar Species: This species is often confused with little brown (*Myotis lucifugus*) and Indiana bats (*Myotis sodalis*). These species generally have larger bodies than the northern long-eared bat and tend to have shorter ears. The most reliable trait used to tell these species apart is the shape of the tragus. The tip of the tragus of little brown and Indiana bats is blunt when compared to the long, gradual, tapering tip of the northern long-eared bat tragus (Kurta, 2008).

Myotis septentrionalis can be detected through acoustic monitoring, but has a very low-intensity, high-frequency echolocation (Szewczak, 2018). Northern long-eared bats use frequency modulated (FM) echolocation calls that are higher in frequency (sweeping from 126 to 40 kHz), shorter in duration (1.01 ms), broader bandwidth (up to 100 kHz), and lower intensity (78 dB) than other species of *Myotis* (Caceres and Barclay, 2000; Szewczak, 2018; see Figure 1). Their calls, although quiet, are consistent and exhibit sharp FM sweeps that are nearly linear in shape (Szewczak, 2018). Their faint echolocation calls and foraging habitat (generally in non-open, forested areas) make them more difficult to detect, especially in open-air deployments, so they may be underrepresented in many standard acoustic surveys.

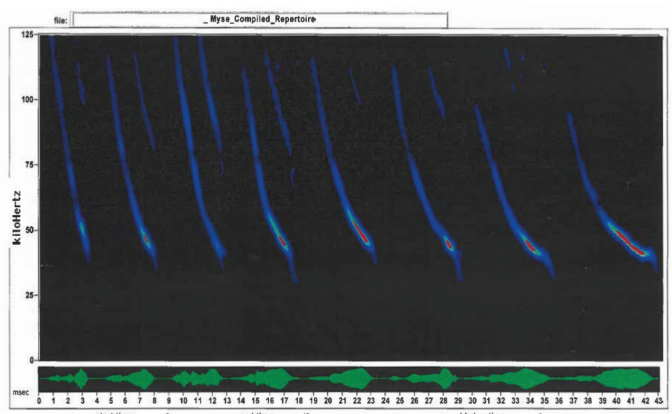


Figure 1. Compiled spectrograph of a northern long-eared bat echolocation call repertoire (compiled by Brian Klatt).

Best Survey Time: Northern long-eared bats are most active from April to mid-to-late October (Migration: April to May, Parturition (i.e., birthing): mid-June to early July, Breeding: September to mid-October). Northern long-eared bats are generally found in their summer habitat from mid-May through mid-August every year; however, in some areas of the southern United States, they are present in potential roosting habitat year-round (USFWS, 2024). Mist netting is the most effective method for capturing flying bats in their summer habitat. Mist nets generally should be set perpendicular to travel corridors such as streams, rivers and trails in forested areas where bats typically forage. Northern long-eared bats, however, are more abundant in forest interiors than edges and non-traditional net placement within forests may be more productive for this species (USFWS, 2024). For survey work, placing mist nets randomly along transects may provide the least biased estimates of species richness and relative abundance. They are sensitive to human disturbance during breeding and hibernation periods, so special precautions should be taken to not disturb them during these times (NatureServe, 2024). Disturbances during hibernation may cause bats to use their fat reserves that are needed to survive the winter.

Habitat: Habitat and roosting behaviors vary seasonally. Northern long-eared bats are associated with forested habitats, particularly old-growth boreal forests (Wilson and Mittermeier, 2019). In Michigan, they are associated with dry northern forest, dry-mesic northern forest, limestone cliff, and mesic northern forest natural communities (MNFI, 2024). Three types of roosts are used by these bats throughout the year: day roosts, night roosts, and hibernacula (winter hibernation sites).

Day and night roosts are used in the spring, summer, and fall when bats are active. Northern long-eared bats tend to use trees as these roosting sites, although some individuals have also been found using human-made structures (Barbour and Davis, 1969; Foster and Kurta, 1999; Caceres and Barclay, 2000; Kurta, 2008). In the southern Lower Peninsula of Michigan, most roost sites are found in ash, elm, and maple trees and in the Manistee National Forest, they have been radio-tracked to black ash, red maples, and quaking aspen (Kurta, 2008). Female northern long-eared bats in Michigan have been found roosting in crevices, hollows, or under the bark of live and dead deciduous trees (Caceres and Barclay, 2000). Males and nonreproductive females roost in or on trees, human-made structures, or in caves (Turner, 1974; Nagorsen and Nash, 1984; Nagorsen and Brigham, 1993; Caceres and Barclay, 2000). Silvis et al. (2012) found that long-term roosting opportunities depended more on the successional patterns of the forest, rather than the tree species that were present. They generally prefer dense to loose tree cover in mixed forests with small gaps such as trails, small roads, or creeks, rather than clear cut or otherwise fragmented areas (USFWS, 2024). Individual trees (live or dead, ≥3 inches in diameter at breast height, that have exfoliating bark, cracks, crevices, or cavities) can be considered summer roosting sites if they are within 1,000 feet of forested or woodland habitat (USFWS, 2024). It is considered a true clutter specialist, producing very quiet echolocation calls and foraging mainly beneath the forest canopy, not in largely open forest areas (USFWS, 2024). Late successional forest characteristics may be favored for several reasons, including the large number of partially dead or decaying trees that the species uses for breeding, summer day roosting, and foraging. Night roosts for this species include caves and rock shelters where they will temporarily rest between feeding bouts (Barbour and Davis, 1969).

Northern long-eared bats spend the winter hibernating in caves and mines (i.e., hibernacula). They use areas in a variety of different-sized caves or mines with constant temperatures, high humidity, and no air currents (Kurta, 1982). Within hibernacula, they are most often found in deep crevices or cracks, rather than clusters on exposed surfaces, which makes them difficult to survey and monitor in the winter (Caceres et al., 2000). Previously, approximately 70 hibernacula sites were known in Michigan. These sites were mainly abandoned mines in the Upper Peninsula, with caves also making up a small number of sites (Stones, 1981). Before the detection of white-nose syndrome in Michigan, they also commonly hibernated in the spillway of a hydroelectric dam facility in Manistee County at Tippy Dam, however they have since disappeared (Kurta et al., 2020). Today they have disappeared from many of the Michigan hibernacula that they used prior to the discovery of white-nose syndrome, however more recent surveys are needed to determine whether or not they are still using the hibernacula found in Michigan's Upper Peninsula.

Biology: Northern long-eared bats can migrate up to 89 km (55 miles) between summer and winter roosting sites (Griffin, 1940; Caire et al., 1979; Nagorsen and Brigham, 1993; USFWS, 2022).

In Michigan, they will form large colonies in May-early June and then break into smaller groups before their young are born (Kurta, 2008). Across their range, maternity colonies are made up of females and their young and are usually small, ranging from 30 to 60 bats; however larger colonies of up to 100 bats have been observed (Caceres and Barclay, 2000; Whitaker and Mumford, 2009). These maternity colonies form in cavities and crevices of live or dead trees or sometimes underneath exfoliating bark, under shingles, and in buildings (Brandon, 1961; Mumford and Cope, 1964; Clark et al., 1987; Nagorsen and Brigham, 1993; Sasse and Pekins, 1996; Foster and Kurta, 1999; Carter and Feldhamer, 2005; USFWS, 2022). Females switch roosts often, every 1-3 days, but an entire colony does not move all at once (Kurta, 2008). Adult male northern long-eared bats and nonreproductive females roost solitarily or in small groups (<10 individuals), usually on or in trees, but they have also been found utilizing buildings, caves, and mines (Turner, 1974; Nagorsen and Nash, 1984; Nagorsen and Brigham, 1993; Caceres and Barclay, 2000).

In late summer or early fall, prior to hibernation, northern long-eared bats migrate to and swarm at the entrances of hibernacula sites. Before white-nose syndrome was detected in Michigan, they were one of the most common species found swarming at some sites on certain nights, however they were usually less abundant than little brown bats (*Myotis lucifugus*) (Kurta, 2008). Males engage more frequently in swarming activities than females, likely reflecting that males will maximize their opportunities to mate (Burns et al., 2015). Mating occurs during swarming in September and October in Michigan. All bats found in Michigan use delayed fertilization, meaning they mate in the fall, store sperm through the winter, and ovulate after hibernation (Thomas et al., 1979; Wai-Ping and Fenton, 1988; Kurta, 2008). In tree-roosting species such as the northern long-eared bat and the Indiana bat, parturition is generally slightly later than building-roosting species such as little and big brown bats. In southern Michigan, most northern long-eared bat births occur in mid-to-late June, while in the Upper Peninsula most births occur in late June or early July (Kurta, 2008). Adult females give birth to one hairless pup weighing only 1.9 grams (0.07 ounces) each year (Barbour and Davis, 1969; Kurta, 2008). Most births within a maternity colony often occur around the same time (Krochmal and Sparks, 2007). Young achieve flight by 21 days of age and are weaned shortly after this (Krochmal and Sparks, 2007; Kunz, 1971; Kurta, 2008). They are likely similar to other species of *Myotis*, not becoming sexually mature until their second year (Fenton and Barclay, 1980). The record longevity for the northern long-eared bat is 18.5 years from Massachusetts (Hall et al., 1957; Kurta, 2008).

Northern long-eared bats are insectivorous and forage for insects at night. All bats in Michigan are aerial hawkers, meaning that they capture insects from the air while both the bat and insect are in flight, however the northern long-eared bat is also capable of gleaning insects that are sitting on leaves, tree trunks, or the ground (Kurta, 2008). The majority of their foraging happens above the understory (1-3 meters above the ground), but below the canopy of the forest (Nagorsen and Brigham, 1993). They usually forage on forested hillsides and ridges instead of along riparian areas that are used by other Michigan bats (LaVal et al., 1977; Brack and Whitaker, 2001). Peak foraging activity occurs within 5 hours after sunset, followed by a second activity peak about 8 hours after sunset (Kunz, 1973). Their diet is diverse and differs geographically and seasonally (Brack and Whitaker, 2001). Their most common prey items are lepidopterans (moths) and coleopterans (beetles), however they also feed on arachnids (Araneae), flies (Diptera), leafhoppers (Hemiptera), and caddisflies (Trichoptera) (Griffith and Gates, 1985; Nagorsen and Brigham, 1993; Brack and Whitaker, 2001; Lee and McCracken, 2004; Feldhamer et al., 2009). Moths cannot easily hear the high, low intensity calls of the northern long-eared bat, making them easy prey (Wilson and Mittermeier, 2019). Bats acquire water from moisture within their prey, and by dipping their mouth into a water body as they fly above the surface (Kurta, 2008).

In August, after their young are weaned, northern long-eared bat maternity colonies disband and bats travel to hibernacula, where they participate in swarming. In Michigan, northern long-eared bats begin hibernation by mid-to-late October (Kurta, 2008). Before white-nose syndrome was detected in Michigan, northern long-eared bats made up about eight percent of all of the bats hibernating in the mines of the Upper Peninsula, however they were rarely abundant at each site (Kurta, 2008). Unlike little brown bats, these bats generally roost solitarily or in small numbers on cave/mine walls or on ceilings and are often found using small crevices and cracks in these locations (Griffin, 1940; Barbour and Davis, 1969; Caire et al., 1979; van Zyll de Jong, 1983; Caceres and Pybus, 1997; Whitaker and Mumford, 2009). Northern long-eared bats usually hibernate with other bat species, particularly the little brown bat, the big brown bat, and tricolored bats. They have high site fidelity to their winter hibernacula; however, they do not always use the same hibernacula sequentially (Wilson and Mittermeier, 2019). Both female and male northern long-eared bats emerge from hibernation in April and May.

Conservation/Management: Turbine collisions, contaminants, predation, poaching, and deforestation are all contributing to the drastic decline in northern long-eared bat populations across their range. Their primary threat in recent years is a fungal pathogen, *Pseudogymnoascus destructans*, the causative agent of white-nose syndrome (WNS). WNS is an often-fatal disease that attacks hibernating bats, causing them to arouse more frequently, using up their limited fat reserves that are required to survive hibernation (Warnecke et al., 2012; NatureServe, 2024). Within the first four years after WNS was introduced to the United States at least 1 million bats succumbed to the disease (Kunz and Reichard, 2010). WNS has been spreading rapidly at an average rate of 200-900 km/year (Wilson and Mittermeier, 2019; Hoyt et al., 2021). Four years after WNS was detected in the United States, it was estimated that the northern long-eared bat declined by 98% among hibernacula in Vermont, New York, and Pennsylvania (Turner et al., 2011). Cheng et al. (2021) estimated population declines of 97-100% across 79% of the northern long-eared bat's range. Variation exists among hibernacula; however, the majority of hibernating northern long-eared bat colonies have developed WNS and serious impacts occurred within 2-3 years after the introduction of *P. destranctans* to each colony (Cheng et al., 2021). There is no apparent containment of the northern or western spread of WNS as proper growing conditions for *P. destructans* are present throughout the entire range of the northern long-eared bat.

Although less than in hoary, eastern red, and silver-haired bats (Arnett et al., 2008; NatureServe, 2024), northern long-eared bat occurrences overlap considerably with wind energy facilities and mortality at these sites has been observed (USFWS, 2022). In 2020, the United States Fish and Wildlife Service estimated that 122 northern long-eared bats die at wind energy facilities every year (USFWS, 2022). Wind energy is expected to expand substantially by 2030 and the impacts of this expansion need to be studied further (NatureServe, 2024). Using data from Wiens et al. (2023), abundance decreases of 24-33% were estimated using the current wind energy scenario and up to 83% were projected using a high impact wind energy scenario by 2060. Most collisions take place in August and September when bats are migrating to their hibernacula (Kurta, 2008).

Natural predators of bats take them opportunistically and generally do not heavily impact their populations, however, introduced predators such as domestic cats have developed the ability to capture many bats due to their proximity to human structures (Fenton and Barclay, 1980). Cats and many other predators (e.g., mice, owls, weasels, snakes, raccoons) utilize the high concentrations of bats in the roosts and some will wait at the entrance of roosts to capture bats that are entering/leaving (Gillette and Kimbrough, 1970; Fenton and Barclay, 1980). Other predator species such as martens and fishers take advantage of helpless pups or hibernating individuals that fall from the roost ceiling or walls (Fenton and Barclay, 1980). In addition, bats are killed each year by exterminators and other humans that find bats roosting in their homes. This is unnecessary, as sealing access sites after bats have left for the night is a much cheaper, safe, and effective option (Barclay et al., 1980).

Northern long-eared bats also face the ongoing threat of hibernaculum disturbance from humans entering hibernacula in winter and waking bats from torpor. Bats in torpor reduce their metabolism and body temperature to low levels that require less energy. Repeated arousals may cause bats to run out of energy reserves before spring arrives and therefore starve in the hibernaculum or die from exposure if they seek food outside. In addition, sealing off abandoned mines potentially affects thousands of bats by removing their hibernacula. Gates or other barriers can be used to allow for bats to enter and exit abandoned mines or caves within human interference.

Pesticides are a threat to many taxa, but bats may be more vulnerable than other small mammals. Water contaminants also impact bats as they are absorbed by the aquatic insect larvae that they eat. The longevity and high trophic level of bats means pesticides and other contaminants can concentrate in their body fat. Fat reserves are depleted during migration or long-distance flights, increasing the concentration of pesticide residues in brain tissue and this may lead to convulsions or death (WIDNR, 2013).

The effects of climate change on the northern long-eared bat are unclear. Predictions suggest a northward expansion in the ranges of all cave-bat species, in pursuit of optimal hibernation. This prediction assumes an abundance of suitable caves and other hibernaculum structures further north but may not hold for karst-free regions at higher latitudes. Bats' adaptive capacities in this regard may be limited and are not well known (USFWS, 2011). Shifts in prey insect emergence may also cause mismatches with bat emergence and cause food shortages in the spring or fall.

Poor-planned cuttings of large, forested tracts and even small woodlots eliminates roosting habitat and can lead to decreased reproductive success depending on the time of year the work is conducted. Maintenance of adequate habitat for all life stages should be monitored every year or two depending on pattern of decline or impacts. Forest management should increase roosting and foraging habitat. Forest managers are encouraged to promote mixed-species, mixed-age plots as the northern long-eared bat chooses trees based on suitability of crevices and bark as roosts, rather than on specific tree species (Kurta, 2008). In addition, during fall swarming events, management activities such as logging and use of heavy machinery within 0.25 miles of hibernacula entrances must not take place because bats may use the surrounding area for roosting (NatureServe, 2024). Leave dead and dying trees with loose bark standing as they provide summer roosting habitat. Land managers should also try to reduce or eliminate burdock (*Arctium minus*), an invasive plant that produces seed heads that can trap bats and cause death from exposure (Norquay et al., 2010). Vernal pools are often considered important food and water sources for bats in forested habitats (Francl, 2008). Special care is required while studying bats to protect both the bat and the researcher. Do not touch a bat unless you are properly permitted to do so, have the proper personal protection equipment, are fully vaccinated against rabies, and are able to perform the proper decontamination protocol. Everything that touches a bat, or its hibernacula must be decontaminated to prevent the spread of white-nose syndrome to other bats/colonies. Cave and mine tours should also take special care and provide decontamination stations for visitors as they can transport *P. destructans* spores on their clothing from one hibernaculum site to another (Zhelyazkova et al., 2020; Shapiro et al., 2021; White-nose Syndrome Disease Management Working Group, 2024).

Research Needs: The status of this species in Michigan needs to be assessed and current hibernacula and maternity roost sites need to be located in Michigan in order to protect these crucial habitats. Researching methods for combating the spread and studying the deleterious effects of *Pseudogymnoascus destructans* (cause of white-nose syndrome) are necessary for the conservation of this species. Additional research is also needed for aspects of this species' life history such as hibernation, roosting and foraging requirements, population dynamics, and migration/dispersal patterns. Telemetry studies of both sexes are needed and should be conducted in advance of potentially detrimental, large-scale habitat modifications, such as intensive logging of older forests and removal of standing dead timber in areas known or suspected to contain this species (NatureServe, 2024). Research is needed on all Michigan bat species to better understand wind-turbine mortality in the state, across their ranges, and the long-term population impacts of turbine-related deaths (WIDNR, 2013).

Related Abstracts: Cave, Floodplain Forest, Northern Hardwood Swamp, Southern Hardwood Swamp, Wet-Mesic Flatwoods, Little brown bat, Indiana bat, Red-shouldered hawk, Short-eared owl, Long-eared owl

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