Species Status Assessment

Class: Mammalia
Family: Vespertilionidae
Scientific Name: *Myotis lucifugus*
Common Name: Little brown myotis

Species synopsis:

The little brown myotis (*Myotis lucifugus*), formerly called the "little brown bat," has long been considered one of the most common and widespread bat species in North America. Its distribution spans from the southern limits of boreal forest habitat in southern Alaska and the southern half of Canada throughout most of the contiguous United States, excluding the southern Great Plains and the southeast area of California. In the southwestern part of the historic range, a formerly considered subspecies identified as *Myotis lucifugus occultus*, is now considered a distinct species, *Myotis occultus* (Piaggio *et al.* 2002, Wilson and Reeder 2005). Available literature indicates that the northeastern U.S. constitutes the core range for this species, and that population substantially decreases both southward and westward from that core range (Davis *et al.* 1965, Humphrey and Cope 1970).

New York was the first state affected by white-nose syndrome (WNS), a disease characterized by the presence of an unusual fungal infection and aberrant behavior in hibernating bats. The pre-WNS population was viable and did not face imminent risk of extinction. However, a once stable outlook quickly reversed with the appearance of WNS in 2006, which dramatically altered the population balance and has substantially impaired the ability of the species to adapt to other cumulative threats against a rapidly declining baseline. In January 2012, U.S. Fish and Wildlife Service (USFWS) biologists estimated that at least 5.7 million to 6.7 million bats had died from WNS (USFWS 2012).

I. Status

a. Current and Legal Protected Status

i. **Federal** ____Not listed____________________ **Candidate?** ___Yes____

ii. **New York** _____Not listed____

b. Natural Heritage Program Rank

i. **Global** ____G3*____

ii. **New York** ____Unranked ____________ **Tracked by NYNHP?** ____No_____

Other Rank:

IUCN Red List— Least concern

COSEWIC: Designated Endangered in an emergency assessment in February 2012.

Status Discussion:

All status ranks were assigned prior to the discovery of WNS, which was first found at Howe's Cave in Schoharie County, NY in February 2006 (Blehert *et al.* 2009, Turner and Reeder 2009). Currently (as of June 2011) the presence of WNS in hibernating bats has been confirmed using histopathological criteria (Meteyer *et al.* 2009) at more than 190 sites in 16 states and 4 Canadian provinces; three additional states are considered suspect for the disease (Turner *et al.* 2011).

II. Abundance and Distribution Trends

a. North America

i. **Abundance**

__X___ **declining** ____**increasing** _____**stable** ____**unknown**

ii. **Distribution:**

____ **declining** ____**increasing** __X___**stable** ____**unknown**

Time frame considered: ____2006 to present____

b. Regional

i. Abundance

__X___ **declining** ____**increasing** ____**stable** _____**unknown**

ii. Distribution:

__X__ **declining** ____**increasing** ____**stable** ______**unknown**

Regional Unit Considered: Northeast
Time Frame Considered: 2006 to present

c. Adjacent States and Provinces

CONNECTICUT **Not Present** _______ **No data** _______

i. Abundance

__X___ **declining** ____ **increasing** ____ **stable** ____**unknown**

ii. Distribution:

_____ **declining** ____ **increasing** __X__ **stable** ____**unknown**

Time frame considered: 2008 to present
Listing Status: Endangered SGCN? Yes

MASSACHUSETTS **Not Present** _______ **No data** _______

i. Abundance

__X___ **declining** ____ **increasing** ____ **stable** ____**unknown**

ii. Distribution:

__X___ **declining** ____ **increasing** ____ **stable** ____**unknown**

Time frame considered: 2008 to present
Listing Status: Endangered SGCN? Yes

NEW JERSEY **Not Present** _______ **No data** _______

i. **Abundance**

__X___ **declining** ____ **increasing** ____ **stable** ____**unknown**

ii. **Distribution:**

_____ **declining** ____ **increasing** __X__ **stable** ____**unknown**

Time frame considered: ______2009 to present___________________________
Listing Status: _________Not listed______________________ SGCN? __Yes____

ONTARIO **Not Present** _________ **No data** _______

i. **Abundance**

__X___ **declining** ____**increasing** ______**stable** ____**unknown**

ii. **Distribution:**

_____ **declining** ____**increasing** ___X___**stable** ____**unknown**

Time frame considered: _______2010 to present_____________________________
Listing Status: _________Endangered_____________________________________

PENNSYLVANIA **Not Present** _________ **No data** _______

i. **Abundance**

__X___ **declining** ____**increasing** ____**stable** ____**unknown**

ii. **Distribution:**

__X___ **declining** ____**increasing** ____**stable** ____**unknown**

Time frame considered: _______2009 to present__________________________
Listing Status: _________Not listed______________________ SGCN? __Yes____

QUEBEC **Not Present** ________ **No data** _______

i. Abundance

__X__ **declining** ____**increasing** _____**stable** ____**unknown**

ii. Distribution:

_____ **declining** ____**increasing** __X__**stable** ____**unknown**

Time frame considered: 2010 to present
Listing Status: Not listed

VERMONT **Not Present** ________ **No data** _______

i. Abundance

__X__ **declining** ____**increasing** ____**stable** ____**unknown**

ii. Distribution:

__X__ **declining** ____**increasing** ____**stable** ____**unknown**

Time frame considered: 2009 to present
Listing Status: Endangered SGCN? No

d. NEW YORK **No data** _______

i. Abundance

__X__ **declining** ____ **increasing** ____ **stable** _____ **unknown**

ii. Distribution:

__X__ **declining** ____ **increasing** ____ **stable** ______ **unknown**

Time frame considered: 2006 to present

Monitoring in New York.

The DEC conducts annual winter hibernation counts. Supplementary corroborating data from sources other than hibernation counts has been obtained as well through a state-wide acoustic monitoring project and mist net reports submitted by various permit holders.

Trends Discussion:

The population estimate for little brown myotis in the core range was 6.5 million individuals in 2006, before WNS hit. This core range is presumed to account for the vast majority of the species' global population. As of 2006, the population was assessed as stable or slightly increasing (Frick *et al.* 2010b).

Once considered a common bat, the little brown myotis has declined considerably within its range. Between 2006 and 2010, the species lost at least 15-20% of its population (Frick *et al.* 2010b). Overall colony losses at the most closely monitored sites reached 95% of individuals at those sites within 2 to 3 years of initial WNS detection. The best available evidence conservatively predicts a 99% chance of little brown myotis extinction in the northeastern U.S. by at least 2026, and potentially much sooner depending on the actual mortality rates as WNS continues to spread rapidly (Frick *et al.* 2010b). Analyses of summer trends of this species have some similar evidence of decline across its range (Dzal et al. 2011). However, a more recent analysis suggests that while initial declines in this species are severe (mean:70%), this species does show evidence of stabilization in sites with >3 years of WNS, although populations stabilize at much lower levels (Langwig et al. 2012).

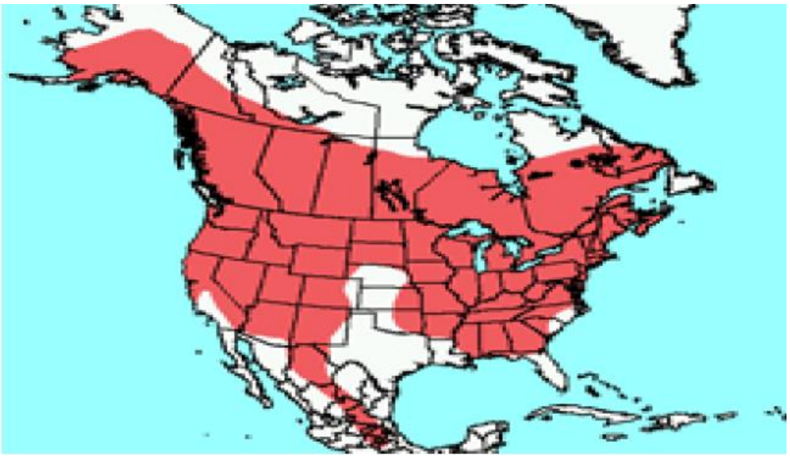

Figure 1. Range of the little brown myotis (Fenton and Barclay 1980)

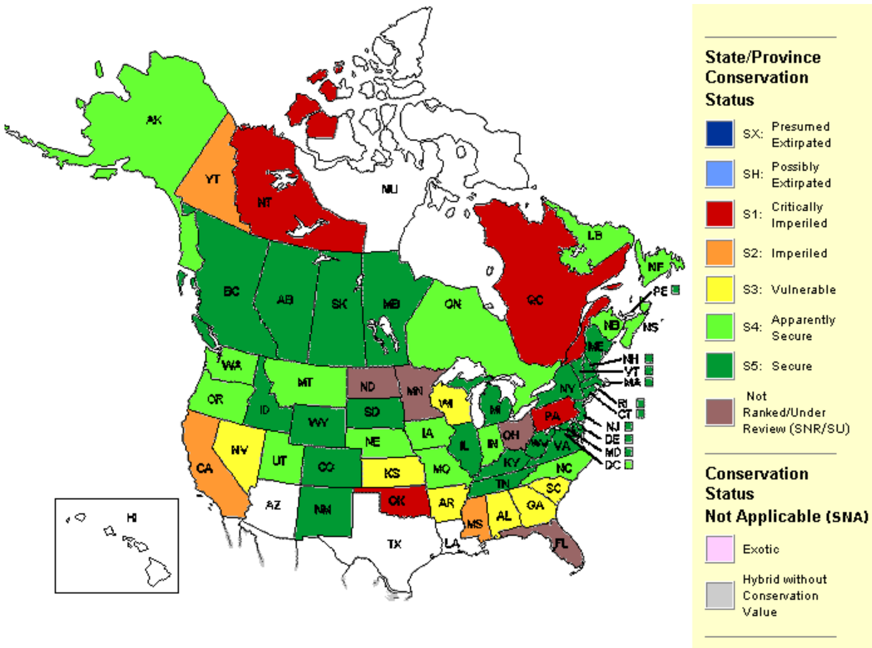

Figure 2. Distribution of the little brown myotis pre-WNS (NatureServe 2012)

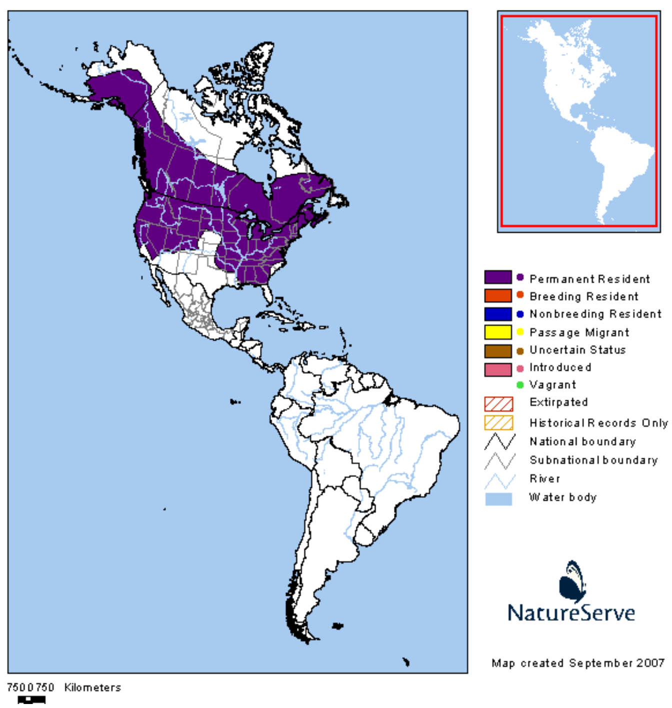

Figure 3. Range of the little brown myotis pre-WNS (NatureServe 2012)

III. **New York Rarity, if known:**

Historic	**# of Animals**	**# of Locations**	**% of State**
prior to 1970	________	________	________
prior to 1980	________	________	________
prior to 1990	________	________	________

Details of historic occurrence:

Current	**# of Animals**	**# of Locations**	**% of State**
	________	________	________

Details of current occurrence:

New York's Contribution to Species North American Range:

% of NA Range in New York	**Classification of New York Range**
____ **100 (endemic)**	__X__ **Core**
____ **76-99**	____ **Peripheral**
____ **51-75**	____ **Disjunct**
____ **26-50**	**Distance to core population:**
__X__ **1-25**	__________

IV. **Primary Habitat or Community Type:**

1. Caves and Tunnels

2. Mine/Artificial Cave Community

3. Commercial/Industrial and Residential

4. Northeastern Upland Forest

5. Northeastern Wetland Forest

Habitat or Community Type Trend in New York:

____ Declining __X__**Stable** **____ Increasing** **____Unknown**

Time frame of decline/increase: ________________________________

Habitat Specialist? __X__ **Yes** ______ **No**

Indicator Species? __X__ **Yes** ______ **No**

Habitat Discussion:

Little brown myotis feed primarily over wetlands and other still water where insects are abundant. They use rivers, streams, and trails as travel corridors to navigate across the landscape and often follow the same flight pattern each night as they search for food. Feeding is often done over open water and at the margins of bodies of water and forests (Anthony and Kunz 1977, Barclay 1991, Belwood and Fenton 1976, Fenton and Bell 1979, Saunders and Barclay 1992). However, foraging habits do vary based on intraspecific competition and flight ability. Juveniles show a preference for foraging in clearings or open forests roads, whereas adults regularly forage in environments that are less open (Crampton and Barclay 1998, van Zyll de Jong 1985). Adults prefer more open areas as well, especially when population density is high (Adams and Hayes 2008).

They prefer summer roosts close to water (New Hampshire Fish and Game 2013) and roost in buildings such as barns, attics, and outbuildings, with males and females roosting apart. The females gather into maternity colonies. They prefer hot spaces, such as right under the roof. The increased heat from the roof and multiple bat bodies helps the pups to grow faster. Males roost in smaller colonies, and may use tree cavities as well as buildings. Both genders can benefit from bat houses, but the females will seek out larger and hotter houses (New Hampshire Fish and Game 2013).

In the winter, little brown bats hibernate in clusters in caves and mines. In order to minimize evaporative losses, the humidity in these hibernation areas must be high, preferably over 90%. A constant temperature of 40 degrees F is desirable for hibernation. These conditions are also prime for the fungus, *Pseudogymnoascus destructans*, formerly *Geomyces*, which is the causative agent of white-nose syndrome (New Hampshire Fish and Game 2013). In New York, sites with warmer temperatures experienced significantly more severe declines than sites with cooler temperatures (Langwig et al. 2012). The hibernacula is a reservoir for the disease. Environmental reservoirs such as this increase the likelihood that a species will go extinct from the disease.

V. New York Species Demographics and Life History

__X____ **Breeder in New York**

__X___ **Summer Resident**

__X___ **Winter Resident**

_____ **Anadromous**

_____ **Non-breeder in New York**

_____ **Summer Resident**

_____ **Winter Resident**

_____ **Catadromous**

_____ **Migratory only**

_____**Unknown**

Species Demographics and Life History Discussion:

The little brown myotis feeds on small (3-10 mm) aerial insects (Anthony and Kunz 1977). They can eat 50% of their own body weight each evening. Pregnant females and those with pups eat even more insects. Two or more feeding bouts per night are average for the little brown myotis. They occupy remote night roosts to rest and digest in between these two bouts (Anthony and Kunz 1977, Anthony *et al.* 1981, Kunz 1980). A colony of 100 little brown bats may eat 19.2 kg (42 lb.) of insects in four months, which indicates the important influence this species, and other bats as well, has on insect populations (Saunders 1988).

Little brown bats hibernate in September and October, emerging in April – June, with females appearing first (Saunders 1988). Reproductive females form maternity colonies in barns, attics, tree cavities and other places that provide darkness during the day (Crampton and Barclay 1998, Davis and Hitchcock 1965). These colonies range in size from tens to hundreds of individuals. Roost fidelity appears high, with adult females typically returning to their natal roosts (Frick *et al.* 2010a, Reynolds 1998). Gestation and postnatal growth of offspring is optimized by warm microclimates in maternity roosts (Baptista *et al.* 2000, Davis and Hitchcock 1965, Fenton 1969, Humphrey and Cope 1976, Kunz and Anthony 1982). Therefore, non-reproductive females and adult males usually roost individually or in small groups (Kunz and Reichard, unpublished).

Summer roosts are abandoned in late summer and fall when individuals depart and migrate to a variety of transient roosts (Fenton and Barclay 1980). Eventually, they arrive at winter hibernacula, which can be up to 300 km (Davis and Hitchcock 1965, Fenton 1969, Griffin 1970, Humphrey and Cope 1976), and even as far as 1,000 km (Wilson and Ruff 1999) from their summer roosts. Caves and mines act as swarming sites during the autumn mating period and as hibernacula during the cold months. Little brown myotis typically exhibit swarming behavior from August through early October, which coincides with the pre-hibernation fattening period (Kunz *et al.* 1998, McGuire *et al.* 2009).

Adults mate in mid to late autumn while swarming near the entrances of hibernation sites. Females store sperm (Wimsatt 1945) and ovulation occurs within a few days of arousal from hibernation in spring (Buchanan 1987, Wimsatt and Kallen 1957) as long as females possess sufficient metabolized fat reserves (Kunz *et al.* 1998). The gestation period lasts 50-60 days (Barbour and Davis 1969, Wimsatt 1945) depending on environmental conditions and the physiological state of the female (Racey 1973). Usually only a single pup is born (Fenton 1970, Kurta *et al.* 1989, Wimsatt 1945). Reproductive success varies and is dependent on availability of insect prey during the summer months (Anthony and Kunz 1977, Anthony *et al.* 1981, Frick *et al.* 2010a, Jones *et al.* 2003). Once the young are weaned after about 26 days, adult females depart from maternity roosts and migrate to the swarming sites. In this way, they arrive to the hibernacula earlier than the yearlings (Kunz *et al.* 1998). Yearling females may breed during the first fall, but males do not breed until their second fall. Potential lifespan of the little brown bat is 34 years, although few individuals live this long (Saunders 1988).

Some individuals that visit a swarming site relocate to alternative hibernacula prior to hibernation (Fenton 1969, Thomas *et al.* 1979). Therefore, mating activity at swarming sites can lead to genetic mixing between roosting or hibernating colonies (Carmody *et al.* 1974). Reproductive rates of females are high, with an average rate of 95% from 1993 to 2008 (Frick *et al.* 2010a).

Between mid-August and mid-September in the northeast, adult little brown myotis rapidly increase their body mass by over 2 g, which is about 30% of their prehibernation body mass (Kunz *et al.* 1998). Bats may resist entering hibernation if they are unable to deposit sufficient white adipose tissue (WAT) reserves (Geiser 2004). The timing of the onset of hibernation varies throughout the species' range due to temperature differences in each area and the length of the hibernation season (Humphries *et al.* 2002).

Selection of hibernacula appears to favor high humidity and relatively stable, cool temperatures above freezing (Fenton 1969, Hitchcock 1949, Humphrey and Cope 1976), usually ranging from 2-12 degrees C (Boyles and Willis 2010, Humphries *et al.* 2002, Thomas *et al.* 1990). Fat reserves provide the energy necessary for the long period of torpor. Hibernating individuals roost in dense clusters, often far back in the recesses of caves and abandoned mines. Disturbances, such as intrusion by people, may trigger arousal and seriously deplete energy reserves, in some cases causing mortality (Saunders 1988).

Healthy little brown myotis are known to arise from torpor approximately every 12-15 days (Brack and Twente 1985, Twente *et al.* 1985). One hypothesis for these arousal periods is that they are necessary to excrete metabolic wastes, sleep, and/or drink (Thomas and Geiser 1997). Euthermia may also be an essential condition for mounting innate, inflammatory, and cell-mediated immune responses to various pathogens or foreign irritants (Predergrast *et al.* 2002, Kunz and Reichard unpublished data).

Although arousals typically constitute only <1% of the total hibernation duration, a potentially significant percentage of WAT reserves (at least >80% and perhaps as much as 95%) are consumed. Subsequently, all bats and little brown myotis in particular, are faced with extreme challenges in temperate climates where WAT reserves deposited to sustain torpor and arousal bouts through long winters present additional constraints on flight ability and energetic costs (Humphries *et al.* 2002, Kunz *et al.* 1998, Thomas *et al.* 1997). Therefore, it has been suspected that bats have evolved to deposit precise WAT reserves to survive hibernation with respect to specific environmental conditions within their specific geographic ranges, and to maintain levels at the end of hibernation that are crucial for successful ovulation and gestation (Krulin and Sealander 1972, Kunz *et al.* 1998, Polskey and Sealander 1979).

VI. Threats:

The threat responsible for the greatest decline is a disease known as white-nose syndrome (WNS), named for the most prominent field sign—white fungus on the muzzle and other areas of exposed skin. The fungus, newly described as *Pseudogymnoascus* (formerly *Geomyces*) *destructans*, also produces characteristic skin lesions on the wings and other membranes of bats (Blehert et al. 2009, Courtin et al. 2010, Meteyer et al. 2009) and is the causative agent of the disease (Lorch et al. 2011, Warnecke et al. 2012). Evidence suggests that the fungus that causes WNS plays a leading role in mortality either through indirect impact on hibernation physiology (Boyles and Willis 2010) or more direct pathogenic mechanisms (Cryan *et al.* 2010, Meteyer *et al.* 2009). Infected bats arouse too frequently (Reeder et al. 2012, Warnecke et al. 2012), often emerge from hibernation too soon, and are seen flying around in midwinter. These bats usually freeze or starve to death.

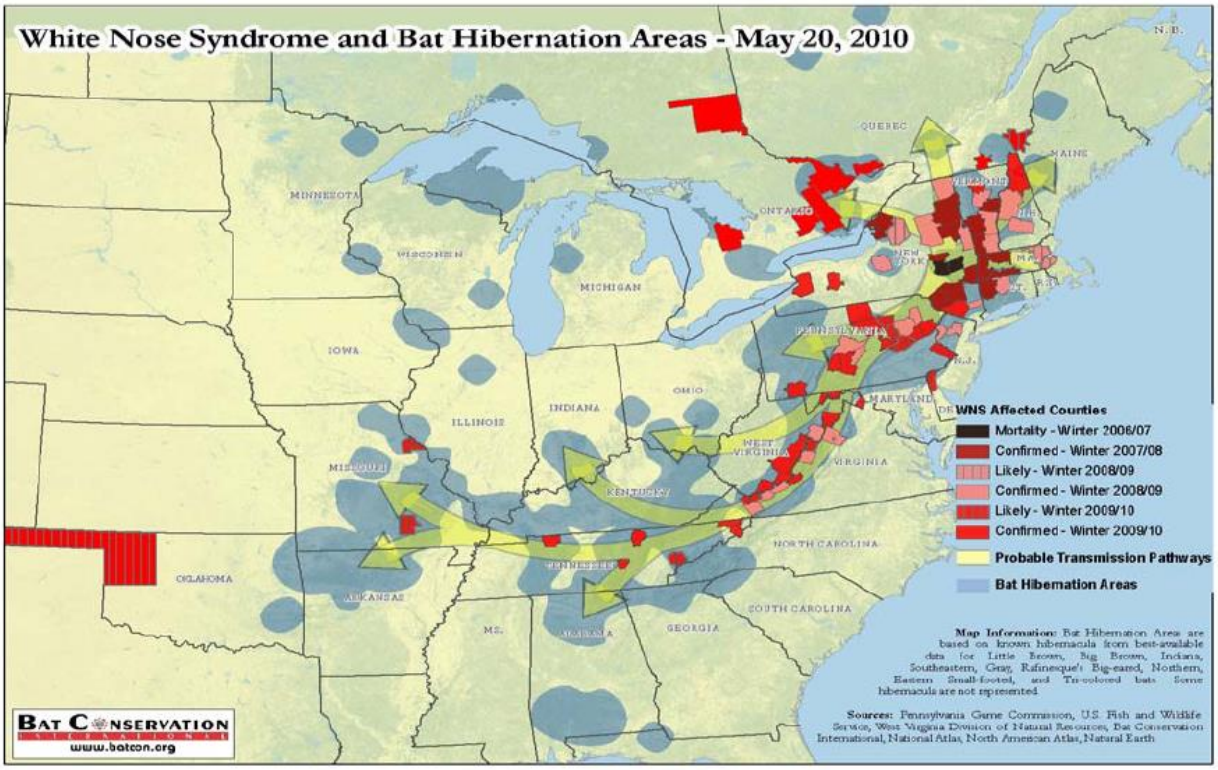

Figure 4. Geographic spread of WNS since 2006 (Bat Conservation International 2010)

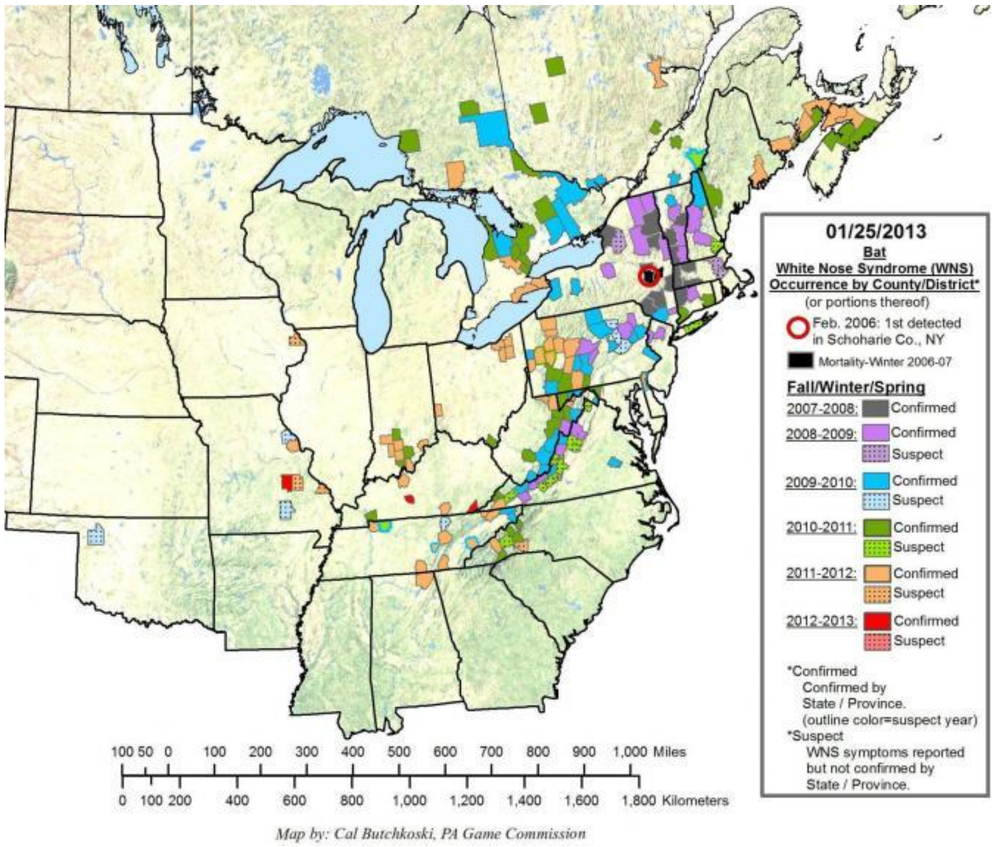

Figure 5. Map of WNS occurrence, January 2013 (PA Game Commission 2013).

Turner *et al.* (2011) utilized data for 42 sites from five states— New York (heavily biased), Pennsylvania, Vermont, Virginia, and West Virginia— to determine the current status of bat populations. Analysis was limited to sites with confirmed mortality for at least 2 years to control for variation, and only included data from the most recent censuses conducted prior to WNS and the latest count following confirmation of the disease. To reduce stochastic variation and/or small sample size issues, the count for each species at each site within a state was added to obtain average mortality estimates per species per state. The data from all states was then combined to obtain an estimate of regional change in species composition and abundance. All counted bats, regardless of species, were aggregated to report the overall change in the total hibernating population for each state and the region. Note that the important number is the percent change in species by state, not absolute numbers, because the 42 sites represent only a fraction of known hibernacula in the region. At these 42 sites, there was a precipitous decline in the number of hibernating bats post-WNS, from 412,340 to 49,579 individuals or an overall decrease of 88%. All six affected species declined, with notable differences among species. Little brown myotis decreased from 348,277 to 30,260, for a decline of 91%.

Although WNS is clearly the greatest, other threats are contributing to the species' fast decline. Wind energy, particularly throughout the core range, is a major threat to the little brown myotis population (Arnett *et al.* 2008, Baerwald *et al.* 2008, Cryan *et al.* 2009, Kunz *et al.* 2007).

Conservatively estimating the installed capacity of wind turbines in 10 eastern states (2,612 MW) and an average mortality rate of 30.1 individuals, of which 6.4% are little brown myotis (Arnett *et al.* 2008), an estimated 4,717 individuals are thought to have been killed in 2010 alone and only across 10 states. More recent monitoring efforts indicate an even greater fatality rate, with wind energy responsible for 25-30% of all little brown myotis deaths at some eastern U.S. facilities (Arnett, Bat Conservation International, unpublished data). WNS-affected bats appear more susceptible to death by turbine collision or barotraumas due to compromised flight ability (Baerwald). Wind turbines also may create a sink affect by creating significant amounts of edge habitat, a favorite foraging place of the little brown myotis (Kunz and Reichard, unpublished).

The little brown myotis is also negatively affected by habitat destruction and modification. These include commercial timber harvesting; oil, gas, and mineral extraction/development; conversion of wetlands and riparian zones to other uses; and residential and commercial development (Kunz and Reichard unpublished report).

Climate change is also a significant threat to the species' survival. Reduced precipitation in the core range during the summer months could have major consequences on both juvenile and adult survival (Adams and Hayes 2008, Frick *et al.* 2010a). There is a direct correlation between cumulative summer precipitation and the probability of little brown myotis survival (Frick *et al.* 2010a). The underlying premise linking climate change/precipitation variances to little brown myotis survival probability is the reduced availability of food sources during the important autumn foraging months before hibernation. Warmer temperatures and reduced precipitation could dry up traditional water sources used as foraging grounds, leading to reduced reproductive success (Adams and Hayes 2010).

Conversely, the little brown myotis was classified as "not vulnerable/presumed stable" (PS) to predicted climate change in an assessment of vulnerability conducted by the New York Natural Heritage Program. Available evidence does not suggest that abundance and/or range extent within the geographical area assessed with change (increase/decrease) substantially by 2050. Actual range boundaries may change (Schlesinger *et al.* 2011).

Are there regulatory mechanisms that protect the species or its habitat in New York?

___X____ No   _____ Unknown

______ Yes

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

As WNS spreads, the challenges for conserving the little brown bat increase. A highly coordinated effort is required for State, Federal, and Tribal wildlife agencies, as well as private partners, to respond effectively (U.S. Fish and Wildlife Service 2011).

A national management plan was written by the U. S. Fish and Wildlife Service in May 2011 which provides the framework for the actions necessary to coordinate management efforts. Working groups must develop and maintain a state management plan containing various components indentified for each element in the national plan (U.S. Fish and Wildlife Service 2011).

In correlation with the listing of the little brown myotis, an important measure that should be implemented as soon as possible is the appropriation of federal funding for research on WNS, with particular aim at finding a cure. Secondary funding should be allocated for mitigation and management of WNS, as well as other threats contributing to decline (Kunz and Reichard, unpublished).

Critical habitat should be designated. Additionally, maternity colony roosts and important roosting and foraging habitat should be designated as critical habitat to protect the species during non-hibernation periods (Kunz and Reichard unpublished report).

Recommendations made in USFWS (2011) should be implemented to develop surveillance, population monitoring, and disease management programs. The Federal role will provide assistance with research, surveillance, disease management, diagnostic testing, communications, information dissemination, and funding for State WNS programs.

Conservation Actions discussed at Expert Meeting in December 2013:

- Work with landowners to erect gates to regulate access to the selected hibernacula. [Partially completed]
- Continue to survey new potential hibernacula as they are discovered. [Ongoing]
- Survey winter populations as indicated in the objectives, develop alternative population monitoring techniques [Ongoing]
- Coordinate with nuisance wildlife control officers
- Coordinate with cavers
- Operational measures for wind projects

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