PETITION TO LIST THE EASTERN-SMALL FOOTED BAT *MYOTIS LEIBII* AND NORTHERN LONG-EARED BAT *MYOTIS SEPTENTRIONALIS* AS THREATENED OR ENDANGERED UNDER THE ENDANGERED SPECIES ACT

Eastern small-footed bat *Myotis leibii* © Roger W. Barbour Collection, Camden-Carroll Library, Morehead State University

Northern long-eared bat *Myotis septentrionalis* Photo credit: J. Scott Altenbach (used with permission)

NOTICE OF PETITION

Kenneth Salazar
Secretary of the Interior
18th and "C" Street, N.W.
Washington, D.C. 20240

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Dear Secretary Salazar:

Pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. §1533(b), Section 553(3) of the Administrative Procedures Act, 5 U.S.C. § 553(e), and 50 C.F.R. §424.14(a), the Center for Biological Diversity hereby formally petitions the Secretary of the Interior to list the eastern small-footed bat *Myotis leibii* and northern long-eared bat *Myotis septentrionalis* as Threatened or Endangered species and to designate critical habitat concurrent with listing.

This petition sets in motion a specific process, placing definite response requirements on the Secretary and the U.S. Fish and Wildlife Service (USFWS) by delegation. Specifically, USFWS must issue an initial finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. §1533(b)(3)(A). USFWS must make this initial finding "[t]o the maximum extent practicable, within 90 days after receiving the petition." *Id.* Petitioners need not demonstrate that listing *is* warranted, rather, petitioners must only present information demonstrating that such listing *may* be warranted. While petitioners believe that the best available science demonstrates that listing the eastern small-footed and northern long-eared bats as endangered *is* in fact warranted, there can be no reasonable dispute that the available information indicates that listing these species as either threatened or endangered *may* be warranted. As such, USFWS must promptly make an initial finding on the petition and commence a status review as required by 16 U.S.C. § 1533(b)(3)(B).

PETITIONER:
The Center for Biological Diversity is a nonprofit conservation organization with 255,000 members and online activists dedicated to the protection of endangered species and wild places. http://www.biologicaldiversity.org

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I. EXECUTIVE SUMMARY

The eastern small-footed bat (*Myotis leibii*) is a species with an extremely small global population size and restricted distribution. The northern long-eared bat (*Myotis septentrionalis*) is widely distributed across North America, but known populations are notably small. Both species are imperiled by a multitude of threats, both local and global, and have recently become the casualties of a novel fungal pathogen complex known as white-nose syndrome (WNS) across a significant portion of their ranges. *M. leibii* is listed as threatened, endangered, or as a species of special concern in most states where it occurs and *M. septentrionalis* is a species of special concern in several states within its range.

The Endangered Species Act states that a species shall be determined to be endangered or threatened based on any one of five factors (16 U.S.C. § 1533 (a) (1)). *M. leibii* and *M. septentrionalis* are threatened by four of these five factors and demonstrably warrant listing as threatened or endangered species based on the threats posed by:

- The loss and curtailment of their habitat or range: habitat essential to both *M. leibii* and *M. septentrionalis* is threatened by residential and agricultural development and related activities and by various resource extractive industries. Because of its association with shale and or talus habitat, *M. leibii* is particularly vulnerable to mining activity and to oil and gas exploration. Logging is a significant threat to *M. septentrionalis* because of this species' reliance on older forests.

- Disease: both *M. leibii* and *M. septentrionalis* are susceptible to white-nose syndrome (WNS), a novel epizootic that has killed more than a million bats in the Northeast since it was discovered in 2006. By many accounts, *M. septentrionalis* is among the species most affected by this disease. Both *M. leibii* and *M. septentrionalis* are experiencing declines of up to 100% in affected hibernacula, and have been entirely extirpated from several hibernacula since the advent of WNS. The geographic epicenter of WNS is located in states that both host the largest populations of *M. leibii* and represent the core of *M. septentrionalis'* range. The possibility that additional bat species may warrant listing as a result of WNS-related declines has been acknowledged by USFWS, and *M. leibii* and *M. septentrionalis* have been mentioned as likely candidates.

- Numerous other natural and anthropogenic factors: a multitude of other factors make these two bat species highly vulnerable to the more immediate threats outlined above. Environmental contaminants associated with agriculture, mining, and industry have been documented to have both lethal and sub-lethal effects on bat populations, primarily by reducing reproductive success. Climate change is expected to cause significant changes in insect distribution, abundance, and phenology; as exclusive insectivores, *M. septentrionalis* and *M. leibii* will be greatly affected by these changes in their prey species. Alterations in annual temperature and precipitation regimes may also disrupt the physiological mechanisms governing hibernation and reproduction. Prescribed burns,

- The inadequacy of existing regulatory mechanisms: while both species are listed as endangered, threatened, or of special conservation concern in many states across their ranges, these designations afford no significant regulatory protection. National Forest management plans do not protect species that are not federally listed, and sympatry with listed species does not adequately protect *M. leibii* or *M. septentrionalis* from logging or other threats on these lands. The regulation of oil, gas, and mineral development on federal, state, and private lands is inconsistent and inadequate, and further development of coal and gas reserves in significant bat habitat is imminent. Cave-dwelling bats are not sufficiently protected from disturbance in hibernacula by either federal or state Cave Protection Acts. Finally, coherent and successful management of white-nose syndrome (WNS) will require more funding, more staff, and better coordination among participating agencies.

Based on the factors outlined above, *M. leibii* and *M. septentrionalis* warrant listing under the ESA.

II. INTRODUCTION

Bats are of great ecological and economic importance. As insectivores, they provide significant natural insect control, quantifiably benefiting both agriculture and public health. An individual bat may consume 500-1000 insects in an hour, and up to 100% of its body mass in insects nightly (Griffin et al. 1960, Kurta et al. 1989). A study done in eight counties of south-central Texas estimated the annual value of the agricultural pest control provided by Brazilian free-tailed bats (*Tadarida brasiliensis*) to the regional cotton industry at $741 000 (Cleveland et al. 2006). Comparable estimates for the value of bats' services to agriculture within the range of *M. leibii* and *M. septentrionalis* are not available, but the role that bats play in pest control is widely recognized (e.g., Ducummon 2000). The loss of these species would be of major consequence for agriculture.

M. leibii and *M. septentrionalis* are imperiled by a host of threats, most of them anthropogenic: habitat loss and degradation driven by agricultural and residential development, logging, mining or other resource extractive practices, environmental contaminants, disturbance by vandalism or recreation, and climate change are all recognized as prominent threats to the persistence of these species. The 2006 discovery of WNS in New York state hibernacula precipitated a cascade of concern about the future of all bat species in the northeastern United States. Since WNS was identified, it is estimated to have killed over a million hibernating bats in the Northeast, and is rapidly spreading south- and westward (J. Coleman, pers. comm.). Mortalities of both *M. leibii* and *M. septentrionalis* are reported from WNS-affected hibernacula; several aspects of these species' life histories may make them especially vulnerable to the disease.

This petition summarizes the natural history and population status of the eastern small-footed bat and the northern long-eared bat and outlines the recognized threats to both species and their habitats. The petition then clearly demonstrates that, in the context of the ESA's five statutory listing factors, the U.S. Fish and Wildlife Service should list *Myotis leibii* and *Myotis septentrionalis* as Threatened or Endangered.

III. NATURAL HISTORY AND ECOLOGY

Eastern small-footed bat *Myotis leibii*

A. Taxonomy

The eastern small footed-bat is a member of the order Chiroptera, family Vespertilionidae, genus and species *Myotis leibii*. Formerly known as Leib's bat, it has been repeatedly recognized as a separate species from the western small-footed bat, *Myotis ciliolabrum,* through mitochondrial DNA analysis (Rodriguez and Ammerman 2008).

B. Description

M. leibii is one of the smallest North American bats; adults weigh between 3 and 5 grams (Harvey and Redman 2003). Total body length is between 73 and 85 mm, and wingspan is between 212 and 248 mm (Erdle and Hobson 2001, Amelon and Burhans 2006a). As its name suggests, this bat has very small feet, between 6 and 8 mm (Erdle and Hobson 2001). Defining field marks include a characteristic black mask and black ears. Dorsal pelage varies from pale yellowish brown to darker golden brown; ventral pelage varies from pale buff to white. Sexes are physically similar.

C. Distribution

M. leibii is relatively widespread in southeastern Canada and the eastern U.S., but its distribution within this range is uneven and populations are generally small ("few high quality occurrences exist" NatureServe 2009). NatureServe (2009) ranks the eastern small-footed bat as critically imperiled in Alabama, Arkansas, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, Oklahoma, Pennsylvania, South Carolina, Vermont, Virginia, West Virginia, and Quebec, imperiled in Kentucky, New York, North Carolina, Tennessee, and Ontario. *M. leibii* was historically found in Alabama, Arkansas, Connecticut, Delaware, Georgia, Kentucky, Massachusetts, Maryland, Maine, Missouri, North Carolina, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, West Virginia, Vermont, Virginia, Ontario, and Quebec, though recent confirmation of species presence is not available from all the above states and provinces.

The largest known populations of *M. leibii* occur in Pennsylvania, New York, West Virginia, and Virginia (NatureServe 2009). The total count for all identified hibernacula is roughly 3,000 individuals, 60 percent of which were found in two locations in New York State (Amelon and Burhans 2006a). This species is most often detected during hibernation; 125 hibernacula containing *M. leibii* have been identified across the species' geographic range, though most contain just a few individuals (Amelon and Burhans 2006a).

D. Habitat

Hibernacula

M. leibii overwinters in hibernacula located in caves or abandoned/inactive mines, and prefers locations close to cave or mine entrances where humidity is low and temperature fluctuations may be high relative to more interior areas (Fenton 1972, Best and Jennings 1997). Individuals have been found hibernating in rock crevices in cave or mine floors and beneath rocks within hibernacula. There is some evidence that this species prefers small caves: in Pennsylvania, a majority of identified hibernacula were less than 150 m in length (Dunn and Hall 1989, Arroyo-Cabrales and Castenada 2009). Like most bat species, *M. leibii* exhibits high site fidelity to hibernacula; individuals return to the same site year after year (Gates et al. 1984).

Summer roosting habitat

M. leibii may also utilize caves or mines as summer roosting sites, but is most often found on buildings, bridges, within hollow trees, beneath loose bark on trees, and in cliff crevices in the summer months (IUCN 2009). Roost sites may be at ground level in talus slopes or shale barrens, or in more elevated sites (e.g., cliff crevices) (Johnson et al. 2008, Johnson and Gates 2008). Within these preferred sites, *M. leibii*, particularly reproductively active females, tend to select for microsites with the highest solar exposure, presumably to maximize the ambient temperature in maternity roosts (Johnson and Gates 2008). Warm temperatures minimize the maternal energetic output for thermoregulation of young and foster rapid offspring growth rates (Harvey and Redman 2001). Both males and females change roost sites often, even daily; the reason for this frequent relocation is not known (Johnson et al. 2008). Male and female bats select forest roosts based on different criteria, and preferences may change throughout the reproductive season. For example, females select warmer roost sites during pregnancy so as to minimize energy expenditure, and choose more thermally stable sites during lactation when nonvolant young are left alone during foraging trips (Chruszcz and Barclay 2002). This intersexual and temporal range of preferences indicates that the retention of a variety of suitable roosts is crucial, and frequent roost-switching behavior necessitates that numerous roosts be available within a colony's home range.

This species has been observed at up to 600 m in elevation in the more southerly parts of its range (Mohr 1976), and is commonly found in hilly or mountainous habitat. *M. leibii* is known to migrate regionally between hibernacula and summer roosting or breeding habitat; no estimation of the average migration distance is available in the literature but recorded migration distances from observational studies vary widely from 1.1 km or less (Johnson and Gates 2008) to 16-19 km (Hitchcock 1955). It is likely that the migration distance of any individual or group is contingent on the local availability of suitable habitat.

M. leibii's preference for talus and shale habitat, unique among sympatric bat species, makes this species particularly vulnerable to oil, natural gas, and mineral exploration that also occur in these naturally rare ecological features.

Foraging habitat

Like many *Myotis, M. leibii* forages primarily over streams, ponds, or other water bodies where concentrations of nocturnal insects are high (MacGregor and Kiser 1998).

E. Foraging

Both adults and juveniles feed almost exclusively on a variety of aerial invertebrates and are known to be dietary generalists that feed primarily on soft-bodied prey (Moosman and Thomas 2007). As nocturnal foragers, they emerge from roosting sites at dusk and feeding activity peaks shortly thereafter, correspondent with a peak in insect activity. *M. leibii's* flight pattern is highly distinctive; their slow, fluttering movement is unusual for small-bodied bats and makes them easy to distinguish from other *Myotis* species in flight. *M. leibii* uses both aerial hawking and gleaning to obtain its insect prey (Moosman and Thomas 2007).

F. Reproduction

Mating takes place in late summer or early fall, prior to hibernation. Many bat species, including *M. leibii,* use delayed fertilization, wherein females store sperm over the winter, and embryo development begins in mid-spring. Gestation lasts approximately 60 days, and parturition occurs in early to mid-summer. Females bear a single offspring annually (Barbour and Davis 1969). Maternity colonies (also known as nursery colonies) comprised of up to 20 females and their offspring form in summer roosting habitat (Erdle and Hobson 2001). The advantages of this practice particular to *M. leibii* have not been explored. Males and non-reproductive females roost singly during summer (Amelon and Burhans 2006a).

G. Demography

Relatively little is known about the demography of *M. leibii* populations. Adult longevity is estimated to be between six and ten years; the oldest recorded specimen was 12 years old at the time of its death (Hitchcock 1965), though *** (emailed S Darling) Trombulak reference. The eastern small-footed bat exhibits low fecundity – reproductively active females produce only one offspring per year. Additionally, juvenile mortality is high as pups are altricial and highly vulnerable at birth, and often have little time to accumulate sufficient fat reserves before hibernation. Survival rates are significantly higher for males (76%) than for females (42%). The reasons for this trend have not been thoroughly explored but it has been suggested that the high energetic costs of reproduction (gestation, lactation, and maternal care) compromise females' ability to accumulate adequate energy reserves prior to entering hibernation (Hitchcock 1984).

Several of *M. leibii's* life history traits make the species particularly vulnerable to the multitude of external threats that the species faces: its naturally small population size, diffuse distribution, and low fecundity increase this species' susceptibility to habitat loss and degradation, disturbance, or stochastic events that cause local or regional decline. Populations of *M. leibii* are slow to recover from the loss of individuals, increasing the probability that the additive mortality caused by white-nose syndrome or other factors will cause extirpation (e.g., USGS 2009a).

H. Hibernation

Physiology

As do many homeotherms, most temperate bat species spend the coldest months of the year in hibernation. As bats enter a state of torpor, body temperature falls to within 1-2°C of the ambient temperature in the hibernaculum (Geiser 2004). The decrease in body temperature and metabolic rate reduce energy expenditures by approximately 95% (as compared to remaining normally active) (Geiser 2004, Dunbar and Tomasi 2006).

Behavior

One of North America's hardiest bat species, *M. leibii* is among the last to enter hibernacula and the first to emerge in spring. Hibernation period is approximately mid-November to March (Amelon and Burhans 2006a). Bats periodically break torpor during the winter and may become active within or occasionally outside of the hibernaculum. The reason for these arousals is the subject of much speculation. The hypotheses for which the most evidence exists are that periodic arousals are necessary to enhance immune function (Luis and Hudson 2006), and that arousals are necessary for bats to obtain the water they must consume (Speakman and Racey 1989, Thomas and Geiser 1997).

The energetic cost of these arousals represents up to 84% of winter energy expenditures (Thomas et al. 1990). *Myotis leibii* is known to be one of the most commonly winter-active bat species, moving both within and among hibernacula (Mohr 1942), but no definitive reason for this activity has been identified (Boyles et al. 2008). Correspondingly, evidence indicates that *M. leibii* spends less time in deep torpor than other co-hibernating species (Hitchcock 1946, Mohr 1936, Tuttle 1964 as cited in Amelon and Burhans 2006a), which may predispose them to more rapid depletion of winter energy reserves.

Unlike most other sympatric species, *M. leibii* is generally found hibernating solitarily (Best and Jennings 1997). Clustered hibernation is known to confer significant thermal benefit by reducing heat loss during brief euthermic periods of arousal, and it has been suggested that such behavior may ultimately reduce mass loss during hibernation through such reduction in energy expenditure (Boyles et al. 2008). Though the possibility has yet to be explored, solitary hibernation may increase the rate at which WNS-affected bats' energy reserves are depleted, making solitary hibernators particularly vulnerable. *M. leibii* does not hibernate in large single-species groups, but is most often found hibernating solitarily in hibernacula amongst other species. *M. leibii* has been observed in hibernacula with *Eptesicus fuscus, Myotis lucifugus, Myotis septentrionalis, Myotis sodalis, Corynorhinus rafinesquii,* and *Perimyotis subflavus* (Butchkowski 2001, Harvey 1989, Schwartz 1951, Sealander 1979, Tuttle 1964, Saugey et al. 1993 as cited in Amelon and Burhans 2006a).

Northern long-eared bat *Myotis septentrionalis*

A. Taxonomy

The northern long-eared bat is a member of the order Chiroptera, family Vespertilionidae, genus and species *Myotis septentrionalis.* It is also known as the Northern myotis or Northern bat, and was formerly considered a subspecies of Keen's bat, *Myotis keenii* (also known as the Eastern long-eared bat), though recent evidence indicates that the two species are, in fact, genetically distinct (Caceres and Pybus 1997).

B. Description

M. septentrionalis is a medium-sized bat; adult weight is approximately 8 g and total body length is approximately 95 mm (Caceres and Barclay 2000). As its name suggests, this bat is distinguishable from other *Myotis* species by its long ears, which extend beyond its nose when pushed forward (average length 17mm, Whitaker and Mumford 2009). The tragus is long and pointed, and often somewhat curved (average 9mm, Whitaker and Mumford 2009). This species is similar in color to *M. lucifugus*; dorsal pelage is a dullish yellow-brown with brown shoulder spots, and ventral pelage is pale gray. Females tend to be slightly larger and heavier than males (Caceres and Pybus 1997).

C. Distribution

M. septentrionalis ranges widely across much of Canada and the U.S., but is patchily distributed and rarely found in large numbers (Barbour and Davis 1969). It is more common in the northern part of its range than in the southern portion (Harvey 1992), and relatively rare in the northwestern part of its range (Caceres and Barclay 2000). It occurs in all Canadian provinces, in the Yukon and Northwest Territories, and in eastern, midwestern, and some southern states (e.g., Crnkovic 2003). A small number of sightings have also been reported in Montana and Wyoming (Schmidt 2001). *M. septentrionalis* is found in: Alabama, Arkansas, Connecticut, Washington, D.C., Delaware, Florida, Georgia, Iowa, Illinois, Indiana, Kansas, Kentucky, Louisiana, Massachusetts, Maryland, Maine, Michigan, Minnesota, Missouri, Mississippi, Montana, North Carolina, North Dakota, Nebraska, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Virginia, Vermont, Wisconsin, and West Virginia. It is listed as imperiled across much of its range.

D. Habitat

Hibernacula

M. septentrionalis overwinters in caves or abandoned/inactive mines in multi-species hibernacula and generally comprise a small proportion (generally less than 25%) of the total number of individuals (Caceres and Pybus 1997). *M. septentrionalis* seems to favor deep crevices for hibernation, and shows no other apparent preferences for particular cave or mine characteristics (Caceres and Barclay 2000). Though this species is not considered migratory, many groups or individuals travel considerable distance to seasonal habitat; distance traveled between hibernacula and summer roosting sites may be up to 56 km (Nagorsen and Brigham 1993).

Summer roosting habitat

Presence of *M. septentrionalis* is correlated with the availability of several features that are most often found in older forests, defined variably within the literature, but generally considered to be comprised primarily of trees 100 years old or older. The vegetational and structural composition of these forests is unique, and though there is no single accepted definition of old growth, mature, or late-successional forest, there seems to be some consensus on several characteristics that typically define this forest type (e.g., Leverett 2001). Features relevant to *M. septentrionalis* include:

1. Advanced tree age in a high percentage of stems
2. Uneven forest age, resulting in a multi-layered vertical structure
3. Single and multiple tree-fall gaps
4. Standing snags
5. Woody debris

These traits are most commonly considered to be characteristic of primary forests; i.e., forests that have never been logged (often referred to as old growth forest). However, they may also appear in non-primary, older forests, that is, forests in the later stages of successional development. There is no evidence to suggest that *Myotis septentrionalis* absolutely requires primary forest habitat, but it is apparent from the literature that the presence and activity level of this forest bat species is consistently highest in forest stands with late-successional characteristics. Because *M. septentrionalis'* preference for older forests appears to be based on the use of the unique structural resources afforded by these stands for both roosting and foraging, it seems reasonable to assert that forest stands that offer the same features will be equally suitable, whether or not they are strictly definable as primary or old growth forest.

M. septentrionalis may favor forests with late-successional characteristics for several reasons; the most unique feature offered by these forests is the large, partially dead or decaying trees that the species relies on as breeding habitat; maternity colonies are often established beneath peeling bark or within hollow trees or cavities (Caceres and Pybus 1997). The presence of such snags is often positively correlated with bat abundance because the habitat they provide is necessary for the establishment of maternity roosts, and because males and non-reproductive females also use these same spaces as day roosts (Waldien et al. 2000). Young forests lack the diversity of habitat features or resources provided by late-successional forest, and thus represent substantially less suitable habitat.

There is evidence that *M. septentrionalis* prefers older forest stands for both roosting and foraging activities. Activity of *M. septentrionalis* and other woodland bat species in the White Mountains of New Hampshire and Maine is highest in old growth hardwood stands (older than 119 years) and close to bodies of water (Krusic et al. 1996). Activity levels of *M. septentrionalis* were also highest in old growth stands (defined as undisturbed for 200 years or more) of Douglas fir forest in the Pacific Northwest, and mixed hardwood in Ontario (Thomas 1988, Jung et al. 1999). This species' preferred habitat has often been characterized as "cluttered"; because *M. septentrionalis* has low wing loading and low aspect ratio, it is highly maneuverable in forested habitat and therefore well-adapted to foraging in dense vegetation, often at canopy level (Patriquin and Barclay 2003, Carter and Feldhamer 2005). Lacki and Schwierjohann (2001) also report that tree diversity plays an important role in bat habitat selection: abundance of roosting *M. septentrionalis* in a New Hampshire forest was highest in stands with high diversity. This species is also frequently reported to forage in close proximity to ephemeral upland pools (Brooks and Ford 2005, Owen et al. 2003).

Male and female *M. septentrionalis* select roosting habitat based on different criteria: Broders and Forbes (2004) found that female *M. septentrionalis* in New Brunswick roosted most often in shade-tolerant deciduous trees of mid-stage decay in mature stands, either colonially or singly, while males were most often located in coniferous trees in conifer-dominated stands, and always roosted alone. Forest composition clearly plays a role in roost selection, as do the characteristics of individual trees: maternity colonies of *M. septentrionalis* occupied trees that were taller and surrounded by more snags than those used by individual bats (Lacki and Schwierjohann 2001). Reproductively active females may select for somewhat different roost sites than other adults, particularly during lactation, when preferred roost sites may be located in less dense forest with higher and more open canopy (Garroway and Broders 2008). Females may be selecting for roost sites with maximum solar exposure so as to minimize the energy expenditure necessary to warm and feed their offspring. Roost selection by individual bats and maternity colonies is reportedly different: individual bats may be more frequently found in cavities while maternity colonies are more often established under exfoliating bark (Lacki and Schwierjohann 2001). Frequent roost-switching has also been observed in this species. Intersexual and temporal differences in roost selection have implications for forest management: the retention of a diversity of roosting habitats is necessary to sustain viable populations of *M. septentrionalis*.

Females exhibit high philopatry to their natal sites, returning year after year to the same area where they were born or bred previously (Arnold 2007). This site fidelity warrants consideration by management; developers are often permitted to clear or selectively cut in bat roosting areas prior to their emergence in spring, a practice intended to limit directly harmful effects of development (Arnold 2007). However, if females consistently return to the same site, this practice may do less to mitigate the immediate effects of habitat loss than anticipated.

In addition to its preference for more mature forests, *M. septentrionalis* is also reliant on intact, interior forest; site occupancy has been documented as being inversely related to the proportion of edge habitat within a patch (Yates and Muzika 2006). Independent of insect abundance, *M. septentrionalis* in a forested-agricultural matrix restricted their foraging to forested patches, emphasizing the constraining influence that the habitat fragmentation wrought by anthropogenic land use change has on this species' movement (Henderson and Broders 2008). Other studies also report that *M. septentrionalis* does not forage in intensively harvested stands, containing movement within intact forest (e.g., Patriquin and Barclay 2003). Habitat fragmentation may thus present a major threat to *M. septentrionalis*, particularly in its summer roosting habitat. Owen et al. (2003) report that female *M. septentrionalis* in managed forests in West Virginia utilized, on average, a 65 ha home range (approximately 160 acres); patches smaller than this likely represent unsuitable habitat.

On the western edge of its range (the Dakotas, Montana, Wyoming), this species is found in wooded riparian zones within badlands or prairie habitat at low elevation, and in dense forest at higher elevations (Barclay 1993, Nagorsen and Brigham 1993).

Foraging habitat

This species forages both above and below the forest canopy, within forest clearings, and occasionally over water (Amelon and Burhans 2006b). Ford et al. (2005) report that foraging activity increases with increasing canopy cover.

E. Foraging

Like other *Myotis* species, *M. septentrionalis* is invertivorous and feeds opportunistically, using both hawking and gleaning to obtain their insect prey (Caceres and Pybus 1997). *M. septentrionalis* feeds on a variety of insects from the orders Lepidoptera, Coleoptera, Neuroptera, Diptera, Hemiptera, Homoptera, and Hymenoptera, though diet varies both seasonally and spatially (Caceres and Barclay 2000).

F. Reproduction

Mating takes place in late summer or early fall and females store sperm until they emerge from hibernation in the spring, when ovulation and fertilization occur. Some individuals mate again upon emergence (Racey 1982). Gestation lasts 50-60 days, and parturition occurs in early to mid-summer. Females bear a single offspring annually, and young-of-the-year may mate prior to hibernation in the fall (Caceres and Barclay 2000, pers. comm. from NatureServe 2009). Though some may roost alone, females often roost colonially; maternity or nursery colonies may be comprised of up to 90 individuals (including young, Layne 1978); the largest maternity colony reported contained 39 adult females (Dickinson et al. 2009). Males and non-reproductive females generally roost singly during the summer months (Caceres and Pybus 1997). Females exhibit high site fidelity to maternity roosts, returning annually to their natal sites. In an attempt to mitigate the effects of such activity on bats, developers or loggers are often permitted to cut or clear before bats emerge in spring; high site fidelity exhibited by *M. septentrionalis* suggests that this practice is not effective (Arnold 2007).

G. Demography

Relatively little is known about the population demography of *M. septentrionalis.* Though sex ratio at birth is 1:1, most studied populations are heavily male-biased (up to 77% male in some winter hibernacula – sexes do not segregate during hibernation), suggesting that females have a higher mortality rate, perhaps due to energetic costs or other hazards associated with reproduction. This species is long-lived: the oldest recorded individual was found dead in the cave where it had been banded 19 years before (Hall et al. 1957). Fecundity is low: reproductively active females produce a single offspring each year. Juvenile mortality is high as pups are highly vulnerable at birth and may have difficulty accumulating adequate energy reserves before the hibernation period begins. Dispersal in studied populations is highly male-biased; females exhibit high site fidelity to their natal sites and thus a higher degree of genetic structuring than do males (Arnold 2007).

Several of *M. septentrionalis'* life history traits make it particularly vulnerable to the multitude of external threats that the species faces; its naturally small population size, diffuse distribution, and low fecundity (reproductively active adults produce only one offspring each year) combine to increase susceptibility to habitat loss or degradation, disturbance, or stochastic events that cause local decline. Populations of *M. septentrionalis* are slow to recover from the loss of individuals, increasing the probability that mortality caused by white-nose syndrome, development, or other factors will cause extirpation (e.g., USGS 2009a).

H. Hibernation

Physiology

Prior to hibernation, *M. septentrionalis* increase their total mass by nearly 50% (males 45%, females 41%) (Caire et al.1979). During hibernation, as bats enter a state of torpor, body temperature falls to within 1-2°C of the ambient temperature in the hibernaculum (Geiser 2004). The decrease in body temperature and metabolic rate reduce energy expenditures by approximately 95% (as compared to remaining normally active) (Geiser 2004, Dunbar and Tomasi 2006).

Behavior

The hibernation period for *M. septentrionalis* is approximately late September or early October to mid- March (NatureServe 2009). *M. septentrionalis* generally makes up a small proportion of the total hibernating population (<1 – 15% NatureServe 2009). This species reportedly hibernates with *Myotis lucifugus, Eptesicus fuscus,* and *Perimyotis subflavus* (Caire et al. 1979, Mills 1971). As do *M. leibii, M. septentrionalis* periodically break torpor during the winter and may become active either within or occasionally outside of the hibernaculum. *M. septentrionalis* generally exhibits strong philopatry to hibernacula, and has also been reported to occasionally move between hibernacula during the winter (Whitaker and Rissler 1992).

IV. POPULATION STATUS

M. leibii

Because of its diffuse distribution and generally low population numbers, *M. leibii* has always been considered somewhat rare (Barbour and Davis 1969). Though some recent studies report *M. leibii* in new locations (e.g., Veilleux 2007), the species is generally thought to have declined across its range in recent decades. Records of this species are still sparse, and where it is documented, sightings report only a few individuals at most, making it difficult to extrapolate any greater trend. Historic declines have been reported in several states – surveys done in Pennsylvania in the 1940s and 1970s found a significant decline in populations of *M. leibii* (Felbaum et al. 1995). Trombulak et al. (2001) report that populations of overwintering *M. leibii* in Vermont have remained very small but relatively stable since the 1930s when hibernacula surveys began.

Essentially, evidence for stability is scant, and evidence for decline is incomplete, but it should be emphasized that all characterizations of the larger population trend in *M. leibii* were made before the advent of WNS. *Myotis leibii* is known to be susceptible to WNS, and has been reported dead in numerous hibernacula (Youngbaer 2009). The rapid spread and devastating effect of this disease on hibernating bats suggests that even formerly stable populations are likely experiencing major declines. In Massachusetts, New York, and Vermont, populations of *M. leibii* have declined 78% overall since the advent of WNS (Langwig et al. 2009). As a species with a naturally small population size, *M. leibii* may be particularly vulnerable to the effects of WNS; small populations are naturally less resilient to disturbance. Additionally, the largest known aggregations of *M. leibii* also occur in the epicenter of the geographic area affected by WNS: New York, Pennsylvania, Virginia, and West Virginia (Szymanski et al. 2009).

NatureServe (2009) lists *M. leibii* as critically imperiled (S1) in Alabama, Arkansas, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, Oklahoma, Pennsylvania, West Virginia, Virginia, and Vermont and imperiled (S2) in Georgia, Kentucky, North Carolina, and New York. It is listed as a state species of special conservation concern in Connecticut, Massachusetts, Maryland, Missouri, North Carolina, New Jersey, New York, Ohio, Oklahoma, Tennessee, Virginia, West Virginia, and Georgia, state-listed as threatened in Pennsylvania and Vermont, and state-listed as endangered in New Hampshire. It is also a federally designated species of special concern, and a former Category 2 listing candidate. All of these designations were made prior to the advent of WNS.

M. septentrionalis

Little is known about population trends in *M. septentrionalis*. All reported occurrences are marked by small population size (Schmidt 2001). Some regional surveys report the species to be stable (e.g., Trombulak et al. 2001), while others suggest that a broader trend toward decline may be driven by habitat loss or disturbance to hibernacula (NatureServe 2009). Overall, though, the paucity of population-level data makes any conclusion provisional at best. The most immediate threat to *M. septentrionalis,* and that which most necessitates quick and decisive conservation action is white-nose syndrome. *M. septentrionalis* has been found dead in many WNS-affected hibernacula (Blehert et al.

2009): this novel threat is absent from most of the published literature. Like *M. leibii*, *M. septentrionalis* naturally occurs in small populations, making it particularly vulnerable to mass mortality events like WNS. Populations of this species in New York, Massachusetts, and Vermont have declined 93% overall since WNS was first discovered (Langwig et al. 2009).

Habitat loss also imperils populations of *M. septentrionalis*: as a species closely associated with mature interior forest stands, the northern long-eared bat is highly sensitive to the fragmentation and destruction of these forested habitats. So little data is available that correlating historical forest losses with historical declines of *M. septentrionalis* is impossible, but current estimates of the total area of mature forest remaining in the eastern United States are exceedingly low (McGrory-Klyza 2001). Additionally, commercial forestry interests control much of the land within this species' range (Dobbs and Ober 1995).

NatureServe (2009) lists *M. septentrionalis* as imperiled (S2) in Montana, Kansas, Oklahoma, Rhode Island, Alabama, vulnerable (S3) in South Dakota, Minnesota, Wisconsin, Indiana, Michigan, Georgia, North Carolina, West Virginia, Virginia, Pennsylvania, New York and New Hampshire, and apparently secure (S4) in Nebraska, Iowa, Missouri, Arkansas, Illinois, New York, Tennessee, South Carolina, Washington, D.C., Maryland, Massachusetts, Maine, and Vermont. It is a species of special conservation concern in Minnesota and Montana, and a candidate for listing in Pennsylvania. Again, all of these status designations were made prior to the advent of WNS.

V. THE EASTERN SMALL-FOOTED AND NORTHERN LONG-EARED BATS WARRANT LISTING UNDER THE ESA

Under the ESA, 16 U.S.C. § 1533(a)(1), USFWS is required to list a species as threatened or endangered if it is in danger of extinction or threatened by possible extinction in all or a significant portion of its range. In making such a determination, USFWS must analyze the status of *M. leibii* and *M. septentrionalis* in light of five statutory listing factors:
(A) The present or threatened destruction, modification, or curtailment of its habitat or range;
(B) Overutilization for commercial, recreational, scientific, or educational purposes;
(C) Disease or predation;
(D) The inadequacy of existing regulatory mechanisms;
(E) Other natural or manmade factors affecting its continued existence.
16 U.S.C. § 1533(a)(1)(A)-(E); 50 C.F.R. § 424.11(c)(1) - (5).

Four of these five factors threaten *M. leibii* and *M. septentrionalis*. Both species are imperiled by habitat loss and degradation, disease, the inadequacy of existing regulatory mechanisms, and several other natural and anthropogenic factors including small population size, human disturbance, wind energy development, climate change, and contamination by toxins associated with mining or oil/gas exploration. Threats to

M. leibii and *M. septentrionalis* in light of each of these factors are discussed in detail below. In light of their small population size, susceptibility to WNS, and other imminent threats, the eastern small-footed and northern long-eared bats clearly warrant protection under the Endangered Species Act.

VI. THREATS

A. Present or threatened destruction, modification, or curtailment of habitat or range

The vast majority of land within the ranges of *M. leibii* and *M. septentrionalis* is private, and therefore subject to little, if any, protective regulation. Federal and state holdings are small, but essential to the conservation of both species (see Figure 1).

<u>Agricultural and Residential Development</u>

Though no statistics that specifically relate bat decline to habitat loss caused by agricultural or residential development are available, this is more likely due to a lack of interest in bats than to any resilience to or tolerance of such habitat loss. The rates of human population growth and of the expansion of development into formerly rural or undeveloped lands has been rapidly accelerating over the past fifty years; in 1950, less than 1% of the conterminous United States was classifiable as urban (more than 1 unit per acre), and 5% was classifiable as exurban (1 unit per 1-40 acres). By 2000, 2% of the total land area was urban, and 25% exurban (Brown et al. 2005). The pace and spatial extent of this development are unprecedented, and the land into which these incursions are being made is often high in biodiversity and therefore both ecologically sensitive and important in the broader conservation picture. The Eastern Temperate and Northern Forest regions, the majority of *M. leibii* and *M. septentrionalis'* ranges, are experiencing the highest rates of exurban development (Brown et al. 2005). The Atlantic Coast, Pine Barrens, and Northern Piedmont regions are also experiencing high rates of urban change. The South currently has the largest human population of any region, and it is projected to grow by 42.9% by 2030 (US Census Bureau 2005). Population growth is inevitably accompanied by expanding development, and if these projections hold true, the South stands to lose much of its already-scant natural habitat.

All of the areas mentioned above fall within the ranges of *M. leibii* and *M. septentrionalis*, and habitat loss inherent in these land use changes is devastating to wildlife populations (Johnson and Klemens 2005).

Riparian areas and temperate forests, two habitat types essential to bat species, are particularly affected by expanding residential development (Smith and Wachob 2006). Both *M. leibii* and *M. septentrionalis* use forested habitat for summer roosting and the formation of maternity colonies, and rely on the insect abundance fostered by riparian habitats to meet the energetic requirements associated with reproduction. Development fragments contiguous habitat patches, increasing the proportion of edge habitat, which has been correlated with reduced occupancy by *M. septentrionalis* in forested habitat (Yates and Muzika 2006). Reduced connectivity among requisite habitat types (e.g., roosting and foraging) increases general energy expenditures and may contribute to local declines. Innumerable studies have documented the negative effects of sprawling residential development on other taxonomic groups, but the current literature largely ignores bats. If groups that utilize similar ecological resources respond comparably, it is expected that the effects of development on bat populations will be manifested in reproductive decline, genetic isolation, changes in demography, and eventual changes in distribution, abundance, community diversity, and population viability. Rapid and decisive action should thus be taken to stop the "continuing encroachment on land previously given to other uses – habitat or agriculture" (Theobald 2001).

Agricultural development is a somewhat different issue: the general effects of agricultural development, habitat loss, degradation, and fragmentation, are similar to those of residential development. However, the percentage of land area occupied by agriculture has been in steep decline in the past several decades (Theobald 2001). Industrial agriculture, generally characterized by large-scale monocropping and the use of copious pesticides, fertilizers, and irrigation, is substantially more detrimental to wildlife than organic or other biodynamic practices; through the pollution of soils and water, erosion, and eradication of local insect populations, agro-industry effectively excludes bats from their former habitats (e.g., Lemly et al. 2000). Organic and biodynamic practices support a higher abundance and diversity of insect prey, which fosters higher levels of bat activity found on these lands than on conventional or industrial farms (Wickramasinghe et al. 2004).

<u>Logging</u>

The loss of forested habitat threatens both *Myotis leibii* and *Myotis septentrionalis*. Logging affects bat populations through the loss of roosting and foraging habitats, changes in forest structure, and changes in insect distribution and abundance (Hayes and Loeb 2007). A substantial proportion of land within the ranges of *M. leibii* and *M. septentrionalis* is privately owned and subject to logging activity. The most commonly employed silvicultural practices are incompatible with bat habitat conservation for several reasons: northern long-eared bats use trees with larger than average diameters and most often occupy stands with higher than average snag density, features most often found in older forests (Yamasaki 2004). The resources that intact, mature stands provide (e.g., diversity of potential roosting sites, proximity to foraging habitat) are necessary to many parts of bat life history, and are essentially excluded by most silvicultural management. For example: the use of short-rotation cuttings (20-40 years) does not allow development of the mature stands with complex vertical structure preferred by *M. septentrionalis*, and favors instead the growth of even-aged, simply structured stands. The density of snags and large-diameter trees is consistently lower in managed forests: snags with a dbh greater than 50cm were more than 50 times more abundant in old-growth stands than in 21-40 year old managed stands in western Oregon (unpublished data as cited in Hayes and Loeb 2007). Under typical management prescriptions, large-diameter snags (≥ 63.5 cm), which both bat species often preferentially select as maternity colony sites, may be up to 100 times less abundant in industrial forests than in unmanaged forest (Wilhere 2003). Several other studies show similar trends: the proportion of snags and large-diameter trees is dramatically reduced in managed stands, even those on relatively long rotation times (40 years or more) (e.g., Duvall and Grigal 1999, Nelson and Lambert 1996, Graves et al. 2000). Additionally, many forestry operations cultivate monospecific stands, which exclude the species diversity favored by *M. septentrionalis* (Pierson 1998).

Commercial forestry within the ranges of *M. leibii* and *M. septentrionalis* occurs primarily in New England's Northern Forest and in portions of the Southeastern United States. The Northern Forest spans 26 million acres in central and northern Maine, northern New Hampshire and Vermont, and the Adirondack and Tug Hill regions of New York. It is one of the largest contiguous forested regions in the United States, and 84% (21.8 million acres) is controlled by private landowners. Forestry is the dominant industry in the Northern Forest, and has been since the late 18th century. Commercial forestry companies own more than 60% of Northern Forest lands, and the majority (70%) of commercially owned land is controlled by a few paper corporations (Dobbs and Ober 1995). Much of the Northern Forest was cut for construction and to accommodate pasturelands in the early years of European settlement, but has significantly regenerated since the mid-19th century; the historical effects of this reforestation on regional bat populations are not documented, but it seems likely that bats would benefit from the regrowth of forested habitat. The early 20th century was a period of some interest in "sustained yield" forestry, and as the timber and pulp industries expanded in the Southeast and Western states, the Northern Forest was largely unaffected (Dobbs and Ober 1995). Beginning in the 1960s, however, the advent of industrialized, motorized logging brought renewed levels of harvesting to the North: the ease of whole-tree harvesting and clear-cutting, and the rising value of mature trees drove logging into many previously uncut or mature second-growth forests. Real estate interests in much of the Northern Forest also spiked in the 1980s, and many timber holdings were liquidated for the development of vacation homes and recreation areas (Dobbs and Ober 1995). The state of Maine has the highest proportion of land controlled by timber interests in the Northeast: 90% of Maine's 17.5 million acres are forested; nearly half of this land is owned by Fortune 500 paper and timber companies, and only 5% is public land, leaving nearly 98% of the state's forests open to timber management (Dobbs and Ober 1995). Industrial forests in the Northeast are often managed in a more ecologically sound fashion than those in the Southeast: multi-age stands and selective cutting are becoming more common practice, though these more sustainable practices have not been implemented on a majority of forestlands (T. McEvoy, pers. comm.).

The Southeast has long been a major industrial forestry region, and is currently predominated by plantations harvested by clearcutting on a 20-25 year rotation (Brown et al. 2005). The Southeast currently supplies 70% of the nation's pulp and paper, products that do not require wood of any specific size or quality and are therefore most efficiently provided by clearcutting (Buckner et al. 2002). Clearcutting is standard forestry practice in Southeastern forests, and Folkerts (1997) reports that the rate of deforestation in this region exceeds that of any comparably-sized tropical area; this destructive harvesting practice has altered more than one-third of the forested area in the Coastal Plain (Folkerts

1997). Virtually no old-growth forests remain in the region, and intact, mature forests are also rare (Wear and Greis 2002). A high proportion of forested lands in the Southeast are privately owned and therefore not subject to environmental regulation that would enforce the use of management practices designed to minimize negative environmental effects (Morse et al. 1997). Regulation of harvesting activities on privately owned timberlands is virtually nonexistent.

Loss of late-successional forest
The loss of older forests is especially injurious to *M. septentrionalis* since the species is more reliant on this particular forest type than *M. leibii*. Most timber companies do not specifically report cutting in late-successional stands, so very little data is available on the distribution or prevalence of such harvesting. Estimates of the proportion of late-successional forest intact and undisturbed in the eastern United States are disturbingly low, particularly in the Southeast, where commercial logging is more extensive (McGrory-Klyza 2001, Wear and Greis 2002). Messick (2001) reports that Minnesota, New York, and the southern Appalachian ecoregion contain the majority of older forest acreage.

Oil, gas, and mineral development

The threats posed by oil, gas, and mineral development are somewhat localized but present across so significant a portion of these species' ranges as to pose a substantial threat to some populations (see Figure 2). New York, Pennsylvania, and the southern Appalachian states (Virginia, West Virginia, and Tennessee) contain considerable reserves of both oil and natural gas. These states are also the current epicenter of White-Nose Syndrome (WNS); if drilling or exploration occurs in close proximity to populations already compromised by WNS, the disturbance and pollution inherent to the process of extraction could be the proverbial nail in the coffin for these bats. *M. leibii's* reliance on loose shale, talus or karst formations often found in mineral-, natural gas-, or oil-rich lands makes them especially vulnerable to habitat loss associated with natural resource exploitation (Amelon and Berhans 2006a).

While the process of extracting natural gas is perhaps less environmentally hazardous than oil or mineral extraction, it is becoming increasingly clear that the primary method of extraction, called hydraulic fracturing ("fracking" or "hydrofracking"), contaminates groundwater and poses serious health risks. Hydraulic fracturing involves the injection of water, sand, and chemicals deep into the earth to break apart rocks and release gas, and is the primary method of extraction used in the U.S. The precise chemical ingredients in drilling fluid have not been disclosed, but a 2004 EPA report identified more than 300 chemicals, 65 of which are listed as hazardous by the federal government. As much as a third of the injected drilling fluids remain in the ground following drilling, and numerous incidences of related water contamination have been reported across the country. The immediate on-site impacts of natural gas drilling include:

- Clearing of forest or other habitat for drill pad (2 acres or more)
- Construction of roads for access to site

- Containment pond for debris collected during drilling and fracking (contains fracking fluid)
- Major noise pollution
- Infrastructure associated with drilling and transport of extracted gas
- Enormous volume of water required for fracking

Natural gas extraction is expected to expand hugely in the Eastern states in the coming years, particularly across the Marcellus Shale, a sedimentary geological formation that extends across much of the Allegheny Plateau from eastern New York to Lake Erie, through Pennsylvania, Ohio, and West Virginia. Small subsurface portions are also found in Maryland, New Jersey, Tennessee, and Kentucky (Figure 5). New York and Pennsylvania are expected to experience the highest levels of drilling. This formation is rich in natural gas: current estimates put the total quantity contained within the Marcellus Shale at approximately 2,445 trillion cubic feet, with approximately 489 trillion cubic feet recoverable (Engelder 2009 as cited in Considine et al. 2009). Accordingly, the Shale is considered by many to be the next major "play" in the East (CatSkill Mountain Keeper 2009).

The geographic coincidence of the Marcellus Shale and the current distribution of white-nose syndrome is striking (see Figure 3). While drilling, mining, and other subsurface exploration have the potential to harm bat populations under normal circumstances, the presence of WNS greatly amplifies the threats these activities pose by compromising the health and stability of these populations. The habitat loss, direct disturbance, and environmental contamination associated with natural gas extraction are significant, and have the potential to further imperil regional bat populations. Drilling activity on the Marcellus Shale in New York is currently halted until the approval of revisions to a General Environmental Impact Statement first written in 1992. The supplementary GEIS (SGEIS) was released in September 2009, and the state of New York anticipates that permits will be issued beginning in 2010 (D. Goldberg, pers. comm.). Significant drilling is already in progress in the portion of the Shale within Pennsylvania's borders, and because state regulations in New York have effectively stalled drilling there for the time being, Pennsylvania has become the focal point for exploration and development on the Shale (Aaron 2009). More than 90 wells in Pennsylvania's Marcellus shale are currently active (PA DCNR 2009). This number is expected to increase significantly in the coming years, as hundreds of other permits have already been issued; ultimately, thousands of wells are expected to be developed (PA DEP 2009).

The nature and spatial extent of coal mining in the Appalachian region of the southeastern U.S. has changed hugely in the past two decades (US EPA 2005). The size of individual operations has increased (many individual permits now occupy more than 3,000 acres, and the largest contiguously permitted area extends over 21,700 acres), and novel industrial extraction technologies have facilitated the development of what is known as mountaintop removal (MTR) or mountaintop mining (MTM) (USGAO 2009). MTR is a process in which explosives are used to blast away mountain summits, exposing underlying coal seams. Rock and soil removed by this process are typically disposed of in neighboring valleys, a practice known as valley fill (VF). Coal slurry, or sludge, a byproduct of post-extraction processing, is either injected into nearby abandoned mines or stored in lagoons or surface impoundments, where contaminants leach into groundwater, poisoning wildlife and humans. The surface area under open permit for MTR in Kentucky and West Virginia has increased annually by approximately 2% since 1990; MTR is now responsible for over 40% of coal production in Appalachia (USGAO 2009). Though all stages of MTR have been acknowledged to be extremely destructive to aquatic and terrestrial habitats by federal agencies (e.g., US EPA 2005), MTR has been permitted to continue virtually unmitigated. More than 12 million acres in Kentucky, West Virginia, Virginia, and Tennessee are currently affected, and within this area, nearly 6.8% of forested habitat has been lost to MTR and VF (1.5 million acres, US EPA 2005). The hardwood forests of Appalachia are critical summer habitat for *M. leibii* and *M. septentrionalis*, and in addition to the total loss of habitat represented by mined areas, MTR/VF fragments remaining forest, reducing its suitability as habitat for these species.

Wind energy development

Wind energy development is known to be most threatening to long-distance migrants and tree-roosting species, but may pose problems for regional migrants like *M. leibii* and *M. septentrionalis* as well, particularly in certain contexts. Bats are killed in significant numbers by utility-scale wind energy facilities, with the greatest number of fatalities occurring along forested ridgetops in the eastern United States (Kunz et al. 2007). Several hypotheses exist about the mechanisms by which this mortality occurs, among them:

- Bats mistake the large monopoles for roost trees
- Cleared area around wind facility provides good habitat for aerial insects, bats are thus attracted to these areas to forage and are subsequently struck by turbine blades or otherwise harmed (blades can move at nearly 200 mph in high winds and therefore have major potential for harm).
- Bats are attracted to or disoriented by the ultrasonic noise produced by turbines
- Electromagnetic fields produced by rotating turbines interfere with bats' spatial perception, causing them to become disoriented and possibly trapped in blade-tip vortices. As the blade swings down, rapid decompression causes internal injury to the trapped bat. Evidence for this hypothesis is strong: many necropsies provide no visible external injuries but internal damage indicative of decompression (Kunz et al. 2007).
- Echolocation is ineffective at distances beyond 10 m: bats are therefore unable to navigate their way around these large obstacles.

Wind power is an increasingly common source of renewable energy in the United States: implemented capacity increased by 26% in 2006 and 47% in 2007 (NASBR 2008) and is expected to continue to rise. Projected annual bat fatalities range from 33,000 to 111,000 (based on different models) in the Mid-Atlantic Highlands region alone (Kunz et al. 2007). It is difficult to make accurate predictions because so little baseline population data exists for most bat species, but the basic and unanimous understanding is that wind energy-related bat deaths are and will continue to be significant.

Casualties of *Myotis septentrionalis* have been reported at several wind energy facilities, but generally comprise a small fraction of total mortality; only 1.3% of total fatalities at a West Virginia facility were identified as *M. septentrionalis* (Kerns and Kerlinger 2004, Kunz et al. 2007). This is consistent with its relative representation in regional bat communities, and should not be taken as an indication that this species is not susceptible to wind energy-related mortality. No reports of dead *Myotis leibii* at wind energy facilities exist, but mist-netting efforts at a wind farm in Pennsylvania revealed that this species is indeed present in surrounding habitat (Capouillez and Mumma 2008). Because of its association with rocky ridgetop habitat, *M. leibii* may be vulnerable to habitat loss caused by wind development in these areas (G. Therres, pers. comm.).
Such additive mortality as is represented by wind energy-related deaths is unsustainable for already small or declining bat populations like *M. septentrionalis* and *M. leibii*.

Mine closures

Concern about the public safety hazard presented by abandoned mines spurred a spate of mine closures in the past two decades. While mine closures may be advisable to mitigate safety hazards, abandoned mines serve as critical habitat for many bat species, and most methods of closure (backfilling, plugging, solid bulkhead exclosures) exclude bats. In a few reported instances, mines were thus closed during the hibernation period, destroying resident bat colonies (Burghardt 2001).

The National Park Service (NPS) established their Abandoned Mineral Land Restoration Program in 1984 "to address the adverse effects of past mineral development on NPS lands", and entered into a Memorandum of Understanding (MOU) with Bat Conservation International in 1995 (Burghardt 2001). "The NPS realizes that abandoned underground mines have become critical to the survival of numerous bat species because a great deal of their natural habitat has been lost to urban development, deforestation, and recreational exploitation of caves …" (Burghardt 2001). Accordingly, and in keeping with the MOU, NPS is required to implement bat-compatible closures and, to date, has installed 102 such closures in 16 national parks, mostly in the western U.S. (Burghardt 2001). Mines on non-NPS land are still often closed improperly, and in some areas this may represent significant habitat loss to bats (BLM 2000).

B. Disease or predation

White-nose syndrome (WNS)

WNS is the most significant known pathogen affecting bats. The disease was first observed in the winter of 2006-2007 at five sites in eastern New York, and in subsequent winters has spread rapidly across the Northeastern United States; in winter 2008-2009, bats in more than 60 hibernacula were reportedly infected with WNS, some as far as 500 miles from the initial site of infection (Szymanski et al. 2009). Named for its most apparent symptom, a characteristic bloom of white fungus on the muzzle, ears, and/or wing membranes of infected bats, WNS has spread rapidly throughout the northeastern United States and has become a topic of primary concern among conservation biologists and wildlife managers. First discovered in New York, WNS has since been confirmed in Vermont, Connecticut, Massachusetts, Pennsylvania, New Hampshire, New Jersey, West Virginia and Virginia. Several possible cases have been identified in Ontario and Quebec, but none confirmed as WNS to date; surveys for WNS in these provinces are ongoing (C. Massey, pers. comm., J. Mainguy, pers. comm.). The possibility that additional bat species may warrant listing as a result of WNS-related declines has been acknowledged by USFWS (Szymanski et al. 2009).

Some data suggest that WNS was first introduced to the United States by cavers who had previously visited Europe; a fungus that is nearly genetically identical to *G. destructans* is known in northern Europe (B. Kilpatrick, pers. comm.). It is possible that the fungus was then spread to distant hibernacula by cavers or researchers: it was first discovered in Howes Cave, the most-visited cave in New York state, and one of two commercial caves there that harbor bats (Hicks et al. 2008). It is believed that WNS can be acquired either from bat-to-bat contact or from contaminated hibernacula. The rate of spread and current radius of the WNS epidemic is consistent with the annual range (distance between summer and winter habitat) of individual bats from WNS-affected hibernacula recorded by summer recapture studies, which suggests that the dispersal of infected bats is at least partially responsible for the continued spread of this disease (Hicks et al. 2008, Reichard and Kunz, in press).

Bats affected by WNS may display some or all of the following symptoms:

- *White fungus on nose, ears, and wing membranes*. This fungus has been isolated and identified as a novel species in the psychrophilic (cold-loving) genus *Geomyces* (Blehert et al. 2009), and has been named *Geomyces destructans* (Gargas et al. 2009). *G. destructans* has been observed to penetrate the dermis of affected bats, eroding wing and ear tissue, and hyphae may extend into hair follicles and sebaceous glands, compromising their function and eventually reaching the tissue beneath, though no local inflammation or immune response has been reported (Blehert et al. 2009, Gargas et al. 2009). Temperatures in WNS-affected hibernacula range annually from 2 to 14°C, well within the fungus' range of thermal tolerance, allowing it to persist and proliferate year-round (Blehert et al. 2009). Formerly thought to be intolerant of warmer conditions, *G. destructans* has recently been shown to survive high temperatures, and thus may not be as range-limited as previously believed. While vegetative growth is inhibited at high temperatures, fungal spores are not denatured by these conditions, which in fact induce germination. Killing temperatures for *G. destructans* are estimated to be above 200ºF (H. Barton, pers. comm.). However, the fungus may have a less destructive influence in warmer climates where bats are not as energy-stressed in the winter months.

- *Depleted white and brown fat reserves by mid-winter.* It has been established that the primary cause of death in WNS-affected bats is starvation. WNS-affected bats at some sites have poorer body condition (lower BMI, less stored fat) in summer *and* winter, and are generally significantly smaller throughout the reproductive period in 2008 than they were in 1975 (Kunz et al. 2008). Concerns have been raised that even those bats that survive the hibernation period with WNS will be unable to reproduce and raise young successfully, further imperiling their populations (Reichard et al., unpublished data). While over 80% of adult females in WNS-affected colonies were observed to be reproductively active in 2008, past research has indicated that, in normal years, over 90% of females are reproductively active (Reichard et al., unpublished data). This study did not address recruitment of young born to WNS-affected parents or the plausible causes of the observed reproductive decline.

One intriguing line of evidence has found that WNS-affected individuals sampled in hibernacula lack chitinase, an essential enzyme that allows bats to digest chitin, a primary component of insect exoskeletons. During the winter months, chitin remaining in the digestive tract from the previous summer's foraging may provide supplementary energy and nutrients crucial to overwintering bats (Whitaker et al. 2004); the absence of chitinase in WNS-affected bats thus seems like a plausible contributor to the observed winter starvation.

- *Reduced capacity to arouse from deep torpor.* WNS-affected bats are significantly less responsive to anthropogenic disturbance than are healthy bats; researchers entering hibernacula report that many bats will not arouse even when touched, which is highly unusual (Hicks et al. 2008, M. Moore, pers. comm.).

- *Changes in immune response during hibernation.* Although immune function is somewhat suppressed in all hibernating bats, there is evidence that WNS-affected bats have further reduced immune competence (Jacob and Reeder, unpublished data). While innate immunity (less energetically costly) seems to be unchanged or even slightly upregulated in WNS-affected individuals, adaptive immunity (energetically expensive) is significantly suppressed (Jacob and Reeder, unpublished data, Moore et al., in prep). The bactericidal capacity of bats from WNS-affected hibernacula is greater on average than that of bats from unaffected sites, though symptomatic bats appear to have lower bactericidal abilities compared to asymptomatic bats from the same site type (Moore et al., in prep.). The immunological mechanisms behind these differences are not yet known, nor is it clear whether asymptomatic bats are actually infected by WNS but not yet evincing symptoms.

WNS-affected bats have significantly lower levels of total immune globulins than their healthy conspecifics in mid-winter, and these levels are even further reduced by the end of the hibernation season (Jacob and Reeder, unpublished data). WNS-affected bats are also unable to repair DNA experimentally damaged by hydrogen peroxide (a measure of an individual's ability to respond to a free radical challenge) (Jacob and

Reeder, unpublished data). Bats (WNS-affected and -unaffected) from which data were collected did not have significantly different body mass indices, suggesting that the compromised immune function evinced by WNS-affected bats is not a function of any difference in energetics.

The finding that WNS-affected individuals mount effective innate immune responses may be attributable to the positive relationship between body temperature and immune function: WNS-affected bats arouse more frequently than healthy bats, which induces the upregulation of immune function. However, this enhanced immune function may ultimately be irrelevant because of the energy expenditure required to arouse and sustain activity.

- *Ulcerated, scarred, or necrotic wing membrane tissue.* WNS-affected bats sampled in late winter show extensive wing damage in the form of tissue scarring and necrosis (Jacob and Reeder, unpublished data). Though some reports indicate that mild scarring or tissue necrosis of wing membranes may heal in the summer season (Kunz 2009), many bats captured in the summer months show substantial and sustained damage that compromises flight and eventually leads to mortality (Darling 2009). Up to 61% of little brown bats *Myotis lucifugus* monitored at two New Hampshire maternity colonies in the summer of 2008 had severe wing damage (necrosis, scarring) from WNS infection in the previous winter (Reichard et al., in press). Bats with severe wing damage had significantly lower body mass than those with little or no WNS-induced wing damage, which may contribute to reproductive decline or failure.

- *Atypical behavior causing bats to arouse more frequently than normal and/or to emerge prematurely from hibernacula in mid-winter*. Healthy bats typically arouse from torpor at 13 to 15-day intervals (most studies suggest that this periodic arousal serves to maintain immune function – in deep torpor, immune response is negligible), but WNS-affected bats have been observed to awaken and become active as frequently as every 2 - 4 days (WNS March 2009 Status Report, B. Kilpatrick, pers. comm.). Each arousal requires the expenditure of substantial energy reserves, both for thermogenesis (of as much as 35°C) and for movement (Boyles and Willis 2009). The reason for increased frequency of arousals in WNS-affected bats has not been conclusively established, but hypotheses include:

  - Irritation by fungal infection prompts bats to awaken and groom
  - Fungal infection prompts bats to awaken so as to enhance immune function
  - As winter goes on and energy reserves dwindle, bats may break torpor more frequently in hopes of feeding; evidence for this hypothesis is strong as bats are often observed leaving hibernacula in mid-winter as if to forage. This behavior is, with few exceptions, fatal. Even if the increased frequency of arousals observed in WNS-affected bats serves to enhance immune function, this benefit is offset by the massive energy requirements involved in these arousals (D. Reeder, pers. comm.).

Hibernacula are experiencing mortality rates over 90%; many hibernating populations have been reduced from thousands to fewer than fifty individuals, and others have been entirely extirpated (B. Kilpatrick, pers. comm.). Major declines (more than 90%) have also been observed at summer maternity colonies that were stable or growing before WNS, and pup mortality in the 2009 reproductive season was unusually high (S. Reynolds, pers. comm.). Species affected include the little brown bat *Myotis lucifugus*, the big brown bat *Eptesicus fuscus,* the tri-colored bat *Perimyotis subflavus*, the Indiana bat *Myotis sodalis*, and the two species addressed by this petition, the northern long-eared bat *Myotis septentrionalis* and the eastern small-footed bat *Myotis leibii* (Blehert et al. 2009). Sampled populations of *M. leibii* in New York, Massachusetts, and Vermont have declined 78% overall, while *M. septentrionalis* has declined 93% overall since the first year of exposure to WNS (Langwig et al. 2009).

To date, WNS is estimated to have killed more than 1.5 million bats in the Northeast (B. Kilpatrick, pers. comm.). In New York, mortality rates in the first year WNS deaths were monitored (2007) ranged from 57 to 64%; in 2008, mortality rates rose to between 81 and 100% (Hicks et al. 2008). Though these species were not common in pre-WNS surveys, counts of both *M. septentrionalis* and *M. leibii* have declined to zero in many caves since the advent of WNS (Hicks et al. 2008).

Much of the pathology of WNS is as yet unknown. It is not clear whether characteristic white fungus is a cause or symptom of this syndrome, how the disease weakens and kills its victims, or how, exactly, it is transmitted among bats and hibernacula. No other bacterial or viral pathogen has been identified by necropsies (Boyles and Willis 2009). Resistance to WNS seems to be neither conferred nor developed: bats that survive one winter can die the following year (and may be more likely to because they are weakened). There is evidence of some temporal delay between the onset of WNS and the full expression of the disease within hibernacula, which may temporarily obscure the eventual effect of the disease on infected populations (K. Langwig, pers. comm.). This complication underscores the importance of periodic monitoring of both infected and uninfected hibernacula to reliable and complete data on the effects of WNS.

C. Other natural or anthropogenic factors

<u>Environmental contaminants</u>

The effect of environmental contaminants on bat populations is a subject of significant conservation concern. Leaching and spills annually cause substantial wildlife mortality, and bats are often disproportionately affected (Eisler and Wiemeyer 2004). Several features of bat life history heighten their susceptibility to contamination, particularly:

- Bat longevity facilitates the bioaccumulation of toxins in body tissue
- *Myotis septentrionalis* and *M. leibii* are exclusively insectivorous; their primary prey is contaminated by pesticides, heavy metals, and other toxins
- Both *M. septentrionalis* and *M. leibii* (particularly *M. leibii*) prefer habitat that is often geographically coincident with mining or drilling sites, habitat often

Three primary sources of environmental contamination threaten bats: non-point source industrial pollutants (e.g., mercury), pollutants or toxins associated with agriculture, and mine-related contaminants.

Non-point source pollutants. Mercury is a neurotoxin that has been linked to numerous adverse health impacts in mammals; reduced immune function, impaired function of the central nervous system (sensory and motor skills), and compromised reproductive ability are among the most pernicious of the documented consequences of mercury contamination (Schweiger et al. 2006). The primary sources of mercury contamination across the range of *M. leibii* and *M. septentrionalis* are the coal-fired utility industry, industrial heaters and boilers, and waste incinerators (Driscoll et al. 2007). Though it was previously thought that piscivorous species were uniquely vulnerable to mercury contamination, recent evidence shows that insectivores are also affected by high levels of this heavy metal (Schweiger et al. 2006).

The northeastern United States, where the largest populations of *M. leibii* and possibly *M. septentrionalis* are found, are a hotspot for mercury contamination because of the deposition of acid precipitation from polluting industries in the Midwest, a phenomenon that has been linked to the decline of many wildlife species (Driscoll et al. 2007, Evers et al. 2007). Forested regions with a high proportion of wetlands, as are found in the Northeast, seem to be among the ecosystems most sensitive to mercury contamination; ionic mercury (Hg) deposited in water is converted to methyl mercury (MeHg), a more bioavailable form of mercury that is ultimately found at toxic concentrations in the highest trophic levels (Driscoll et al. 2007). Both *M. leibii* and *M. septentrionalis* rely on wetlands and riparian areas as foraging habitat. Hazardously elevated levels of mercury have also been found in bats, including *M. septentrionalis,* in Virginia, Arkansas, and Kentucky (Yates and Evers 2006, Massa and Grippo 2000, Clark et al. 2007). For example, hair samples from bats in Mammoth Cave National Park were found to have levels of mercury ten times higher than that deemed safe for humans by the EPA; such bioaccumulation is of major concern (Clark et al. 2007).

Mining-related contaminants are an acknowledged threat to bats. The mine-related contaminant that has received the most research attention to date is cyanide. Many gold mining operations use cyanide extraction techniques to chemically separate gold from other minerals; the contaminated solution that remains is then stored in sludge ponds or heaps (O'Shea et al. 2000). Wild animals are often attracted to cyanide ponds to drink, behavior that may be fatal as cyanide is absorbed quickly and acts as a rapid asphyxiant. Unlike many other environmental toxins, however, cyanide does not persist in ecosystems, and does not biomagnify; sublethal doses may be ingested, detoxified and eliminated easily (O'Shea et al. 2000, Eisler et al. 1999).

Agriculturally-associated contaminants are known to be a significant threat to many bat populations. Bats may ingest these toxins from their insect prey or from contaminated water sources; agricultural runoff is one of the primary causes of the decline of riparian habitat used by bats as foraging grounds (Mason 1997). The legacy of the organochlorine pesticides used in the 20th century is well-known; though they are no longer used in the United States, DDT, dieldrin, and other related pesticides persist in many ecosystems and may continue to harm to bat populations (Clark et al. 1980, Corrao et al. 1985, Schmitt et al. 1999, McFarland 1998, Stansley et al. 2002). Because these compounds are lipophilic, they are especially harmful to hibernating bats; they accumulate in stored fat, and as these reserves are depleted, the chemicals are mobilized and often cause death (Secord et al. 2009). Remnant organochlorine pesticides also have many sub-lethal effects on bats, including loss of coordination, increases in metabolic rates, and reduced levels of food consumptions (Swanepoel et al. 1999, Clark and Shore 2001). While many of the studies of pesticide contamination in bats discuss the role of now-banned DDT in major historical bat declines, several more contemporary studies link other agrochemicals to bat decline.

Contemporary classes of pesticides (e.g., organophosphates, pyrethroids, neonicotinoides) have also been determined to have sub-lethal effects on many bat populations (Secord et al. 2009). Carbamate and organophosphate pesticides inhibit the neurotransmitter cholinesterase, affecting thermoregulation, reproduction, immune function, motor coordination, and foraging behavior; they are therefore considered to be toxic to mammals. Compromised neurotransmitter function may negatively influence navigational and foraging abilities, which may in turn affect bats' ability to meet energy requirements (Secord et al. 2009). Studies in Missouri and Indiana confirmed that a significant number of Indiana bat carcasses collected from hibernacula contained measurable concentrations of chlorpyrifos and dichlorvos, respectively (Sparks 2004, 2005, 2006, Eidels et al. 2007). Chlorpyrifos is one of the most widely used pesticides in New York (Secord et al. 2009).

Pyrethroid pesticides are also neurotoxins and are known to have similar effects as carbamates and organophosphates. Though they were until recently considered to be less toxic than organophosphate, carbamate, and organochlorine pesticides, the newer generations of pyrethroids are increasingly toxic (Secord et al. 2009). There is little information on the effects of pyrethroids on bats, though their use in crepuscular or nocturnal mosquito control may affect bats by direct exposure or by reduction in prey abundance. The effect of reduced prey abundance may be particularly harmful near maternity colonies. Two types of pyrethroids were found in hibernating *M. septentrionalis* carcasses in Missouri (McFarland 1998 as cited in O'Shea and Johnson 2009).

Current correlations between bat decline and pesticides seem to be largely mediated by insects; pesticide use causes both the diversity and abundance of insects to decline, reducing the local diversity and abundance of bat species. Accordingly, organic farms have a significantly higher abundance and diversity of nocturnal insects, which supports the higher bat activity found on these facilities than on conventional farms

(Wickramasinghe et al. 2004). Finally, it has been posited that pesticides or other environmental contaminants might play some role in WNS, by compromising metabolic, neurologic, or immune function or otherwise predisposing them to infection by another agent (Secord et al. 2009). USFWS proposed an investigation of this possibility in 2008, but no data has been collected (WNS Science Strategy Meeting Agenda 2008).

Climate change

Climate change is widely recognized as an imminent threat to individual species and entire ecosystems alike. Because they are exclusive insectivores and obligate hibernators, bats may be among the groups most affected by climate change. Though the ecological alterations wrought by climate change will be geographically variable, changes in the distribution, abundance, and phenology of insects are widely expected and already being observed in some regions (e.g. Parmesan 2003, Rodenhouse et al. 2009, Hughes 2000, Bale et al. 2002, Menendez 2007). Changes in temperature and precipitation regime are also anticipated; water availability in the summer season may be significantly diminished, adversely affected bat reproduction by inhibiting lactation and thus juvenile recruitment (Adams and Hayes 2008, Rodenhouse et al. 2009). It is projected that winters in the Northeast will become shorter and warmer (evidence of this trend is mounting) and that the frequency of freeze/thaw cycles, which may disrupt mammalian hibernation, will increase (Gu et al. 2008).

Milder winter conditions may permit bats to enter hibernacula later than usual; however, less food is available later in fall, which would cause them to enter hibernation with fat reserves inadequate to last the winter. Warmer or more variable winter temperatures may also induce more frequent arousals in hibernating bats: energy requirements are minimized at approximately 2º C, while warmer or cooler temperatures greatly increase energetic costs; rising or fluctuating temperatures may thus cause arousal frequencies unsustainable for these species (Humphries et al. 2002, 2004). It has also been posited that changes in winter temperature regime may disrupt bat reproductive physiology by diminishing the viability of spermatozoa stored in the female reproductive tract over winter (females will therefore not become pregnant upon emergence) or by causing accelerated embryonic development and parturition earlier in the spring, which may lead to declining recruitment if conditions are not suitable for young (Jones et al. 2009).

M. leibii and *M. septentrionalis* may be differently affected by climate change: *M. leibii* often hibernates in small rock crevices, under rock slabs or in other microhabitats that are more susceptible to temperature fluctuations than cave interiors (where *M. septentrionalis* are more commonly found) and may thus be more likely to be frequently aroused from torpor, depleting energy reserves (Rodenhouse et al. 2009).

Disturbance at hibernacula or maternity roosts

Recreation: the locations of maternity roosts and hibernacula are often coincident with prime recreational lands – both caving and rock climbing often conflict with the protection of bat habitat. Both *M. leibii* and *M. septentrionalis* are susceptible to human disturbance in hibernacula. Cavers, researchers, and any other unusual activity that precipitates arousal may disturb bats in hibernacula. Because breaking torpor requires major energy expenditure, increased arousal frequency contributes to premature energy depletion. Disturbance by human visitation during hibernation has been linked to significant overwinter weight loss in Indiana bats (Johnson et al. 1998).

M. leibii is also particularly vulnerable to disturbance in maternity roosting sites, which are often located on rock outcrops or cliff faces suitable for rock climbing or rappelling (Erdle and Hobson 2001). Through physical alteration of cave habitat, cave commercialization (permitting visitors to tour caves during the hibernation period) may cause bats to abandon their hibernacula. One of the largest known populations of *M. leibii* in North America was entirely evicted by the commercialization of Fourth Chute Cave in Ontario as a result of changes in airflow that warmed the cave (Mohr 1972).

An abandoned railroad tunnel in Maryland, the Indigo Tunnel, houses what is likely to be the third-largest hibernating population of *M. leibii* in the species' range, and the largest population as yet unaffected by WNS: estimated population size in fall 2008 was 142 (A. Haskew, pers. comm.). The tunnel is also used as breeding habitat during fall swarm. State authorities proposed the development of this tunnel into an expansion of the Western Maryland Rail Trail, a bicycle recreation trail, in 2007. If the disturbance and physical changes caused by development did not exclude this colony entirely, prolonged exposure to tourist traffic certainly would. Environmental assessments of the proposal are slated to be complete in the fall of this year, 2009, but groups opposing the development have no substantial legal basis for opposition, though the state has acknowledged that the species is in dire need of conservation action. Two other abandoned rail tunnels (Kessler and Stickpile Tunnels) in Maryland that provide significant habitat for *M. leibii* are also threatened by recreational development (G. Therres, pers. comm.).

Vandalism is known to be a major issue at some hibernacula sites (Trombulak et al. 2001, Tuttle 1979). Intentional harm to bat colonies is an alarmingly common occurrence; Tuttle (1979) reports finding sticks, rocks, spent shotgun and rifle shells, fireworks fragments, and smoke stains on cave ceilings at many caves where research on bats was conducted. Intentional killing of bats has presented itself as a significant problem for some populations. Public misperceptions about bats are rampant; concerns about public health and the transmission of rabies, contamination of homes or other buildings by guano, and the general stigma associated with bats inspire many attempts to eradicate bats from both natural and anthropogenic habitat. Intentional killing of bats in caves, both commercial and non-commercial, by clubbing, stoning, burning, shooting, and other means is well documented as a cause of substantial bat mortality (e.g., Greenhall 1973, Tuttle 1979). The most recent report of such activity is an incidence of vandalism that killed more than 100 bats at Carter Caves State Resort Park in Kentucky in October 2007 (Southeastern Bat Diversity Network 2007). Additionally, the only known maternity colony of *M. leibii* in Maryland, at a state park wildland in Garrett County, was vandalized in the late 1990s (G. Therres, pers. comm.).

Prescribed burning

Prescribed burning is primarily of concern in the southern portion of these species' ranges. Most prescribed burns in the southeastern U.S. occur in the winter season, and are often considered to be more beneficial than harmful to most bat species because they may create snag habitat by killing trees (Carter et al. 2000). However, prescribed burns have also been documented to destroy snags in mid- to late stages of decay that provide suitable bat roosts (Horton and Mannan 1988). Though little research has been conducted on the effects of fire on bat communities (most of what is known applies to habitat rather than individuals or communities), winter burns are not thought to affect cave-hibernating (cavernicolous) species. However, caution should be taken so as to not to burn in locations or conditions where smoke might be driven into a cave, disturbing or killing hibernating bats. Summer burns have the potential to harm tree-roosting species, particularly because young are non-volant (though females *are* able to carry their young short distances). Prescribed burns slated to occur in the summer months have been proposed in the Monongahela National Forest; the consequences of such poorly timed management may be injurious to local bat populations (J. Rodd, pers. comm.).

This management practice may be especially relevant to *M. leibii*, whose summer roosting habitat (crevices in rock outcrops or cliff faces) is often spatially coincident with fire-prone or fire-reliant plant communities (pine species, ericaceous herbs); renewed interest in maintaining or restoring these plant communities through prescribed burning in areas where fire has been historically suppressed may threaten *M. leibii*'s summer habitat (Carter et al. 2000).

A study of the response of *M. septentrionalis* to prescribed summer burns in eastern Kentucky found that bats were able to track and successfully exploit changes in prey abundance and roost habitat availability following fires. The abundance of important insect prey species increased after a burn, as did the availability of snags and decaying trees suitable for roosting. Post-fire home ranges were found to be closer to burned habitat than to unburned habitat (Lacki et al. 2008). Based on this data, *M. septentrionalis* seems to be somewhat tolerant of fire, although researchers did not investigate changes in population structure or other demographic parameters following burns. Finally, prescribed fires may indirectly affect bat populations by affecting the local distribution and abundance of insects, either through direct mortality, or through changes in soil or vegetation characteristics (McCullough et al. 1998). Precautions should be taken to protect resident bat populations in plans for prescribed burns.

D. The inadequacy of existing regulatory mechanisms

No existing regulatory mechanisms adequately protect either *M. leibii* or *M. septentrionalis* from the variety of threats they face across their ranges.

Private

Private lands comprise approximately 90% of the land area within the ranges of *M. leibii* and *M. septentrionalis*. Regulation of activities that degrade or destroy bat habitat on these lands is minimal. State land-use planning legislation is highly variable both among and within states, and rarely includes any requirements for habitat protection, let alone species-specific conservation provisions. As mentioned in previous sections of this petition, loss of habitat to **development** is the foremost cause of species endangerment in the United States, and perhaps also the least regulated. For example, in Massachusetts, loss of forestlands to residential or commercial development far outstrips habitat loss to logging; between 1985 and 1998, more than 66% of forest losses in the state were attributable to development (MA DCR 2009). Improved long-range land use planning and development reform is essential.

Timber corporations have significant holdings in many states within the ranges of *M. leibii* and *M. septentrionalis*, and regulation of harvesting or other activities on these lands is virtually nonexistent: there are no requirements for long-term planning or habitat preservation or restoration on privately owned timberlands (C. Johnson, pers. comm.).

The Nature Conservancy (TNC) holds a conservation easement on the second-largest occurrence of *M. leibii* (Aitkin Cave in the R.O. Rowlands Preserve, Pennsylvania) and has a management agreement that confers limited protection to the largest occurrence. Several other, lower-quality occurrences are also owned by TNC (NatureServe 2009).

Federal

Between 4 and 6% of the total land area within the ranges of *M. leibii* and *M. septentrionalis* is federally owned (See Table 2). Because roughly 90% of the land within the ranges of *M. leibii* and *M. septentrionalis* is private, strong protections on public lands are essential to the conservation of these bats. The vast majority of federal land within these ranges is National Forest, and therefore falls under the jurisdiction of the U.S. Forest Service (USFS). Species protections on these lands are outlined in Land and Resource Management Plans (LRMPs, or Forest Plans), drafted and revised by each forest every 10-15 years.

Land and Resource Management Plans (LRMPs) for National Forests on which federally listed bat species occur make some provisions for the protection of habitats known to host these species (See Table 3). These protections generally include some or all of the following requirements, though stringency and specific stipulations vary among forests.

- The establishment of buffer zones around known hibernacula or maternity roosts used by listed species and the prohibition of timber harvesting, herbicide application, trail or road construction, or other disturbing activity within these zones. Buffer depth varies from 200 ft. to 2.5 miles.

- Mandates that prescribed burn plans be sensitive to the life history of listed species, both spatially and temporally: many prohibit burning during breeding season, hibernation, or both
- Restricted or prohibited access to caves inhabited by listed species to minimize human disturbance
- The retention of a specified density of snags or canopy cover within harvested forest stands
- Requirements for consultation with USFWS for projects that could potentially impact listed species
- Requirements that any alteration or demolition of man-made habitat be preceded by surveys for listed species, and that alternative habitat be provided if necessary

National Forest LRMPs do not include any provisions for the protection of bat species not federally listed as threatened or endangered. Protections conferred by management for listed species sympatric with *M. leibii* or *M. septentrionalis* (the Indiana bat, *Myotis sodali*s, gray bat *Myotis grisescens,* and Virginia big-eared bat, *Corynorhinus townsendii virginianus*) may be beneficial to co-occurring populations of *M. leibii* or *M. septentrionalis,* but are not sufficient to protect these species because neither their life histories nor ranges are identical.

Though recent surveys are not available for most forests, based on its known range, *M. leibii* may be present in the Allegheny, Bankhead, Chattahoochee, Cherokee, Conecuh, Croatan, Daniel Boone, Finger Lakes, Francis Marion, George Washington, Green Mountain, Jefferson, Mark Twain, Monongahela, Nantahala, Oconee, Ouachita, Ozark-St. Francis, Pisgah, Shawnee, Sumter, Talledega, Tuskegee, Uwharrie, White Mountain, and Wayne National Forests. It is designated as a Regional Forester's Sensitive Species (RFSS) in the Daniel Boone, Cherokee, Finger Lakes, Francis Marion, George Washington-Jefferson, Green Mountain, Mark Twain, Monongahela, Nantahala, Ouachita, Ozark, Pisgah, Sumter, and White Mountain National Forests.

Though recent surveys are not available for most forests, based on its known range, *M. septentrionalis* may be present in the Allegheny, Bankhead, Beaverhead, Bienville, Bitterroot, Black Hills, Conecuh, Chattahoochee, Cherokee, Chequamegon, Chippewa, Croatan, Custer, Daniel Boone, Deerlodge, De Soto, Delta, Francis Marion, Finger Lakes, Gallatin, George Washington, Green Mountain, Helena, Hiawatha, Hoosier, Homochitto, Holly Springs, Huron-Manistee, Jefferson, Kisatchie, Kootenai, Lewis and Clark, Lolo, Mark Twain, Nantahala, Nebraska, Nicolet, Oconee, Ottawa, Ouachita, Ozark-St. Francis, Pisgah, Samuel R. McKelvie, Shawnee, Sumter, Superior, Talledega, Tombigbee, Tuskegee, Uwharrie, and White Mountain National Forests. It is designated as a Regional Forester's Sensitive Species (RFSS) on the Allegheny National Forest.

Maintenance of the Regional Forester's Sensitive Species list falls under the jurisdiction of a Forest Service directive last rewritten in 2005 (FSM Sec. 2670.44). The directive describes the procedures and regulations that should govern Regional Foresters' treatment of species designated as sensitive, but because it is not published in any code of federal regulations is not legally binding. Being designated as "sensitive" confers no habitat protection to a species and requires only that the relevant agency analyze the impacts of proposed actions on the species under the National Environmental Policy Act (NEPA). If adverse effects are expected, there is no requirement for the selection of a benign alternative action or for any monitoring or mitigation. All protections to RFSS are therefore given wholly at the discretion of the Regional Forester, and RFSS status cannot be said to constitute any significant regulatory protection. Additionally, no regulatory protections are specifically crafted to protect late-successional forests, despite their acknowledged ecological significance, and neither the National Forest Management Act (NFMA) nor the National Environmental Protection Act (NEPA) protects these older stands from logging (Messick 2001). Wilderness areas are the only wholly protected habitat within National Forest boundaries, and while federal holdings in the Eastern United States are small, the wilderness areas within them represent an even smaller proportion of total land area. The proportion of wilderness that could be considered suitable habitat for *M. leibii* or *M. septentrionalis* is not known (see Table 4).

Several anthropogenic threats exert a considerable influence on the suitability of National Forest lands as habitat for bats and other species. Development related to oil, gas, or mineral extraction and logging are the primary causes of habitat destruction, though anthropogenic disturbance to caves, maternity roosts, or other critical habitat is also a threat. Wind energy development is a secondary concern for these cavernicolous bats, though increasing pressure to expand renewable energy portfolios may raise the profile of this threat in the near future. Regulatory protections relevant to these individual threats may exist, but do not address the protection of species not federally designated as threatened or endangered.

Administration of **oil, gas, and mineral extraction** on federal lands is complex because of the proportion of land in split estate, a situation wherein the rights to minerals occurring beneath federal lands are privately held. USFS records indicate that at least 33% of mineral rights beneath wilderness areas and experimental forests are privately owned in Region 9 (Eastern region). Region 8 (Southern region) was unable to provide data. Bat populations ostensibly protected by the domain of federal agencies and environmental regulations may therefore be threatened by drilling or mining activities on these privately held subsurface estates; there is, as yet, no legal consensus about the rights or privileges accorded to mineral estate holders, the Forest Service, or other federal agencies. To date, individual cases have made various determinations about whether NEPA is applicable to drilling on split estate lands. The current intensity of drilling on National Forest lands suggests that the permitting process for access to potential drilling sites is so lenient as to allow excessive levels of resource extraction on these public lands. The threats that these activities pose to bats are widespread and continue to expand.

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) established the Office of Surface Mining (OSM) and is intended to mitigate the environmental effects of coal mining, and while it includes programmatic provisions for the minimization of harm to wildlife habitat, only federally listed species are considered in site-specific planning. Additionally, it is widely and acknowledged that economic considerations consistently take precedence over species protections; even in situations where listed species are imperiled by proposed mining operations, mining interests are favored:

> "[I]t has been the [Fish and Wildlife] Service's experience, after dealing with hundreds of mining projects, that in nearly all cases where there is a conflict between endangered species and a mining project, the project is permitted with only minor modifications." – USFWS 1997 pp. 1651

There is no requirement for OSM oversight of post-mining reclamation once a permit has been issued, and though wildlife habitat is cited as the predominant post-mining land use (PMLU) across most coal mining regions, there is little evidence to support the success of these reclamation programs (USGAO 2009).

Further evidence of the inadequacy of current regulation of oil, gas, and mineral extraction is found in the 2005 Energy Policy Act, which contained a provision that exempts all earth-disturbing activities associated with oil and gas development from the Clean Water Act's National Pollutant Discharge and Elimination Systems (NPDES) permit requirements. Since the passage of this exemption, the number of active wells in the Allegheny National Forest has doubled, putting both aquatic and terrestrial species and their habitats at risk (Wildlands CPR 2007).

The Forest Service initiated rulemaking on changes to outdated suitability determinations for oil and natural gas development on Eastern National Forests in the spring of 2009, but little, if any, progress has been made to date on this issue.

Both regulation and enforcement are therefore inconsistent and wholly inadequate to protect sensitive species on split-estate lands.

Anthropogenic disturbance by recreational cavers, researchers, or other visitors to cave habitat during hibernation has been identified as a serious threat to cave-dwelling bat species like *M. leibii* and *M. septentrionalis*, because it causes bats to break torpor and expend energy reserves at the time of year when it is most critical to conserve them. This threat may have a particularly strong effect on juvenile bats (NatureServe 2009). The effects of winter disturbance on bats are amplified by WNS, making the strict protection of hibernacula even more imperative.

The Federal Cave Resources Protection Act of 1988 (16 U.S.C. 4301-4309) regulates activity in caves on federally owned land; the most relevant stipulation in this legislation is the requirement of a permit for the take (destruction, disturbance, or other harm) of any cave "resource", a term which includes all cave fauna. The Act also prohibits the public disclosure of the exact locations of caves deemed "significant" by the Secretary of the relevant department (either DOI or USDA) so as to protect the resources within these caves from disturbance or harm. However, a substantial number (likely the majority) of hibernacula occur on private lands not within the jurisdiction of this protection.

Federal oversight of **wind energy development** is limited: while USFWS may recommend pre- and post-construction surveys, developers are not required to engage in any surveying, monitoring, or mitigation unless a federally listed endangered species is present. Even in cases where listed species are present, oversight is minimal, and enforcement of any regulatory protections generally lax.

A high-quality occurrence of *M. leibii* is located on National Park Service land in Arkansas (Buffalo National River, Graening et al. 2006)

State

State-owned lands comprise approximately 5% of the total land area within the ranges of *M. leibii* and *M. septentrionalis* (see Table 2). General protections afforded to *M. leibii* and *M. septentrionalis* by state legislation are minimal: *M. leibii* is listed as endangered in New Hampshire, threatened in Vermont and Pennsylvania, and as a species of special concern in Connecticut, Massachusetts, Maryland, Missouri, North Carolina, New Jersey, New York, Ohio, Oklahoma, Tennessee, Virginia, West Virginia, and Georgia. *M. septentrionalis* is a candidate for state listing in Pennsylvania and a species of special concern in Missouri and Montana. All of these designations were made prior to the discovery of WNS. While most states within these species' ranges have endangered species legislation, protections thus afforded are narrow. Most state endangered species laws protect against trade or possession of any listed species, but make no provisions against the destruction of habitat, which makes them virtually powerless in shaping any significant conservation measures; even if state-listed species occur on land proposed for development or resource extraction, there is no legal authority to stop such actions on the basis of harm to the species (George and Snape 2010).

Several anthropogenic threats imperil *M. leibii, M. septentrionalis*, and the integrity of their habitats on state lands. Much **oil, gas and mineral extraction** in the Eastern U.S occurs on state lands and is administered by state agencies. The permitting process varies from state to state, but there is no legislation that requires the effects of any resource extractive activity on unlisted species to be assessed or mitigated. Additionally, as previously mentioned, even state-listed species are not conferred any substantive regulatory protection.

As mentioned under Threats (Section VI), the Marcellus Shale, an extensive geological formation rich in natural gas, is expected to become the next major gas play in the Eastern United States in coming years. It is geographically coincident with significant bat habitat, the majority of which is affected by WNS. A large part of the Shale falls within New York's borders, and leases are administered by the state's Department of Environmental Conservation (NYSDEC), which recently released a supplementary general environmental impact statement (SGEIS) on the effects of natural gas extraction, to be used in the administration of new gas leases (NYSDEC 2009a). The assessment of potential effects on wildlife and habitat is cursory at best, and makes no commitment to the mitigation of any anticipated adverse consequences. The evaluation is so brief as to omit the mention of any particular species or groups of concern, and makes only this blanket statement: "Available site-specific options include required setbacks between the disturbance and a habitat or plant community, relocation of a proposed access road or well pad, replanting of cover vegetation in disturbed areas, complete avoidance of specific habitats or endangered plants and seasonal restrictions on specific operations." (NYSDEC 2009a Sec. 6.4).

Within the SGEIS, there is no specific mention of the emergent threat of WNS in the region, no discussion of the potential effects of water withdrawal or injection on cave hydrology or microclimate, no acknowledgement of the disturbing noise pollution inherent to the process of natural gas extraction, and no statement about the potential destruction or degradation of foraging habitats (wetlands and riparian areas) by drilling-related erosion, sedimentation, or pollution. Perhaps most importantly, the SGEIS makes no specifications about where or when mitigation of adverse impacts on species and their habitats will be required, leaving such actions to the discretion of developers.

While state lands comprise a lesser proportion of total land area in most states than federal or private lands, holdings are still significant in many Eastern states (see Table 2), and many state forestlands are managed for **timber production**. Management plans for these lands are highly superficial in their inclusion of any provisions for habitat conservation; only game species seem to warrant specific discussion.

A sampling of state forestry practices gives a good indication of the broader picture of forestry on state-owned lands. While, in some ways, New York is exemplary in its forest conservation practice (both the Adirondack Forest Preserve and Catskill Forest Preserve contain huge "forever wild" acreage), consideration of bat natural history is minimal in the management plans for the state's more than 700,000 acres of state forest: though many regional forest management plans include stipulations for the retention of snags within timber stands, no mention of other bat-oriented habitat preservation criteria exists, though the state hosts globally significant bat populations (see NYSDEC 2009b).

Vermont has 174,000 acres of state forestland, much of which is managed for multiple uses, including timber production (M. Fraysier, pers. comm.). Much of the land that is now state-owned was formerly private and acquired by the state from individual landowners; consequently, most of it was cleared or intensively logged in the past, and current timber management strategies are largely focused on stand improvement (T. McEvoy, pers. comm.). Management plans for these state forests include very general provisions for wildlife habitat conservation, e.g. "Wildlife and Fisheries management activities are directed at protecting and enhancing wildlife habitat for species needing to be conserved as well as those of public interest and utilization." (VT ANR Townsend State Forest LRMP) and the only species to which individual consideration is given are those of economic interest. Massachusetts has 285,000 acres of state forest managed by the Department of Conservation and Recreation (DCR) Management Forestry Program. Between 22 and 29% of DCR forestlands are designated as forest reserves where no commercial forestry is permitted. The Virginia Department of Forestry manages 19 state forests and other state lands, totaling 57,553 acres. The Tennessee Department of Agriculture manages 15 state forests for multiple uses, including timber, but no law mandates the use of best management practices.

Regulatory authority over **wind energy development** is variable both among and within states: in some states, permitting and siting authority is held by state agencies, while others place such decisions within the jurisdiction of county or municipal authorities (e.g., planning or zoning boards) (National Wind Coordinating Committee 2006). In instances where threatened or endangered species are present on proposed wind facility sites, consultation with relevant state or federal wildlife agencies is mandated, but the selection of an alternative site may not be. In most states, siting guidelines are only voluntary and therefore confer no regulatory protection to species of concern (NWCC 2006).

Most states have Cave Protection Acts, which limit the take of cave-dwelling species and prohibit **vandalism**. However, the degree to which these laws are enforced is variable, as reports of vandalism in both public and private caves are common (Trombulak et al. 2001, Southeastern Bat Diversity Network 2007, G. Therres pers. comm.).

Several state-owned caves inhabited by *M. septentrionalis* have been gated in West Virginia, Pennsylvania, and Illinois, and two are protected but not gated in North Carolina (LeGrand 1992, Wilkinson 1992, Garner 1992). This species has legal protection under state law only in North Carolina, where it is listed as a species of special concern, which stipulates only that a permit is required to collect specimens (LeGrand 1992).

Management of WNS

Neither federal nor state agencies have yet taken the cooperative, multilateral action necessary to stop the spread of WNS to new sites and mitigate its effects where it is already present. Relevant to this lack of management, a major scarcity of funding has persisted at great cost to affected bat species.

In September 2009, USFWS issued a draft management plan designed to assist states, federal agencies, and tribes in managing WNS (USFWS 2009a). While is it commendable that USFWS has drafted the beginnings of a plan to manage and mitigate WNS, a review of its contents brings up several significant issues. It is not clear how the actions laid out in this ambitious framework will be implemented with the modest funding appropriated by Congress: the $1.9 million allocated to date is substantially less than the amount scientists testifying at 2009 Congressional hearings stated was necessary for research, management, and mitigation, but a vast improvement from the $500,000 originally appropriated. The recent awarding of $800,000 in grants for research on WNS is also a laudable and important step in managing this crisis, but is likely not sufficient. At this time, efforts seem limited to planning rather than implementation; admittedly, developing methodology to contain and eliminate a disease whose pathology is poorly understood is a major challenge, but the draft plan provides little more than a basic theoretical outline for the management of a disease that has been recognized as an evolving conservation crisis for more than two years. Most importantly, though, management plans such as this do not wield legal authority and therefore cannot be said to constitute regulatory protection for any species. The legally binding regulatory protection afforded by listing under the ESA is essential to the conservation of these bat species affected by WNS.

The USFWS also released a report on the strategic decision-making process undertaken to evaluate options for managing WNS in October 2009 (Szymanski et al. 2009). The report defines three geographic areas with respect to management planning:

Area 1: where WNS is most prevalent and spread has stabilized – all areas north and east of New York, and possibly the northeast corner of Pennsylvania
Area 2: a matrix of affected and unaffected sites at the leading edge of the disease – Pennsylvania, New Jersey, West Virginia, Virginia, eastern Ohio, eastern Tennessee, and eastern Kentucky
Area 3: the area not currently known to be affected but considered susceptible to the disease, >250 mi. from closest affected site

It then outlines numerous alternative management plans, and based on a weighted analysis, recommends a plan for Area 3 that a. places a blanket restriction on cave and mine access to commercial and research purposes only, and b. stipulates that if a site within the Area becomes infected, all access will be prohibited to the site and all caves within 75 miles of the site will be accessible for research purposes only. It also recommends that caves within Areas 1 and 2 remain open for research and commercial purposes. Other management options for Areas 1 and 2 have yet to be evaluated.

While it seems premature to evaluate this report as if it held regulatory authority, the actions outlined within the plan would be inadequate to protect bats affected by or susceptible to WNS if they were to be implemented as they stand for several reasons, but primarily because:

1. Reducing disturbance to hibernacula and possible vectors for infection by WNS is paramount: keeping caves within Areas 1 and 2 open to commercial use seems like an admission that these areas are a total loss for bat conservation; while this may ultimately be true, relinquishing protections now is premature. However, access for research purposes should be maintained. Similarly, keeping caves within Area 3 open to commercial use is an invitation for infection and disturbance of caves that represent refugia for affected bat species. Maintaining access for research purposes, e.g., periodic surveys, seems advisable. Given the implications of recent evidence that *G. destructans* is present in sediment samples from the floors of infected caves for human transmission of WNS (USGS 2009b), closure of all caves to *all* recreational purposes is critical.

2. A comprehensive approach to conserving bat species affected by WNS is essential: the management actions outlined in this report do nothing to protect non-hibernacula habitat in any part of these species' ranges from the numerous threats whose cumulative effect on the availability and quality of habitat is significant. Establishing refugia for populations unaffected by WNS is critical for population recovery.

Regional cave closure orders have been the most substantive regulatory management of WNS to date: in the spring of 2009, the U.S. Forest Service issued an emergency temporary closure order for all caves and mines on USFS lands in the Southern (Region 6) and Eastern (Region 9) regions, which include, respectively: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia; Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, and Wisconsin (USFS 2009a,b). Rationale for this order is given below:

> Federally endangered species are at risk from White-Nose Syndrome. We cannot stop bat-to-bat or bat-to-cave/mine transmission, but we can prevent the human transmission of White-Nose Syndrome to unaffected sites in the rest of the country. (USFS Rationale for Cave Closure Order)

The temporary closures are effective for one year from the date of implementation: from May 21, 2009 – May 21, 2010 in the Southern region and from April 24, 2009 – April 24, 2010 in the Eastern region. As per the USFS Emergency Closure Order, entering or damaging any cave or mine posted closed on National Forest lands is strictly prohibited for the protection of endangered, threatened, or sensitive bat species (36 CFR 261). Violation of these prohibitions is punishable by fines and/or imprisonment under the authority of Title 16 U.S.C. 551, Title 18 U.S.C. 3359 and 3751 (USFS Emergency Closure of All Caves and Mines on National Forest Land in the Eastern Region, April 24, 2009).

Several caves under the National Park Service's jurisdiction have also been closed as a means of protecting bats possibly affected by WNS. Although WNS has not yet been identified in North Carolina or Tennessee, in April 2009 wildlife managers at the Great Smoky Mountains National Park closed all caves within the park indefinitely in response to the threat of WNS (NPS 2009). Buffalo National River in Arkansas also proactively issued closure orders for the majority of its caves in June 2009 (NPS 2009b).

State-level response to WNS has been neither cohesive nor particularly thorough. The USFWS issued an advisory in March of 2009 encouraging all states affected by WNS or adjoining affected states to place a moratorium on caving as a means to halt the spread of the disease (USFWS 2009b). Only West Virginia, Virginia, Pennsylvania, and New York subsequently enacted such a voluntary moratorium. Tennessee state agencies issued a formal closure order effective from July 1, 2009 to May 2010 for all caves on state lands for one year; (Caves.org 2009), the Indiana Department of Natural Resources (DNR), following the protocol used by the Forest Service, proactively closed all but three (commercial) caves and mines on DNR land in October 2009 (INDNR 2009).

VII. CONSERVATION RECOMMENDATIONS

The eastern small-footed and northern long-eared bats should be expeditiously listed as Threatened or Endangered species, and critical habitat designated concurrent with listing. Funding for the continued research, mitigation, and management of WNS should be immediately designated, as this disease poses the greatest immediate threat to the persistence of these two species. If, as it now seems, major populations of *M. leibii* and *M. septentrionalis* are going to be extirpated by WNS, it is essential to these species' persistence that peripheral populations be protected and conserved to the absolute best of managers' ability. Protection of unaffected habitat from infection by WNS and other anthropogenic threats is crucial.

The identification and protection of hibernacula and maternity roosts used by either or both species should be a priority. Foraging habitat nearby should be included in protected areas. Protection and restoration of riparian zones, late-successional forest stands, and snag habitat is critical. Caves and mines perceived as hazardous to public safety should be gated using bat-appropriate methods so as to preserve and protect important habitat.

Management recommendations specific to WNS

Boyles and Willis (2009) suggest two temporary management strategies to preserve WNS-affected bat populations until more permanent solutions are devised or discovered. Based on the understanding that WNS causes death by causing starvation, they suggest that managing bats' energy budgets may provide an intermediate conservation solution and propose two ways in which this could be accomplished: (1) Provide source of energy (food) to hibernating bats (2) Reduce amount of energy needed to survive hibernation by providing thermal refugia within hibernacula. While both of these suggestions seem highly impractical as long-term solutions, it is possible that they could provide short-term support for populations under duress until a more permanent solution is devised.

Additionally, the removal of dead bats from all WNS-affected hibernacula seems highly advisable; decomposing carcasses represent potential sources of infection (WNS or other pathogens) (D. Reeder, pers. comm.).

A comprehensive management strategy for WNS should include the closure of all caves on public lands in states affected by WNS and adjacent states deemed likely to be infected based on an understanding of migratory pathways, the mixing of populations during hibernation and breeding season, and other environmental factors that contribute to the susceptibility of sites to infection by WNS. Removing the potential for anthropogenic contamination of habitat is critical. Strict protocols for decontamination and movement between caves for research purposes should be developed and enforced. Population monitoring should become a priority of the highest order, as an understanding of the temporal and spatial patterns of decline is essential: identifying and protecting both high-risk and more stable populations should be part of a comprehensive management strategy, particularly because most hibernacula host multiple species which may not respond synchronously to infection.

Finally, the additional protections conferred by ESA listing are necessary. Wildlife management agencies have no set precedent for managing an epidemic such as WNS, and while solutions are being developed, the protections conferred by E/T status are vital to the persistence of these affected bat species, *Myotis leibii* and *Myotis septentrionalis*.

VIII. CRITICAL HABITAT

Protecting hibernacula and maternity roosts from disturbance is the highest conservation planning priority; nearby foraging habitat is also essential. A single hibernaculum should not be considered adequate habitat for local bat populations as changes in climate, hydrology, or other environmental conditions may make certain hibernacula more or less suitable in a given year; the availability of alternative habitat is critical to bat survival (NatureServe 2009). Roosting habitat should provide suitable numerous roosts to accommodate roost-switching behavior, and should be located near still water and/or other suitable foraging habitat.

The ESA mandates that when the USFWS lists a species as endangered or threatened, the agency generally must also concurrently designate critical habitat for that species. Section 4(a)(3)(A)(i) of the ESA states that, "to the maximum extent prudent and determinable," the USFWS: shall, concurrently with making a determination . . . that a species is an endangered species or threatened species, designate any habitat of such species which is then considered to be critical habitat . . . . 16 U.S.C. § 1533(a)(3)(A)(i); *see also id.* at § 1533(b)(6)(C). The ESA defines the term "critical habitat" to mean:

i. the specific areas within the geographical area occupied by the species, at the time it is listed . . . on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and ii. specific areas outside the geographical area occupied by the species at the time it is listed . . . upon a determination by the Secretary that such areas are essential for the conservation of the species. *Id.* at § 1532(5)(A).

The Center for Biological Diversity expects that USFWS will comply with this unambiguous mandate and designate critical habitat concurrently with the listing of the eastern small-footed bat and northern long-eared bat.

IX. CONCLUSION

Both the eastern-small footed bat and northern long-eared bat are in danger of extinction or likely to become so in the foreseeable future. Though this danger has yet to be formally acknowledged by most state and federal agencies, the information presented by this petition, particularly the threat posed by WNS, should serve as proof that prompt attention to these species is prudent.

In light of the variety and magnitude of threats to their continued persistence, *Myotis leibii* and *Myotis septentrionalis* are absolutely in need of the protections afforded by the Endangered Species Act.

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XI. ACKNOWLEDGEMENTS

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XII. FIGURES

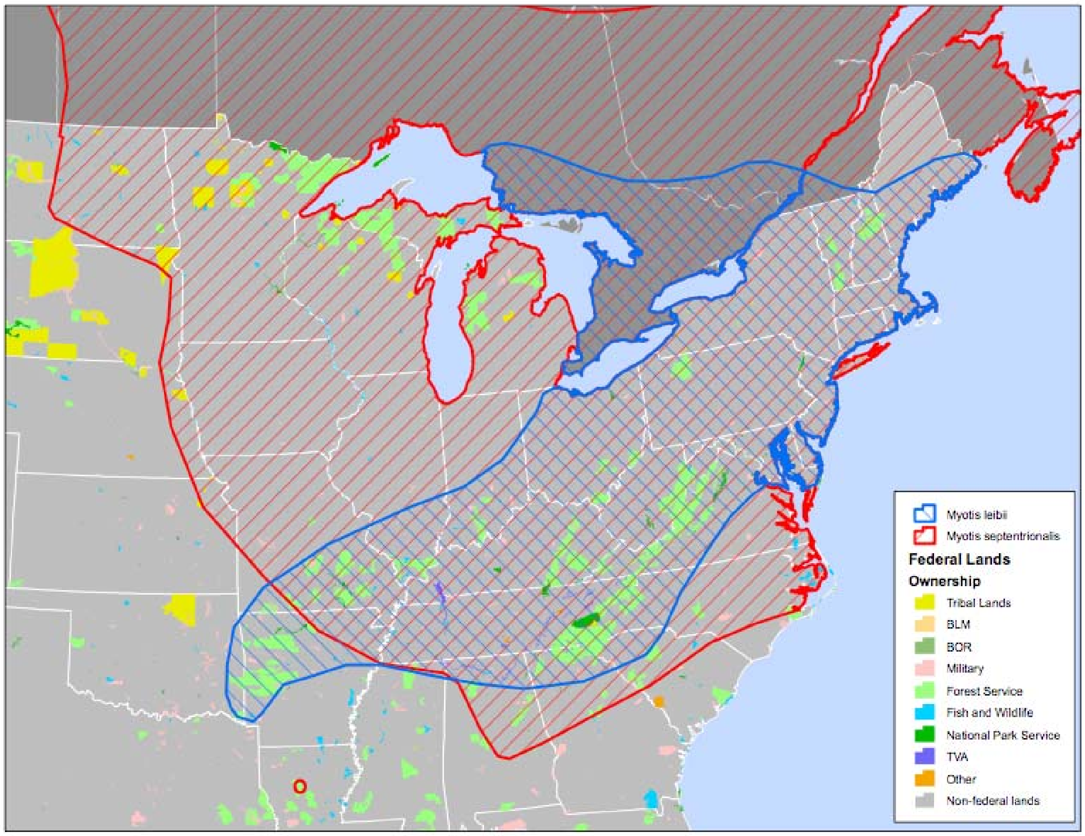

Figure 1. Land ownership within ranges of *Myotis leibii* and *Myotis septentrionalis.* Approximately 90% of the land within the ranges of *M. leibii* and *M. septentrionalis* are privately owned and therefore subject to little, if any, protective environmental regulation. State and federal lands comprise a small fraction of the total land area within these species' ranges; protections on these lands are therefore essential to conservation.

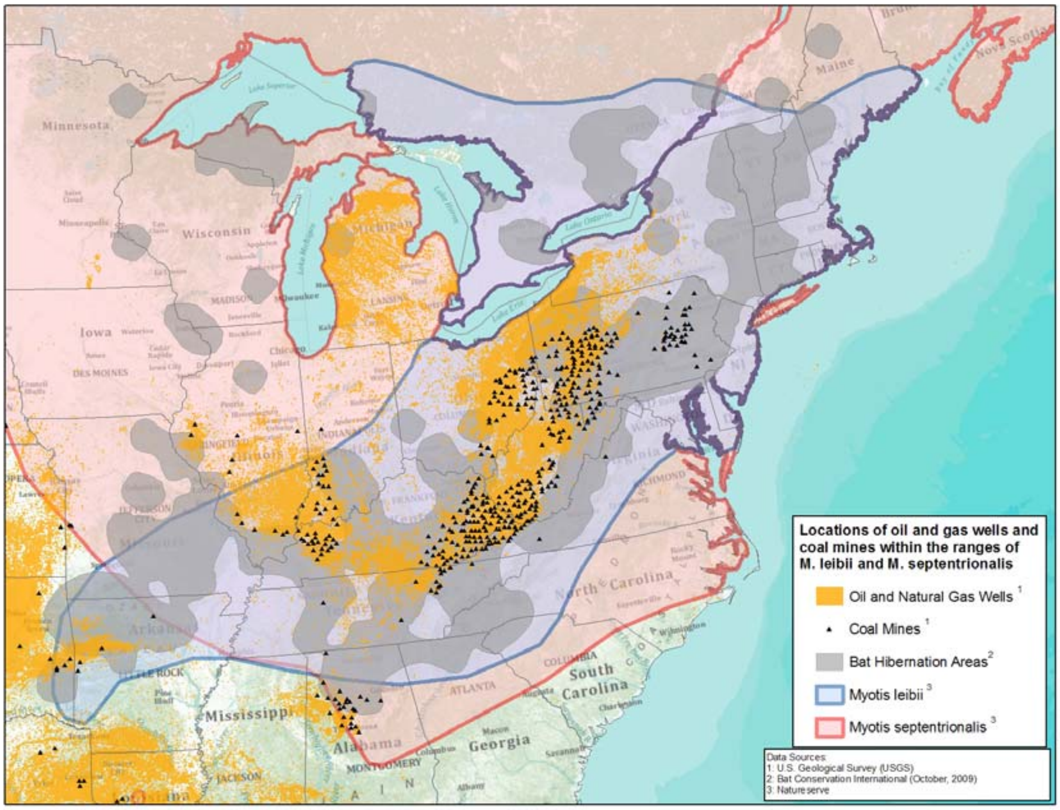

Figure 2. Locations of gas wells and (surface) coal mines within the ranges of *M. leibii* and *M. septentrionalis.* Southern Appalachia has the highest concentration of these industries, and bat populations in this region are expected to be imminently affected by WNS as it spreads; the convergence of habitat loss, disturbance, and disease in this region in particular represents an enormous threat to the persistence of *M. leibii, M. septentrionalis*, and other species.

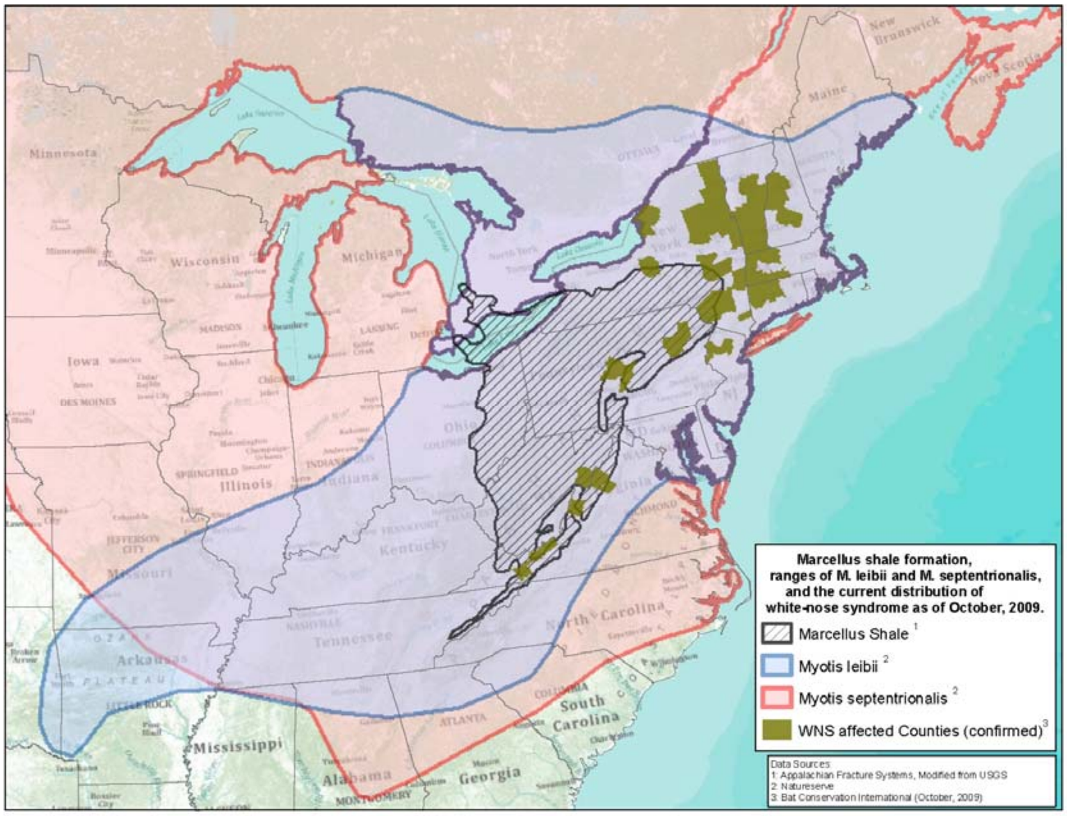

Figure 3. Extent of the Marcellus Shale formation, ranges of *M. leibii* and *M. septentrionalis,* and the current distribution of WNS. Bat populations already compromised by WNS may be unable to tolerate the added stresses of habitat loss and disturbance caused by gas extraction on the Marcellus Shale, which is expected to expand hugely in coming decades.

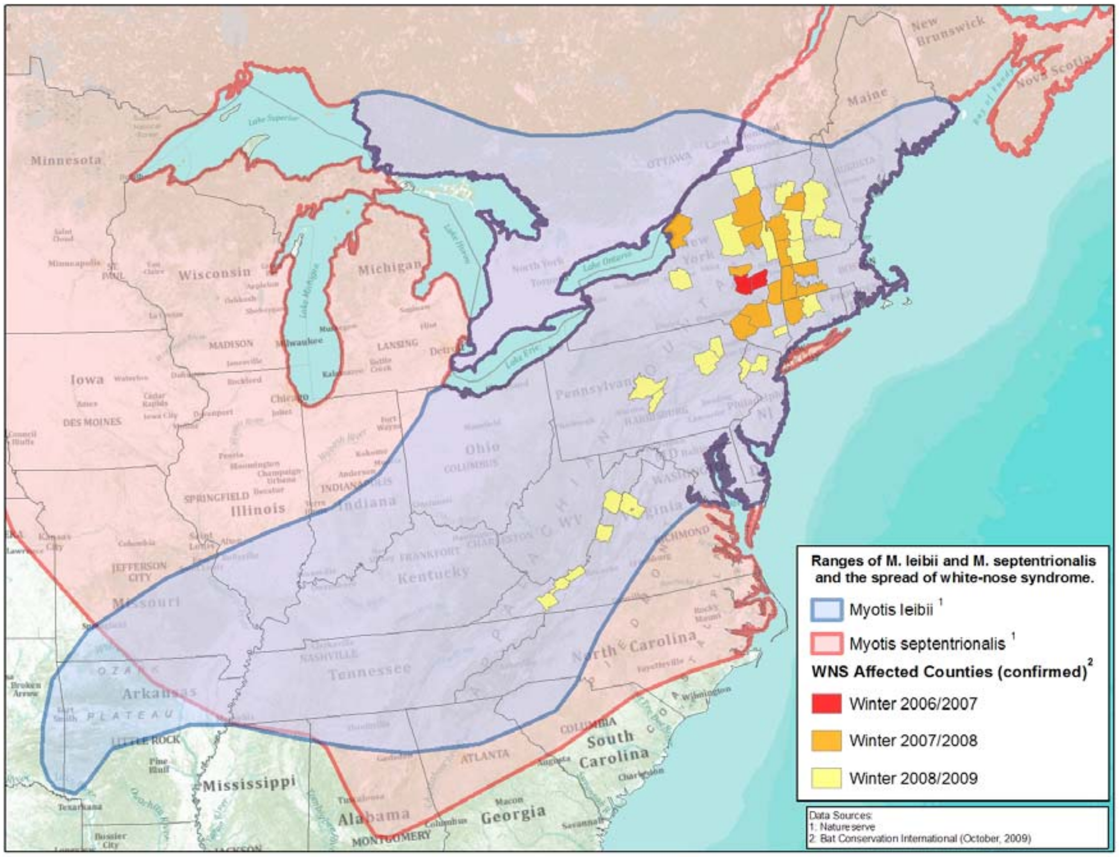

Figure 4. Annual spread of WNS within the ranges of *M. leibii* and *M. septentrionalis*. The disease was first identified in five caves in eastern New York in the winter of 2006-2007, and has since been confirmed in nine states. In the winter of 2007-2008, 38 infected hibernacula were reported within a 125-mile radius of the initial sites of infection, and in 2008-2009, more than 60 affected hibernacula within a 500-mile radius of initial sites were reported (Szymanski et al. 2009). Further spread is expected in the winter of 2009-2010.