Tricolored bat (*Perimyotis subflavus*) Species Guidance

Formerly known as Eastern pipistrelle and formerly *Pipistrellus subflavus*

Family: Vespertilionidae – the evening bats

State Status: Threatened

State Rank: S1S3

Federal Status: None

Global Rank: G3

Wildlife Action Plan Area of Importance Score: None

Range of tricolored bat in Wisconsin.
Source: WI Bat Program 2012

Dave Redell, Wisconsin DNR

Species Information

General Description: The tricolored bat is Wisconsin's smallest bat, and weighs just four to eight grams (0.1 – 0.3 oz; Kurta 1995). This species has a forearm length of 32-36 mm (1.3-1.4 in) and a total length of seven to eight centimeters (2.8-3.1 in; Kurta 1995). Total wingspread is 21-26 cm (8.3-10.2 in; Barbour and Davis 1969). Fur color ranges from golden brown to reddish brown. The tricolored bat has black forearms that contrast with the red membrane of the wing. The dorsal guard hairs have a distinct tricolored appearance – dark at base, yellowish in middle and dark at the tip – that give the bat its name and a harlequin appearance.

Similar Species: The tricolored bat may be confused from a distance with Wisconsin's *Myotis* species, the little brown bat (*Myotis lucifugus*) and northern long-eared bat (*Myotis septentrionalis*), because of its similar size and coloring. However, it is readily distinguished at close range by its distinct tri-colored fur and harlequin appearance (Barbour and Davis 1969). The tricolored bat and the *Myotis* species can sometimes be confused during hibernaculum surveys because the two species appear similar from a distance. The tricolored bat can be identified by its tan or sandy coloring, and also by its heart-shaped face and ears compared to the dark brown fur and linear face and ears of the little brown bat (see Fig. 1). The tricolored bat can also be identified by its echolocation call (see Fig. 2), but the eastern red bat (*Lasiurus borealis*) shares similar call characteristics, and only trained individuals should positively identify bat species through echolocation calls.

Figure 1. Tricolored bat (top) and little brown bat (bottom) hibernating together. The tricolored bat has lighter fur and a heart-shaped face. Heather Kaarakka, Wisconsin DNR

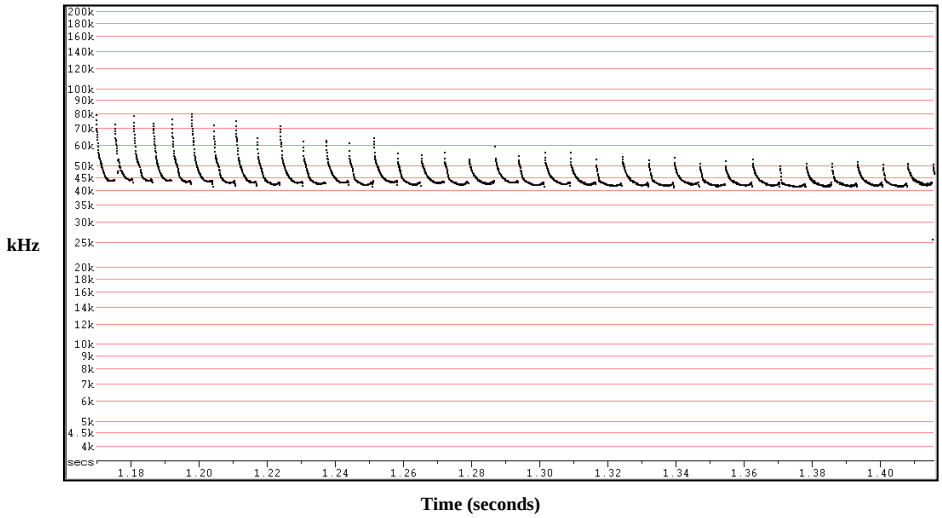
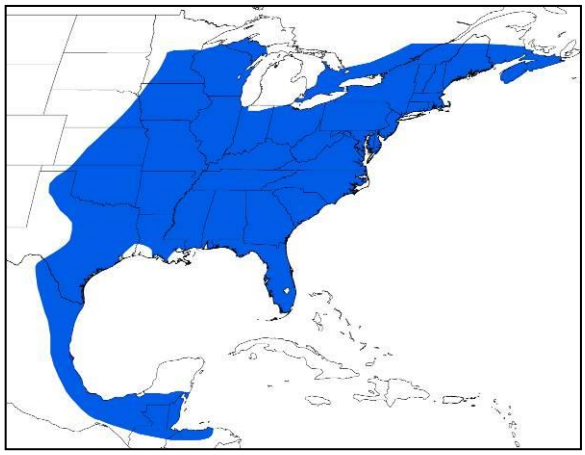


Figure 2. The tricolored bat produces a high-frequency call, the hook of which hovers almost exclusively at 42 kHz. Each call in the pass has a distinct hook at the base during the search phase of the pass. This pattern is similar to that of the eastern red bat.

Associated Species: Tricolored bat predators include owls, hawks, occasionally snakes, and raccoons (*Procyon lotor*). As many as 13 feral cats have also been observed congregating at a mine entrance at dusk to prey upon bats as they leave the hibernaculum (D. Redell pers. obs.). Tricolored bats often share hibernacula with other bat species such as the little brown bat, the northern long-eared bat, the Indiana bat (*Myotis sodali*) and the big brown bat (*Eptesicus fuscus*), but the tricolored bat will rarely, if ever, form hibernating clusters with other species. Tricolored bats forage with other bat species, but there is no evidence of direct competition between species.



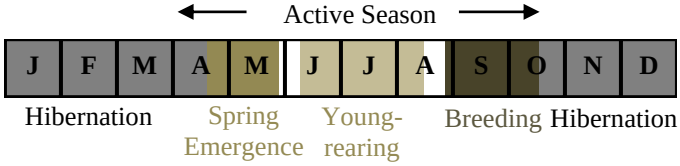
Global distribution of the tricolored bat. (BCI 2012)

State Distribution and Abundance: Tricolored bats are primarily found in the western half of the state, possibly because the Great Lakes create a cold landscape (Jackson 1961, Kurta 1995, WDNR 2013), but hibernaculum surveys show hibernating tricolored bats in Door County and northeastern Wisconsin (WI Bat Program 2011). Tricolored bats are not a common species in Wisconsin (Kurta 1995).

Global Distribution and Abundance: The tricolored bat was a common species in North America before white-nose syndrome (see "Threats" section). It ranges from northern United States into Florida and Central America. It is absent from the western portion of the United States (BCI 2012), and is in severe decline in the northeastern US and adjacent areas in Canada.

Diet: The tricolored bat is a generalist insectivorous bat. Diet consists mainly of small beetles (*Coleoptera*), wasps (*Hymenopt* flies (*Diptera*) and moths (*Lepidoptera*; Fujita and Kunz 1984). Tricolored bats use echolocation to locate and capture prey mc commonly while in flight.

Reproductive Cycle: The tricolored bat's reproductive cycle begins when fertilization occurs in spring with sperm stored by the female over winter (Fujita and Kunz 1984). Reproductive female bats exit hibernacula in late spring and usually roost alone, or rarely with other female tricolored bats. Gestation period is around 45-50 days (Wimsatt 1945). Females give birth to usually two pups in late June and early July (Fujita and Kunz 1984). The pups are left at the roost nightly while the mother goes out to forage, and they mature after about three weeks. After pups become volant (able to fly), the bats work their way to hibernacula where mating occurs in late summer through fall. Females and males do not reach sexual maturity until the following fall (Fujita and Kunz 1984).



Ecology: In Wisconsin, tricolored bats leave hibernacula in late April and early May, and make short migrations to summer roosting sites. Reproductive females roost alone or may form small maternity colonies of up to 30 bats in trees, buildings, and rock crevices (Whitaker 1998). Birthing dates for tricolored bats are from mid-June through July, although some regional variation exists within the state. Maternity colonies disperse in late July and August, and both males and females make their way to winter hibernacula. The tricolored bat is long lived for its size and lives up to seven and eight years in most cases, and males generally live longer than females (Barbour and Davis 1969). Tricolored bats are among the earliest bats to feed in the evening and have a characteristic slow, erratic flight pattern (Fujita and Kunz 1984) that sometimes causes these small-sized bats to be mistaken for moths.

Tricolored bats typically hibernate alone, rather than in clusters like other cave bat species, and the association shown in figure 1 is unusual. They prefer to hang from the walls of the cave rather than from the ceiling, and in deeper and warmer parts of the site than other cave hibernating bats (Fujita and Kunz 1984). More research is needed on tricolored bats' basic life history and behavior.

Natural Community Associations: (WDNR 2005 and WDNR 2009)

Many bat species are associated more with structural features within natural communities than with any particular natural community or group of natural communities (see "Habitat" section). However, additional research may reveal new information regarding bat species' natural community requirements.

Significant: none

Moderate: none
Minimal: none
Habitat: Tricolored bat habitat use changes over the course of the year, and varies based on sex and reproductive status. Reproductive females often use different summer habitat than males and non-reproductive females.

Summer: Male and non-reproductive female tricolored bats are solitary and roost in the foliage of deciduous trees (Fujita and Kunz 1984), where they disguise themselves as leaves for protection from predators. Reproductive female tricolored bats may occasionally use human-made structures such as barns for maternity colonies, but they also normally choose to roost in clusters of oak and maple leaves (Fujita and Kunz 1984, Perry and Thill 2007). Both sexes appear to prefer to roost in dead and live leaf clusters on oak trees (*Quercus*) of upland, mature forests (> 50 years) (Veilleux et al 2003, Perry and Thill 2007). Year-to-year site fidelity may be high for females of this species, but bats often switch roost trees over the course of the summer (Perry and Thill 2007). Tricolored bats use caves, mines and rock crevices as summer night roosts (Barbour and Davis 1969). Foraging habitats of the tricolored bat include waterways, along forest edges and in forest canopies (Fujita and Kunz 1984). More information is needed to more fully describe tricolored bat foraging habitats and summer roosting in Wisconsin.

Tricolored bat summer roosting habitat: Oak savanna with numerous foliage roosting opportunities (left; Ryan O'Connor, Wisconsin DNR) and southern dry mesic white oak forest (right; Andy Clark, Wisconsin DNR).

Edge habitat (transition zone between two types of vegetation) is important for tricolored bats as they migrate and forage. When bats migrate from wintering caves to summer habitat, or commute from roosts to feeding grounds, they move through the landscape in a manner that protects them from wind and predators. Instead of flying the shortest distance across a field, for instance, bats will take longer routes that follow edge habitat. In addition to offering protection, this behavior may also allow bats more feeding opportunities because food is more abundant around edge habitat (Limpens and Kapteyn 1991). Commuting along edge habitat may assist the bats with navigation and orientation through use of linear edges as landmarks (Verboom and Huitema 1997).

Home range: Little is known about tricolored bat home range and daily movement, and more research is needed.

Winter: Tricolored bats overwinter deep in caves and abandoned mines by hanging on walls where temperatures remain relatively constant (Fujita and Kunz 1984). They tend to hibernate alone rather than in clusters like bats of other species (Fujita and Kunz 1984).

Hibernating tricolored bats in sites in southwestern WI: Tricolored bat hibernating in a room of a cave (left) and on a wall with water condensation on its fur (right). Heather Kaarakka, Wisconsin DNR

More research is needed to determine summer roosting and foraging habitats as well as home range.

Threats: Lack of information on bat species' basic ecology is one of the greatest threats to bat conservation in Wisconsin. The tricolored bat faces two emerging threats, and several ongoing threats. White-nose syndrome (WNS) was discovered in 2006 in a hibernaculum in New York State, and appears as a white, powdery substance on the bat's face and body. White-nose syndrome has spread rapidly since 2007 to other hibernacula in neighboring states (USFWS 2012). Infected tricolored bat hibernacula in New York and surrounding states have experienced mortality rates of over 90%. White-nose syndrome has been called the "most precipitous wildlife decline in the past century in North America" (BCI 2009), and is caused by a fungus called *Psuedogymnoascus destructans* (Lorch et al. 2011, Minnis and Lindner 2013). This fungus grows best in the cool, wet conditions of hibernacula (Verant et al. 2012). Mortality from the fungus appears to come from increased arousals during torpor, which depletes bats' fat reserves and causes starvation (Reeder et al 2012) and dehydration (Cryan et al. 2010). For up to date WNS information, see the USFWS WNS website and the USGS National Wildlife Health Center website (see *Additional Information*). Neither the fungus nor the disease has been found in Wisconsin as of this writing. Cave-hibernating bats, including the tri-colored bat, should be monitored closely for any indication of WNS; the Wisconsin Bat Program conducts WNS surveillance and monitoring in the state.

Wind power is another emerging threat to bats – wind turbines have been shown to fatally impact all bat species in Wisconsin (Johnson 2003, Arnett et al. 2008). Wind-turbine blades cause mortality through direct impact or through the pressure differential caused by the motion of the spinning blades. This pressure differential causes a bat's lungs to fill with fluid as it flies near the spinning blades, and this phenomenon (known as barotrauma) kills the bat instantly (Baerwald et. al. 2008). More research is under way to better understand bat wind-turbine vulnerabilities, but current studies suggest that bats face the greatest risk during migration from summer foraging sites to wintering grounds (tree bats) or hibernacula (cave bats) (Johnson 2003, Kunz et al. 2007). Research is needed on all Wisconsin bat species to better understand wind-turbine mortality in the state and the long term population impacts of turbine-related deaths.

Tricolored bats also face the ongoing threat of habitat degradation. Habitat degradation is caused by increased agricultural, industrial, and household pesticide use, and it has negative effects on bats through direct exposure and through dietary accumulation (O'Shea et al. 2001). Pesticides are a threat to many taxa, but bats may be more vulnerable than other small mammals due to certain life characteristics (Shore et al. 1996, O'Shea et al. 2001). Bats' longevity and high trophic level means pesticides can concentrate in their body fat (Clark and Prouty 1977, Clark 1988). Even after pesticide exposure ceases, residues can be passed on to nursing young (Clark 1988). Bat species that migrate long distances may be more affected because pesticide residues become increasingly concentrated in the brain tissue as fat reserves are depleted during long-distance flights. This concentration can lead to convulsions and even death (Geluso et al. 1976, Clark 1978).

Tricolored 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 than being fully awake. Interrupting torpor costs energy; for example a little brown bat uses up to 100 mg of fat reserves waking and the returning to torpor (and more if the bat starts flying), or the energetic equivalent of up to 67 days of torpor (Thomas et al. 1990, Thomas 1992). This loss clearly represents a large percentage of total body weight of the bat, and repeated arousals may cause bats to run out of energy reserves before spring arrives and therefore starve in the hibernaculum or die from the elements if they seek food outside (Thomas 1995).

Climate Change Impacts: The effects of climate change on the tricolored bat are unclear. Predictions suggest a northward expansion in the ranges of all cave-bat species, in pursuit of optimal hibernation (Humphries et al. 2002, USFWS 2007). This prediction assumes an abundance of suitable caves and other hibernaculum structures further north, but this assumption may not hold for karst-free regions at higher latitudes. Bat species may adapt by reducing torpor depth and duration during winter if prey insect species are available for more of the year (Weller et al. 2009), but bats' adaptive capacities in this regard may be limited and are not well known. Shifts in prey insect emergence may also cause mismatches with bat emergence and cause food shortages in the spring or fall.

Survey Guidelines: Persons handling tricolored bats must possess a valid Endangered and Threatened Species Permit. If surveys are being conducted for regulatory purposes, survey protocols and surveyor qualifications must first be approved by the Endangered Resources Review Program (see *Contact Information*).

Acoustic surveys, which should be done by trained individuals, are performed for all Wisconsin bat species in spring, summer and fall, and are used to determine presence/absence, phenology, and distribution around the state. The Wisconsin Bat Program's eventual goal is to use acoustic survey data to determine bat population trends in Wisconsin. In summer, tricolored bats are found in southern and western portions of the state and surveys can be conducted wherever suitable habitat exists. Acoustic recording systems that detect echolocation calls can survey bats as they fly through an area. The bat detection system detects and records these acoustic signals as bats fly by, and records the date and time of each encounter. The Wisconsin Bat Program currently uses broadband frequency division ultrasound detection equipment with a PDA (Personal Data Assistant) and a Global Positioning System. Start acoustic surveys half an

hour after sunset, but only if the daytime temperature exceeds 50° F, and conduct the survey for at least one hour. There are three seasons for acoustic surveys: spring (April and May), summer (June and July), and fall (August and September). Acoustic surveys record bat passes, which can then be identified to species by trained individuals. These surveys could be used by land managers to create inventories of species distribution and relative abundance. Visit the Wisconsin Bat Program website for additional information.

Wisconsin DNR also conducts a roost monitoring program to determine abundance of bats roosting in buildings and bat houses. People with bat houses or other roost sites identify species and count bats over the summer at night as bats leave the roost. People who find a bat roost while doing surveys should contact the Wisconsin Bat Program to report the information.

Tricolored bats roost in tree foliage, but such roosts are hard to locate in practice and more information is needed to determine tricolored bats' roost preference and conditions of roost trees in Wisconsin. Suspected roost trees (see "Habitat" section above) may be identified by sitting at the tree site at dusk and watching for emergence or looking for evidence of bats such as buildup of guano. Known roost trees are of particular importance for both conservation and research purposes and should be avoided. People who find roost trees should contact the Wisconsin Bat Program to report the information.

Summarize results, including survey dates, times, weather conditions, number of detections, detection locations, and behavioral data and submit via the WDNR online report: <http://dnr.wi.gov, keyword "rare animal field report form">.

Management Guidelines

The following guidelines typically describe actions that will help maintain or enhance habitat for the species. These actions are not mandatory unless required by a permit, authorization or approval.

Summer Management

Summer roost (see "Habitat" section) availability may limit tricolored bat population levels (Fenton & Barclay, 1980), and therefore current summer roost sites should be protected and managed. Tricolored bats choose sites based on conditions that can be found in foliage of specific tree species. Bats also appear to choose natural roosting sites based on the maturity of the forest. In particular, tricolored bats are found roosting in mature stands significantly more often than in younger stands, presumably because old growth oak provide more roosting opportunities as the branches break and fold down (Veilleux et al. 2003, Perry and Thill 2007). Protection and management of old stands of forest may be the best way to encourage tricolored bats to use an area. Forestry management practices that reduce clutter within the forest, such as thinning and burning, and increase edge habitat can encourage tricolored bats to forage and roost (Duchamp et al. 2007). Linear corridors are important for bat commuting, and forests may be managed such that suitable foraging habitat is connected by corridors; this may include managing edge habitat along roads, logging trails and riparian corridors. Land managers should also make an effort to reduce or eliminate burdock (*Arctium minus*), an exotic weed that produces seeds that trap bats and cause death from exposure.

Special consideration should be given to protecting dead and dying oak trees, especially those near known roost locations, particularly from June 1 through August 15 while bats may have pups at the roost.

Woodland seasonal pools may be important foraging and water sources for the tricolored bat and other Wisconsin bat species because they provide areas for feeding and drinking in an otherwise closed-canopy forest (Francl 2008). Pool size and depth do not appear to determine usage by tricolored bats; instead the presence of an opening in the forest is enough to encourage foraging and drinking (Francl 2008).

Fall Management

During fall swarm, large proportions of Wisconsin's cave bat population gather near entrances of the state's hibernacula (see "Habitat" section above), and become concentrated and vulnerable to direct impacts. To avoid disturbance during crucial life history events, management activities such as logging and use of heavy machinery within 0.25 miles of hibernacula entrances should be avoided during fall swarm (August 15-October 15) or during spring emergence (April 1-May 15) because bats may use surrounding area for roosting during those time periods (USFWS 2007).

Winter Management

Little is known about how tricolored bats choose hibernation sites, but suitable Wisconsin hibernacula typically have steady temperatures between 4° C and 12° C (39-53° F), high humidity, and no human disturbance. Artificial sites that can mimic this environment may provide suitable hibernacula. Artificial hibernacula include bunkers, food storage-caves and basements. Contact the Wisconsin Bat Program to inquire about developing artificial hibernacula.

Natural hibernacula can also be managed to encourage bat use. For example, closing but not sealing the entrance to an abandoned mine not only buffers temperature and humidity, it also reduces disturbance from humans and predators. Eliminating disturbance from

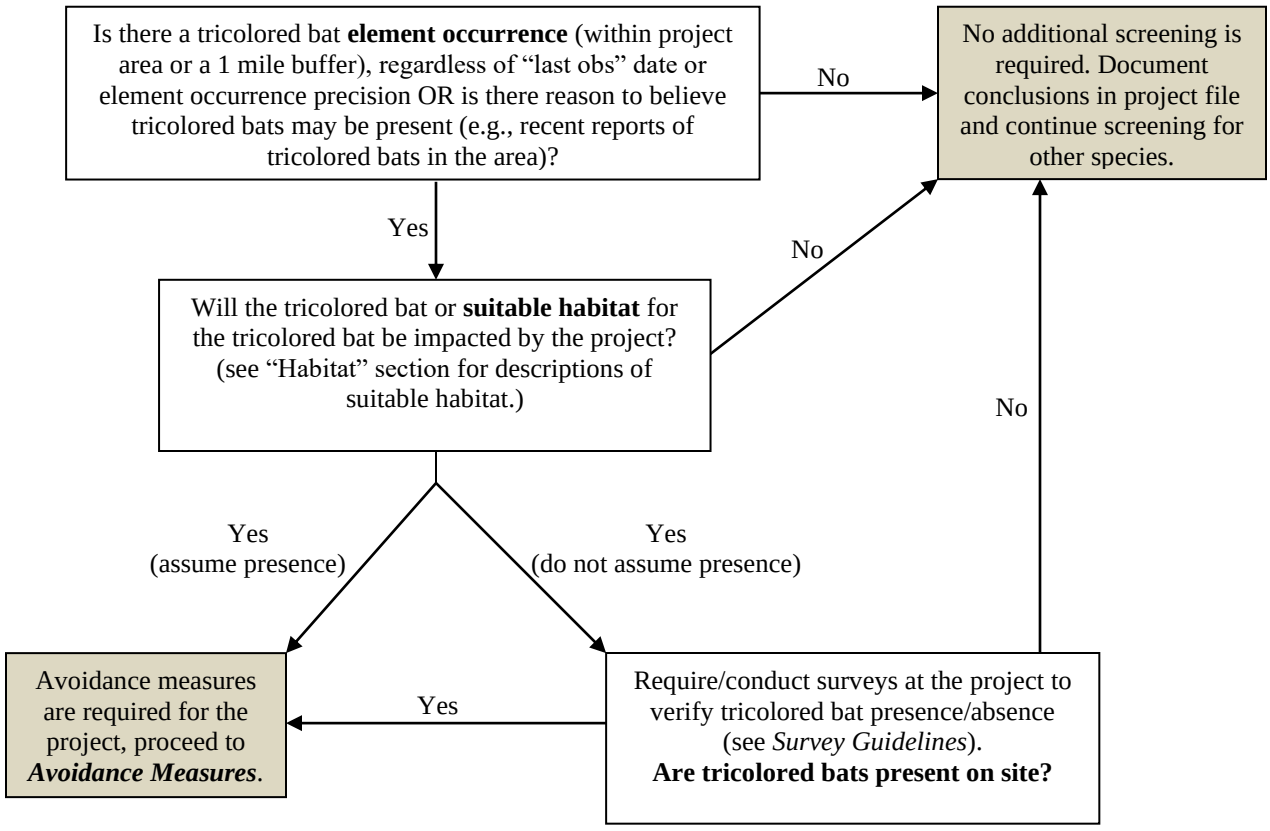
humans, except for WNS surveillance, is the best management activity for natural cave hibernacula. Contact the Wisconsin Bat Program for more information about managing bat hibernacula.

Tricolored bats – and their populations as a whole – are particularly vulnerable during winter hibernation because they are concentrated in just a few major hibernacula and because repeated disturbance during hibernation can lead to mortality (see "Threats" section). Each time a bat is aroused from torpor, it uses up a substantial proportion of the fat reserves it relies on to hibernate through the winter and faces greater odds of starvation before spring (see "Threats" section above). Therefore, avoid entering hibernacula from October 1 through May 15 unless conducting approved and permitted management, surveillance, or research.

Screening Procedures

The following procedures must be followed by DNR staff reviewing proposed projects for potential impacts to the species.

Follow the "Conducting Endangered Resources Reviews: A Step-by-Step Guide for Wisconsin DNR Staff" document (summarized below) to determine if tricolored bats will be impacted by a project (WDNR 2012):



Avoidance Measures

The following measures are specific actions required by DNR to avoid take (mortality) of state threatened or endangered species per Wisconsin's Endangered Species law (s. 29.604, Wis. Stats.) These guidelines are typically not mandatory for non-listed species (e.g., special concern species) unless required by a permit, authorization or approval.

According to Wisconsin's Endangered Species Law (s. 29.604, Wis. Stats.), it is illegal to take, transport, possess, process, or sell any wild animal on the Wisconsin Endangered and Threatened Species List (ch. NR 27, Wis. Admin. Code). Take of an animal is defined as shooting, shooting at, pursuing, hunting, catching or killing.

If *Screening Procedures* above indicate that avoidance measures are required for a project, follow the measures below. If you have not yet read through *Screening Procedures*, please review them first to determine if avoidance measures are necessary for the project.

1. The simplest and preferred method to avoid take of tricolored bats is to avoid directly impacting individuals, known tricolored bat locations, or areas of suitable habitat (described above in the "Habitat" section and in *Screening Procedures*). The U.S. Fish and Wildlife Services identifies humans and their equipment as possible vectors for spores of *Pseudogymnoascus destructans* – the fungus that causes white-nose syndrome (WNS) – and therefore simply entering hibernacula at any time of year and moving between them poses threats to bats. Cavers and researchers must observe all cave and mine closures and decontamination protocols (s. NR 40.07, Wis. Admin. Code) (see *Additional Information*). In addition, it is illegal to use pesticides and poisons when attempting to evict bats from house roosts (s. 94.708, Wis. Stats.).

2. If suitable habitat cannot be avoided, follow these time-of-year restrictions to avoid take:

Summer Avoidance **(June 1-Aug 15)**

Reproductive females and their young are highly vulnerable to mass mortality during the species' maternity period (June 1 – August 15) because they may aggregate in maternity colonies, and because pups cannot fly and therefore cannot leave the roost for several weeks after birth. Many maternity colonies occur in human structures, and those seeking to exclude bats from a building or other roost must follow the Cave Bat Broad Incidental Take Permit and Authorization (see *Additional Information*).

3. If impacts cannot be avoided during restoration or management activities, including wind projects and forestry management, but activities are covered under the Cave Bat Broad Incidental Take Permit and Authorization; the project is covered for any unintentional take that may occur. For information about natural roost avoidance, see *Management Guidelines* and "Habitat" section above.

4. Those seeking to complete wind farm projects should review and follow the Guidance for Minimizing Impacts to Natural Resources from Terrestrial Commercial Wind Energy Development created by the WDNR.

5. If tricolored bat impacts cannot be avoided, please contact the Natural Heritage Conservation Incidental Take Coordinator (see *Contact Information*) to discuss possible project-specific avoidance measures. If take cannot be avoided, an Incidental Take Permit or Authorization (see *Additional Information*) is necessary.

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Linked Websites:

- Cave bat Broad Incidental Take Permit and Authorization:< http://dnr.wi.gov/topic/erreview/itbats.html>
- Natural Communities of Wisconsin: <http://dnr.wi.gov/org/land/er/communities/>
- Natural Heritage Conservation Permit Requirements: <http://dnr.wi.gov/topic/EndangeredResources/permits.html>
- Rare Animal Field Report Form: <http://dnr.wi.gov, key word "rare animal field report form">
- USFW WNS Website: <http://www.whitenosesyndrome.org>
- USGS National Wildlife Health Center: <http://www.nwhc.usgs.gov/disease_information/white-nose_syndrome/
- Wind Guidance: <http://dnr.wi.gov/topic/Sectors/documents/energy/WindGuidelines.pdf>
- Wisconsin Bat Program Exclusion Instructions: <http://wiatri.net/inventory/bats/Monitoring/Roosts/docs/BatExclusion.pdf>
- Wisconsin Bat Program: <http://wiatri.net/inventory/bats>
- WDNR Decontamination Protocols for Preventing Spread of White-nose syndrome: <http://dnr.wi.gov/topic/WildlifeHabitat/documents/WNS_DeconProtocols.pdf>
- Wisconsin Endangered and Threatened Species: <http://dnr.wi.gov, key word "endangered resources">
- Wisconsin Endangered and Threatened Species Permit: <http://dnr.wi.gov, key word "endangered species permit">"
- Wisconsin Initiative on Climate Change Impacts: <http://www.wicci.wisc.edu/>
- Wisconsin Natural Heritage Inventory Working List Key: <http://dnr.wi.gov/topic/NHI/WList.html>
- Wisconsin's Wildlife Action Plan: <http://dnr.wi.gov/topic/wildlifehabitat/actionplan.html>

Funding

- Natural Resources Foundation of Wisconsin: <http://www.wisconservation.org/>
- USFWS State Wildlife Grants Program: <http://wsfrprograms.fws.gov/subpages/grantprograms/swg/swg.htm>
- Wisconsin Natural Heritage Conservation Fund
- Wisconsin DNR Division of Forestry

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