Technical Summary and Supporting Information for an Emergency Assessment of the Little Brown Myotis *Myotis lucifugus*

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February 2012

COSEWIC
Committee on the Status of Endangered Wildlife in Canada

COSEPAC
Comité sur la situation des espèces en péril au Canada

Assessment Summary – February 2012

Common name
Little Brown Myotis

Scientific name
Myotis lucifugus

Status
Endangered

Reason for designation
Catastrophic declines and predicted functional extirpation (<1% of existing population) in the northeastern United States will very likely apply to the Canadian population of this species within 3 generations. There have been massive mortality events recorded in New Brunswick in 2011, significant declines in Quebec and Ontario hibernacula, and evidence of flying bats in winter at numerous sites where the White-nose Syndrome (WNS) is known. WNS recorded in 4 Canadian provinces and expanding at average rate range of 200-400km/yr, to date. If the spread of WNS continues at the current rate, the entire Canadian population would likely be impacted within 11-22 years.

Occurrence
Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan, Yukon

Status history
Designated Endangered in an emergency assessment on February 3, 2012.

Executive Summary

Between 5.7 and 6.7 million bats, of several species, but mainly Little Brown Myotis, are estimated to have died in the last 6 years in the northeastern United States and eastern Canada. Mortality associated with White-nose Syndrome (WNS), caused by a fungus likely from Europe, has reduced populations by >75% in infected hibernacula, and the species has been modelled to be functionally extirpated (<1% population) in 16 years in the northeastern U.S. (Frick et al. 2010). There is strong evidence that the same result will occur in the Canadian population of Little Brown Myotis; significant declines and mortality events were recorded in Canada in 2011 and susceptibility to WNS is expected to be similar across Canada.

Population size and trends for the Little Brown Myotis before the arrival of WNS are not known, but they were considered abundant and stable. An average decline of 73% for Little Brown Myotis has been recorded in 115 infected hibernacula in the northeastern U.S. (Frick et al. 2010) within 2 years of infection and 91% for the 54 hibernacula with more than 2 years' exposure to WNS. The mortality rates in infected sites in Ontario, Quebec and New Brunswick are over 80%. It is assumed that the rate of spread and the mortality levels recorded to date will continue westward and impact most of the Canadian population within 20 years.

Imminent decline and threat to the survival of this species is based on results from the northeastern U.S. and eastern Canada and the predicted spread of WNS across the Canadian population in the near future. It is likely that significant declines from WNS could occur across the Canadian range of this once-abundant species within two to three generations.

Technical Summary

Myotis lucifugus
Little Brown Myotis (Little Brown Bat)   Petite chauve-souris brune

Range of occurrence in Canada:
Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan, Yukon

Demographic Information

Generation time. *Range of 3-10 years accounts for mean age of longevity – 1 year for subadult period = 14; mean age of adult females = 10 and data from banding data in Manitoba, which suggests 3 years.*	3-10 years (est.)
Is there an observed continuing decline in number of mature individuals? *Populations considered stable until present, although they receive minimal survey attention.*	Yes, significant declines noted in some sites in last 2 years
Estimated percent of continuing decline in total number of mature individuals within 2 generations (6-20 yrs). *Populations considered stable until present, although they receive minimal survey attention.*	Unknown, but considered high in future
Inferred percent reduction in total number of mature individuals over the last 3 generations (9-30yrs). *Populations were considered stable until WNS, although they receive minimal survey attention.*	Unknown, but likely stable prior to WNS
Projected percent reduction in total number of mature individuals over the next 3 generations (9-30yrs). *Catastrophic decline is predicted in eastern range within 5 years and could occur in remainder of range within 11-22 years, based on mortality data and rate of spread to date.*	At least 90% (assuming continued spread westward and north)
Estimated percent reduction in total number of mature individuals over 3 generations, over a time period including both the past and the future.	At least 90% (assuming continued spread westward and north)
Are the causes of the decline clearly reversible and understood and ceased? *WNS is cause of mortality but absent of any remedy it is expected to continue; spores persist in cave environments*	Understood, but not ceased, nor currently reversible
Are there extreme fluctuations in number of mature individuals? *Variation in individual hibernacula recorded but extreme fluctuations not evident for any known populations.*	Unknown, but not likely

Extent and Occupancy Information

Estimated extent of occurrence. Newfoundland to British Columbia, north to Yukon and NWT, edge of range in Nunavut	Well over 20,000km^2
Index of area of occupancy (IAO) (Always report 2x2 grid value). *Hibernacula and maternity roosts historically reused specific locations but summer foraging is over entire range*	Well over 2,000km^2
Is the total population severely fragmented? *Range is contiguous (with possible exception of the Island of Newfoundland)*	No
Number of locations* *1 location, based on WNS as an all-encompassing threatening event.*	1
Is there an observed continuing decline in extent of occurrence? *Predictions are based largely on mortality data from northeastern U.S.*	Not yet but predicted over next 3 generations
Is there an observed continuing decline in index of area of occupancy? *Predictions are based largely on mortality data from northeastern U.S.*	Not yet, but predicted over next 3 generations
Is there an observed continuing decline in number of populations? *Predictions are based largely on mortality data from northeastern U.S.*	Not yet, but predicted over next 3 generations
Is there an observed continuing decline in number of locations*? *Canadian population exists as 1 location*	No
Is there an observed continuing decline in area of habitat? *Hibernacula are habitats critical for population sustainability; WNS appears to turn sites into mortality sinks. Declines recorded in some hibernacula, and may have occurred in others.*	Yes
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*? *Canadian population exists as 1 location*	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

* See Definitions and Abbreviations on COSEWIC website, IUCN 2010 for more information on this term.

Number of Mature Individuals (in each population)

Population	**N Mature Individuals (estimated minimum)**
Unknown, considered common across its range in Canada, but possibly less abundant in western and northern Canada. Estimates of 6.5 million in northeastern U.S. (Frick *et al*. 2010) also suggest that Canada's population would number in the millions.	
Total	Unknown: several millions

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years]. *Model predictions (Frick* et al*. 2010, for species in northeastern U.S. and based on 30 years pre-WNS data and 4 years of documented declines since WNS) predict 99% probability of 'regional extinction' within 16 years. If WNS spreads at current rate (range: 200-400km/yr), it could occur across Canada within 11-22 years, approaching the estimated range of 5 generations (15-50 years).*	Probability is 99% in northeastern U.S. Similar result expected for central and eastern Canada. If rate of spread continues westward, probability of extinction would be similar.

Threats (actual or imminent, to populations or habitats)

White-nose Syndrome is caused by a fungal pathogen (*Geomyces destructans*) that likely arrived from Europe and was first recorded in North America in 2006, and 2010 in Canada. All Myotid species that hibernate in cold, damp conditions are vulnerable. After more than 2 years of exposure, average mortality in 54 infected hibernacula averaged 91% in northeastern United States. Similar results are now occurring in Canada; 92% decline in 8 Ontario hibernacula, declines of mortality during winter 2011 was 94% and 99% in 2 New Brunswick and Quebec caves, respectively. Autumn mixing of bats results in likely spread to all hibernacula. Rate of spread averages 200-400km/yr, to date.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)?	
Is immigration known or possible? *Little Brown Myotis are mobile and some individuals undertake movements of 200-300 km between seasons and hibernacula.*	Likely
Would immigrants be adapted to survive in Canada? *Climate and food sources are similar to American conditions but any immigrants would not be adapted to* Geomyces destructans*.*	Yes/No

Is there sufficient habitat for immigrants in Canada? *Roosts and food are not thought to be limiting but hibernacula infected with* Geomyces destructans *would become population sinks.*	No
Is rescue from outside populations likely? *Except for a population in Alaska, populations only exist south of Canada and they have been near extirpated in northeastern U.S. states; populations in western United States and Alaska predicted to be significantly reduced within 3 generations and unlikely able to recolonize Canadian population.*	No

Current Status

COSEWIC: Not assessed. Considered abundant throughout most of range. Assessment for endangered status is being prepared in the United States.

STATUS SUMMARY:

Status and Reasons for Designation

Status: Endangered	**Alpha-numeric code:** A3bce+4bce; E
Reasons for designation: Catastrophic declines and predicted functional extirpation (<1% of existing population) in the northeastern United States will very likely apply to the Canadian population of this species within 3 generations. There have been massive mortality events recorded in New Brunswick in 2011, significant declines in Quebec and Ontario hibernacula, and evidence of flying bats in winter at numerous sites where White-nose Syndrome (WNS) is known. WNS recorded in 4 Canadian provinces and expanding at average rate range of 200-400km/yr, to date. If the spread of WNS continues at the current rate, the entire Canadian population would likely be impacted within 11-22 years.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals):

Meets A3b,c,e: COSEWIC criterion of ‘projected reduction in total number of mature individuals is >50% over 3 generations’ is projected or suspected to be met because we expect nearly 100% of hibernacula will be affected in <22 years (3 generations is 9-30 years), and likely at near 100% mortality. This projection is based on evidence of WNS in Canada (multiple sites with declines >90% in 3 provinces), documented declines averaging 91% in 54 infected hibernacula in 5 nearby U.S. states after 2 years of exposure, and 73% average decline in all infected hibernacula of northeastern U.S. after 1 year of exposure.

Meets A3b because the number of mature individuals is projected to decline by over 90% over the next 3 generations based on the current rates of mortality recorded in 54 infected hibernacula in the U.S. after 2 years of exposure. Similar patterns are being documented in eastern Canada and hibernacula across Canada are expected to be affected in 3 generations, given a continued rate of spread of 200-400km/year.

Meets A3c because the EO and IAO are projected to decline by more than 50% over the next 3 generations as populations are extirpated following the spread of the disease. Bats were extirpated from 12 of 54 (22%) hibernacula in the northeastern U.S. by 2010, 5 years after the discovery of WNS.

Meets A3e because *Geomyces destructans*, the cause of WNS, is believed to be an introduced pathogen from Europe and is responsible for population declines of over 90% in hibernacula within two years of infection.

Meets A4b,c,e because impact of WNS at present, combined with future predictions exceeds 50%, and reduction or cause may not cease and may not be reversible, given lack of remedy (see rationale for b,c,e above).

Criterion B (Small Distribution Range and Decline or Fluctuation): not applicable

Criterion C (Small and Declining Number of Mature Individuals): not applicable

Criterion D (Very Small or Restricted Total Population): not applicable

Criterion E (Quantitative Analysis):

The COSEWIC criterion of minimum 20% probability of extinction within 20 years or 5 generations is met because results from nearby and similar regions have modelled regional extinction of this species within 20 years at 99% probability. This species is predicted to be impacted across the Canadian range before the 5-generation (15-50 years) threshold.

Emergency Assessment – Little Brown Myotis

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Context for the report

The *Species at Risk Act* and Section 5.5 of the Operations and Procedures Manual for COSEWIC contains the context of an emergency assessment. The following report outlines evidence of the serious decline in the population of the Little Brown Myotis that results in an imminent threat to their survival.

Overview of the species and evidence of threat to survival

The Little Brown Myotis (*Myotis lucifugus*) (also called Little Brown Bat) is a common, insect-eating bat found throughout much of Canada and the United States (Fig. 1). Approximately 50% of its global range is in Canada, and it occurs in every province and territory. The Little Brown Myotis is believed to be the most common bat in Canada. Due to its being relatively common and widespread, limited effort has been made to determine overall population size. Information on overwintering sites (hibernacula) are generally well known in central and eastern Canada, but less so in western Canada.

Small-bodied bat species that winter in caves or mines are dying from White-nose Syndrome (WNS), caused by a fungus, *Geomyces destructans* (*Gd*), that is hypothesized to have originated in Europe (Pikula *et al*. 2012, Turner *et al*. 2011), and was first detected in North America in 2006 (Lorch *et al*. 2011). The fungus grows in humid, cold environments, typical of caves where bats hibernate (Blehert *et al*. 2009). Mortality during winter is hypothesized to be caused by starvation through excessive activity; insect-eating bats that would normally hibernate become active, dehydrated and hungry because of infection from the fungus that grows on them while their body temperature (Turner *et al*. 2011) and immunity (Carey *et al*. 2003) is low. The bats leave the caves in search of food and water but die outside, or at the hibernacula entrance. Physiological processes associated with hydration, and damage to wings, may also be related to mortality (Cryan *et al*. 2010).

The Little Brown Myotis is predicted to be functionally extirpated (i.e. <1% of existing population) in the northeastern United States within 16 years (Frick *et al*. 2010). An estimated 1 million bats died in the northeastern U.S. within 3 years of WNS arrival (Kunz and Tuttle 2009). A recent mortality estimate of 5.7-6.7 million bats within 6 years of WNS arrival was made by the WNS management team in the United States (U.S. Fish and Wildlife Service news release; January 17, 2012). Mortality results to date support the predictions in the Frick *et al*. (2010) model (Turner *et al*. 2011).

The populations of affected species are not expected to recover quickly because bats, typically, have slow population growth rates. Mortality is high in yearlings while adults are long-lived and only produce 1 young every year or two. Such a life-history strategy heightens the vulnerability of these bat species to high adult mortality rates. Experience from the U.S. indicates significant declines often occur in the second year after first detection (Turner *et al*. 2011) and thus we emphasize data with > 1yr post-exposure in this report. Population declines in infected areas (much of the northeastern United States) have been catastrophic. Average declines in the 54 hibernacula in 5 northeastern U.S. states after 2 years exposure to WNS is 91% for Little Brown Myotis (Table 1; Turner *et al*. 2011). Twelve of 54 sites declined to 0 bats. As of 2011, WNS has been recorded in 190 hibernacula in 16 states and 4 provinces. The same results are occurring in Canada where WNS has been reported for > 2 years (see details below).

Recent Canadian data

In eastern Ontario, 8 hibernacula are being monitored for changes in abundance; all had significant declines after 1 year of exposure to WNS, with average decline of 30%. After 2 years of exposure, the average decline was 92% (Table 2). Additional hibernacula are being identified but monitoring for WNS often is restricted to searching for flying bats or carcasses near the entrance, and % declines cannot be calculated from these data.

In Quebec, 5 hibernacula are being monitored relative to WNS using laser counters at the hibernacula entrance. In autumn 2011, one hibernaculum (Mine-aux-Pipistrelles, in southern Quebec near the U.S. border and the closest site to the origin of WNS) had a decrease from >5000 to 8 bats (min. 99% decline), concurrent with hundreds of dead bats on the ground (Mainguy and Desrosiers 2011). Ninety percent of the bats in the hibernaculum were Little Brown Myotis. Ten other sites are monitored by observation but access and quality of survey results varies; 1 site (Emerald Mine) recorded signs of WNS and “many” dead bats in February 2010.

In New Brunswick, 11 sites have been monitored for WNS in 2010-12. The first record of WNS was in March 2011 when over 80% of 6000 bats in Berryton Cave died in 1 month (McAlpine *et al*. in press). A total of 350 bats were counted in December 2011, a 94% decline over 2 years. A sample of 357 dead bats from the 2011 event contained 91% Little Brown Myotis (D. McAlpine, pers. comm.). WNS was recorded in an additional 3 sites in December 2011.

In Nova Scotia, permission to enter caves is restricted and surveys have been limited to winter-time visits to the entrance of caves, collecting dead bats, and reports from the public of bats flying during winter. Carcasses are submitted to veterinary pathologists, who have confirmed *Gd*.

As of autumn 2011, WNS has not been recorded in Prince Edward Island or Newfoundland, or west of Ontario.

Recent summer data

Data from summer are sporadic and systematic acoustic monitoring has only recently begun in many jurisdictions. Where available, summer data indicate similar declines as reported during winter. Therefore, it is unlikely that empty hibernacula during winter indicate bats have simply moved to new and unsurveyed sites. Monitoring results from surveys of summer maternity colonies of Little Brown Myotis in Massachusetts indicate declines of >70% in the last 3 years (Gillman *et al*. 2011; unpub. data) and correspond to average declines for bats based on winter data (Brooks 2011). In Virginia, captures at 5-6 autumn swarm sites declined from early-WNS levels of 14 Little Brown Myotis captures per site to approximately 2 bats per site in 2011 (Fig. 4) (Rick Reynolds, pers. comm., unpublished data; Virginia State Biologist).

In Ontario, 5 maternity colony sites are monitored; 4 sites declined for an average decline of 71% in 2011 (Table 3). Summer data from maternity colonies on population size or trends are not available for Quebec or the Maritimes.

Imminent threat to survival

An imminent threat to the survival of this species is based on three assumptions: a) the expectation that mortality results from the northeastern United States will apply to the Canadian population; b) that there is a high probability that mortality from WNS will rapidly spread to all hibernacula in the Canadian range; and c) there is no likelihood of rescue effect.

a) Application of U.S. results to Canada

The outbreak of WNS occurred first in the northeastern U.S. and more data are available for this population on the effects of WNS after multiple years. Also, hibernacula were generally better monitored and population trends more known in the U.S., which facilitated population modelling of WNS impacts. Mortality rates recorded in the U.S. are expected for Canadian populations because hibernacula conditions, such as temperature and humidity, are similar and fall within the range of *Gd* growing conditions. There likely is movement of some bats between the two countries and no genetic differences are expected between bats in the northeastern U.S. and Canada. As such, there is no reason to expect increased resistance within Canadian bats and results from the northeastern U.S., including the population model, mortality rates, and rate of spread should be similar.

b) Rate of spread

White-nose Syndrome was first recorded 6 years ago (February 2006) in a cave near Albany, New York (Frick *et al*. 2010, Fig. 2). It has spread at a rate of approx. 200-400km per year, reaching Ontario and Quebec in 2010, and New Brunswick and Nova Scotia in 2011 (Fig. 1, 2). Straight-line distance of WNS spread from the epicentre at Albany, NY to the farthest site (Missouri) from 2006-2011 was approximately 1000km, a rate of 200km/yr. A recent case from Oklahoma is 2200km from the epicentre (440km/yr) (Turner *et al*. 2011, Fig. 1, 2). In Canada, the rate to New Brunswick was 200km/yr, and from the epicentre to the farthest western site to date (Wawa, Ontario) was 250km/yr. The average rate of spread appears to range between 200-400km/yr. The distance from the epicentre to the first site in Ontario (Cochrane) was 1000km, which may indicate WNS can spread in large leaps, either by bat migrations or human movement, or that WNS was already present in Ontario sites closer to Albany.

The vector for transmission is believed to be bats that have been in contact with conidia of infected bats or walls of hibernacula, and people visiting caves. An unknown proportion of Little Brown Myotis move hundreds of kilometres between their summer and winter ranges. Swarming behaviour in August and September is likely a main mechanism for *Gd* transfer between subpopulations. Swarming behaviour shows young where to go to hibernate and also heralds the start of the mating season. Extensive bat-to-bat contact during swarming is believed to be instrumental in the spread of WNS (B. Fenton, pers. comm.). Bats have been recorded swarming at one site but hibernating in another (Humphrey and Cope 1976), potentially transmitting spores between sites (Turner *et al*. 2011).

WNS is expected to continue spreading throughout Canada and the western United States because most caves and mines used by bats have similar conditions. Based on *Gd* growing conditions (minimum and maximum temperatures in hibernacula, and the relationship of temperature and lipid reserves in Little Brown Myotis) (Hallam and Federico 2011), it is predicted that much of the United States has the conditions for WNS, and assuming spread between colonies will occur as it has in eastern North America, much of the area will be impacted by WNS by 2018 (Fig. 3). The predictive map was not made for Canada but similar hibernacula conditions in Canada would suggest similar potential for WNS as shown in the U.S. map (Fig. 3).

It has been suggested that the rate of spread may not be as fast in western Canada because colonies are more dispersed than in the east (C. Willis, pers. comm. 2012). There are no data to accept, or refute, this statement because so little is known on hibernacula in western regions of Canada, and the dynamics of transmission of WNS across different densities of bats is unknown. From what we know to date, WNS impacts colonies of different density: it appears to be first detected in a large hibernaculum, and then is found in adjacent hibernacula containing fewer bats. If we use the recorded average rate of spread (200-400km/yr), and assume it will continue at this rate, WNS will occur on the west coast of North America within 11-22 years. Additionally, the WNS site in Oklahoma is 500km from the Rocky Mountains, and it is possible that WNS will move northward into Canada via the Rocky Mountains, instead of crossing the Canadian prairies.

There also is the strong possibility that WNS will reach western populations faster than predicted based on the movement of bats. The discovery of *Gd* in North America was at a cave that has high human visitation. It is suspected that *Gd* was accidently brought to North America by tourists who had visited caves in Europe (Turner *et al*. 2011). There is concern that *Gd* will be transmitted to western hibernacula by tourists or spelunkers who visit multiple sites.

In conclusion, the dynamics of movement in bats is not well understood and there may be differences in spread of WNS among the Rocky Mountain region, but there is strong evidence that WNS will continue to spread and be as catastrophic in the western region as it has to date in eastern North America. The precautionary principle would suggest that the observed rate of spread could be assumed to apply from eastern to western Canada.

c) Potential for refugia and rescue effect

There is no expectation of a rescue effect. Except for a relatively small population in Alaska, the Canadian population of Little Brown Myotis is at the northern edge of its geographic range (Fig. 1) and therefore any rescue would mostly come from southern populations in the United States. High mortality rates associated with WNS have occurred in the regions south of Canada and populations are so reduced that immigration north into Canada is very unlikely.

Southern regions in the United States, and possibly coastal areas, where it is warmer and bats need fewer lipid reserves, may not be susceptible to WNS (Fig. 3). However, *Gd* spores have been recorded in soil in hibernacula (Lindner *et al*. 2011) and it is likely that any populations expanding northward would be impacted by WNS when they use hibernacula in Canada.

There is no expectation that western populations of Little Brown Myotis will be immune to WNS, further precluding the possibility of rescue effect for eastern bats. Bats in northern hibernacula (i.e. Northwest Territories) hibernate in relatively colder conditions (1-2˚C) (S. Carrierre, pers. comm. Jan. 2012) and may be less susceptible to WNS because *Gd* does not grow as well at that temperature (Gargas *et al*. 2009). However, numbers of bats in these conditions would be a small percentage of the Canadian population, and thus would not offset massive declines. Also, any northern populations expanding into the south would be susceptible to persistent spores within southern hibernacula.

Hope for any recovery of the species is based on the likelihood that some small percentage of the population will be resistant to the effects of *Gd*. These survivors would pass on this resistance to their offspring and populations would increase. It is believed that such a situation occurred in Europe because several species of bats get WNS, but mortality levels are low (Turner *et al*. 2011).

There is evidence that some individuals exposed to WNS can survive, based on laboratory (Meteyer *et al*. 2011) and banding studies (Dobony *et al*. 2011). In the Dobony study, in Fort Drum, New York, a small number (i.e. <20) of Little Brown Myotis were captured in summer showing evidence of WNS-related wing damage and then recaptured the following year. Five females were recaptured after two years, and with lactation noted in some females, there is evidence of possible reproduction in some animals. One cave in New York has had a population of 1,000 bats for 4 continuous years, suggesting stabilization (Turner *et al*. 2011). These results suggest hope for recovery. It is noted, however, that declines at these sites were 88% (Ft. Drum) and 93% (New York) and apparent stability at some hibernacula may be due to movements of uninfected bats from other areas, and that lactation does not mean that pups survived if adults are physiologically stressed (Dobony *et al*. 2011).

Factors related to specific COSEWIC criteria

Generation time

Generation time in the COSEWIC guidelines is based on the mean age of the breeding population. The average breeding age of Little Brown Myotis is not known, but they start breeding after one year, continue breeding annually and have been recorded to live over 30 years (Fenton and Barclay 1980). The mean age of breeding animals likely is near 10 years for Little Brown Myotis.

However, data from 22 years of banding of Little Brown Myotis in Manitoba were analyzed for this report by Craig Willis and he recommends a shorter generation period. Dr. Willis writes: “based on our data 5 years would be a very generous average. Over the 22 year period, folks have been collecting banding data in Manitoba and NW Ontario, the mean ± SD from capture (before 2000) to last recapture is 3.04 ± 2.85 years (n = 1,386 recaptures between 1989 and 2011). In other words, after about 3 years on average, they disappear. We occasionally get a bat or two close to 20 but they are exceedingly rare.” (Craig Willis, pers. comm. January 2012). Similar conclusions on generation time could not be found in the literature and the results from Manitoba constitute a single study; however, the sample size is robust and suggests that the generation time is likely less than 10 years for this species. As a compromise, generation time in this report is given as a range of 3-10 years.

COSEWIC criteria use 3 generations, thus the time period over which declines must be calculated is 9-30 years for Little Brown Myotis.

Limits of census data

Several COSEWIC criteria rely on population trend information. Estimates on the number or percent of bat mortality in Canada are severely limited because of little survey effort. Little Brown Myotis are abundant and widespread; as such, they have not been a priority for surveys. In addition, bats are inherently difficult to survey.

Overwintering sites are critical to their survival but we do not know all the caves that contain bats, or the number of bats within these caves, especially in larger provinces of Ontario and Quebec. Systematic acoustic surveys have begun in some jurisdictions, but it is unclear if some areas have already been impacted by WNS before the survey. In the end, however, the lack of summer acoustic data should not preclude an emergency assessment because WNS is already present in the jurisdictions, and population declines that occurred in the U.S. will likely occur in Canada, if they have not already.

Threat and number of locations

The Little Brown Myotis population in Canada would comprise a single location because the fungus is most likely an invasive, exotic pathogen impacting a naive population. Hibernacula conditions are similar across the range of Little Brown Myotis and mortality rates are predicted to be the same for the entire population. WNS impacts many Myotid species (Turner *et al*. 2011), and since the genetic variation between species of Myotis is greater than that within the species itself, it is unlikely that any genetic-based differences in the Canadian population would provide resistance.

Designatable units

Little Brown Myotis in Canada comprise a single designatable unit. The distribution of Little Brown Myotis in Canada is continuous and there is no known significant genetic or other differentiation within the species' range to warrant separate designatable unit status.

Acknowledgements

This overview was written with input from numerous people involved with bats and White-nose Syndrome in North America, and was, in part facilitated by discussion during the recent North American Bat Research Conference in Toronto (October 2011). The author wishes to thank everyone and, in particular, to Al Hicks, Lesley Hale, Simon Dodsworth, Jeremy Coleman, Krishna Gifford, Brock Fenton, Mark Brigham, Hugh Broders, Jeff Bowman, Mark Elderkin, Justina Ray, Don McAlpine, Karen Vanderwolf, Carl Herzog, Rick Reynolds, Craig Stihler, Calvin Butchkowski, Eric Britzke, Emily Brunkhurst, Erin Fraser, Julien Mainguy, Tom Hallam.

The report was reviewed by bat and WNS specialists Jeremy Coleman, Brock Fenton, Mark Brigham, Ian Barker, Hugh Broders, and Craig Willis, as well as members of the COSEWIC Terrestrial Mammals Subcommittee and the Emergency Assessment on Bats Subcommittee.

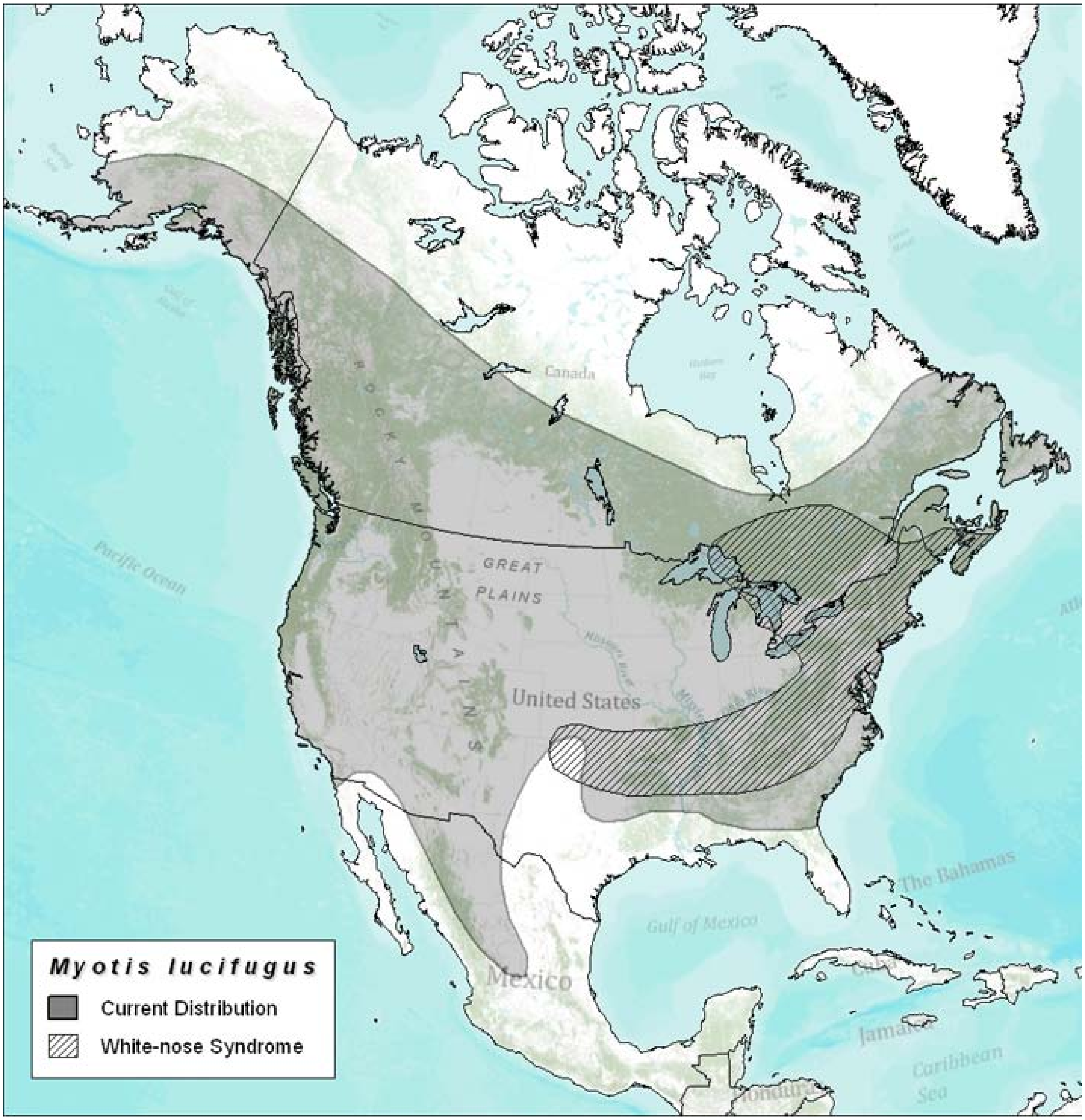

Figure 1. Approximate distribution of the Little Brown Myotis and White-nose Syndrome, as of October 2011. Distribution based on Van Zyll de Jong (1985) and National Wildlife Health Centre; http://www.nwhc.usgs.gov/disease _ information/white-nose_syndrome/) (Map created by J. Wu, COSEWIC Secretariat.)

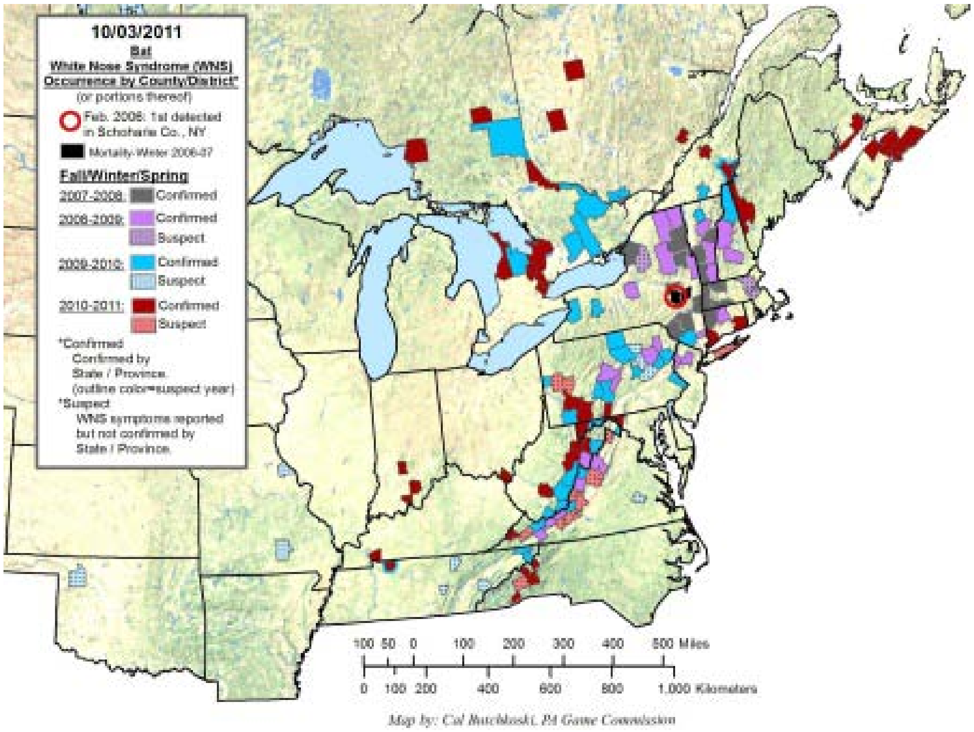

Figure 2. Location of confirmed and suspected cases of White-nose Syndrome in North America as of October 2011. First record was in Albany, New York (shown as a circle) in 2006. The suspected case in Oklahoma is >2000km from epicentre. Source: National Wildlife Health Centre; http://www.nwhc.usgs.gov/disease_information/white-nose_syndrome/.

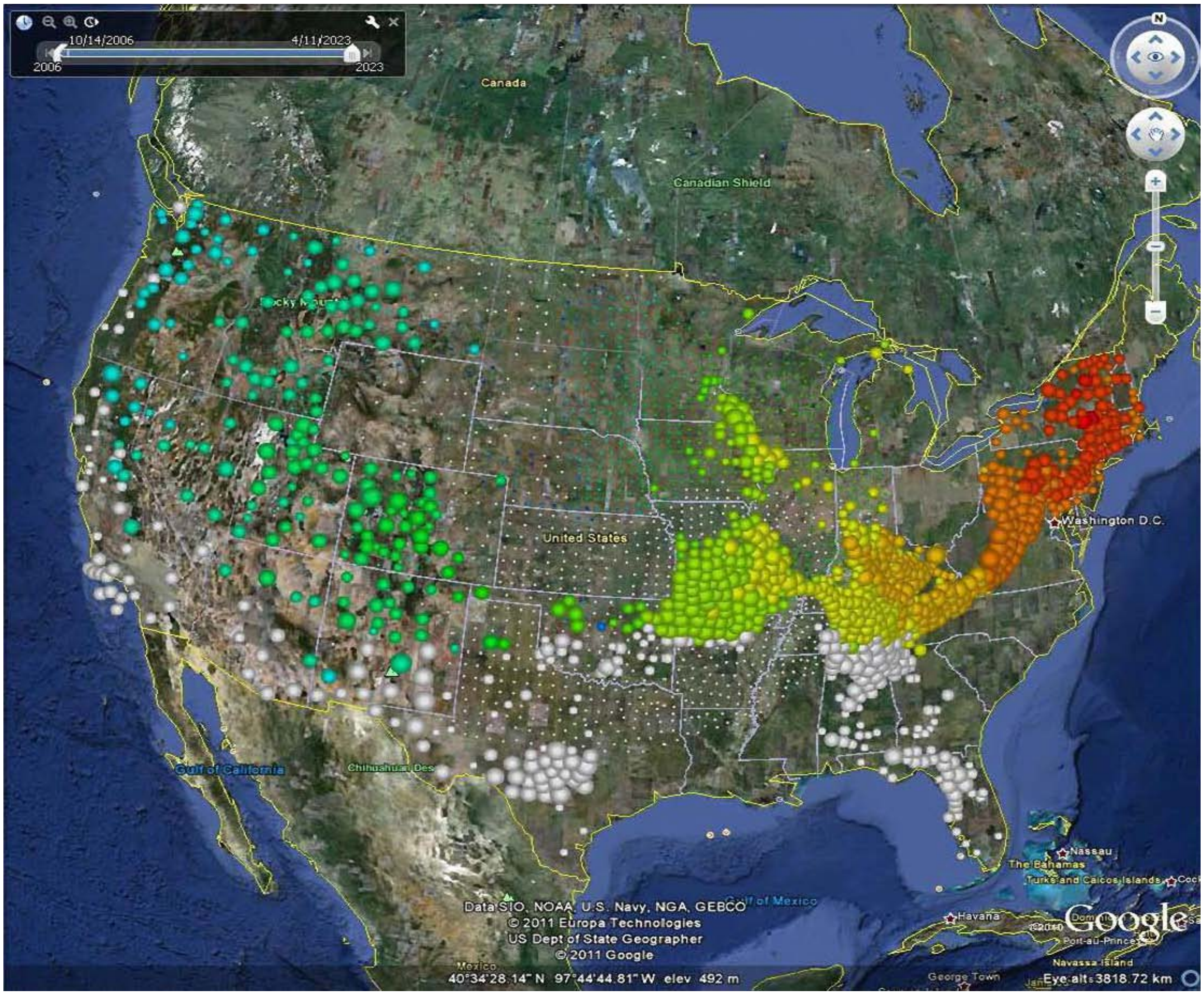

Figure 3. Baseline simulation of the epizootic dispersal based on minimum and maximum temperatures in hibernacula and lipid reserves in Little Brown Myotis. The projected epizootic wave throughout the U.S. study area as determined by 1000 simulations. The dynamic evolution of the epizootic wave of *Gd*-affected hibernacula for the stochastic resolution of the suite of 1000 simulations is indicated. The projected years of the *Gd*-affection occur according to the colour scheme: red shades, 2007-08; dark orange shades, 2008-09; light orange shades, 2009-10; yellow shades, 2010-11; light green shades, 2011-12; medium green shades, 2012-13; darker green shades starting in Oklahoma, 2013-14; additional dark green shades, 2014-15; light blue shades, 2015-2016; dark blue, 2016-17; purple, 2017-2018. White represents caves that are unaffected during the 15-year simulation. The size of the circle is indicative of the size of the colony in the cave. Image was created from Google Earth. Map supplied by Tom Hallam (University of Tennessee, Knoxville) in association with publication: Hallam and Federico (2011).

Table 1. Change in Little Brown Myotis (*Myotis lucifugus*) population counts at winter hibernacula with a minimum of 2 years' exposure to White-nose Syndrome in 5 states of the northeastern United States. Adapted from Turner *et al*. (2011).

State (# sites)	Pre-WNS #	# >2 yrs Post-WNS	% Difference	# Sites to 0 bats
New York (38)	326867	28890	-91	10
Pennsylvania (6)	14229	198	-99	1
Vermont (5)	1943	114	-94	1
Virginia (2)	4844	1032	-79	0
West Virginia (3)	394	26	-93	0
Totals (54)	**348277**	**30260**	**-91**	**12**

Table 2. Changes in abundance estimates for bats using hibernacula (caves or mines) in Ontario. The majority of bats are Little Brown Myotis, but sites also include Northern Myotis and Tri-colored Bat. Average decline is 92% in sites with >2 years of post-WNS exposure. Information courtesy of Ontario Ministry of Natural Resources.

Site Name	Individuals Counted and Date Count Completed			Percent Change 2009 to 2010	Percent Change 2010 to 2011	Total Percent Change
	2009	2010	2011			
Craigmont	30,461 November 2, 2009	24,837 November 1, 2010	1,457 October 24, 2011	-18%	-94%	-95%
Hunt (Renfrew)	14,378 October 20, 2009	7,005 November 7, 2010	2,638 November 5, 2011	-51%	-62%	-82%
Crystal Lake	725 Fall? 2009	539 November 29, 2010	10 November 4, 2011	-26%	-98%	-99%
Croft*	N/A	3000+ October 2, 2010	1,537 November 4, 2011	N/A	-49%+	-49%+
Silver Crater	N/A	251 November 29, 2010	29 November 4, 2011	N/A	-89%	-89%
MacDonald	N/A	21 November 23, 2010	0 November 4, 2011	N/A	-100%	-100%
Watson	N/A	96 November 23, 2010	0 November 4, 2011	N/A	-100%	-100%
Clyde Forks	N/A	117 November 30, 2010	7 November 2, 2011	N/A	-94%	-94%

*Croft population estimate in 2010 was only completed in a portion of the mine (approximately 50% chamber length counted)

Notes:

1. All sites are known to be infected with *Geomyces destructans* either through lab testing or visual observation. Abundant mortality has not been documented at any of the sites although small numbers have been recorded. None of these sites are monitored frequently enough in the winter to observe abundant mortality episodes; however, a notable decline in population is evident at all sites.

2. WNS was first visually observed in Craigmont Mine during the 2008-2009 season. It was documented during a site visit on May 6, 2011. The 2009 population estimate is indicative of the pre-population estimates periodically recorded at Craigmont and Hunt Mines. WNS was confirmed by CCWHC through lab results in Craigmont and Hunt Mine in 2009-2010 season.

Table 3. Change in population estimates in 5 maternity roost sites in eastern Ontario. The majority of bats are Little Brown Myotis, but sites also include Northern Myotis and Tri-colored Bat. Average decline is 71%. Data courtesy of Ontario Ministry of Natural Resources.

Site Name	Year				Percent Change
	Late May 2010	Mid-July 2010	Late May 2011	Mid-July 2011	
Springtown Church		500+		53	-89%
Foy Road Church		67		75	+12%
Burnstown Church		400		58	-86%
Cameron Farms	57		52		-9%
Petawawa Church		81		78	-4%

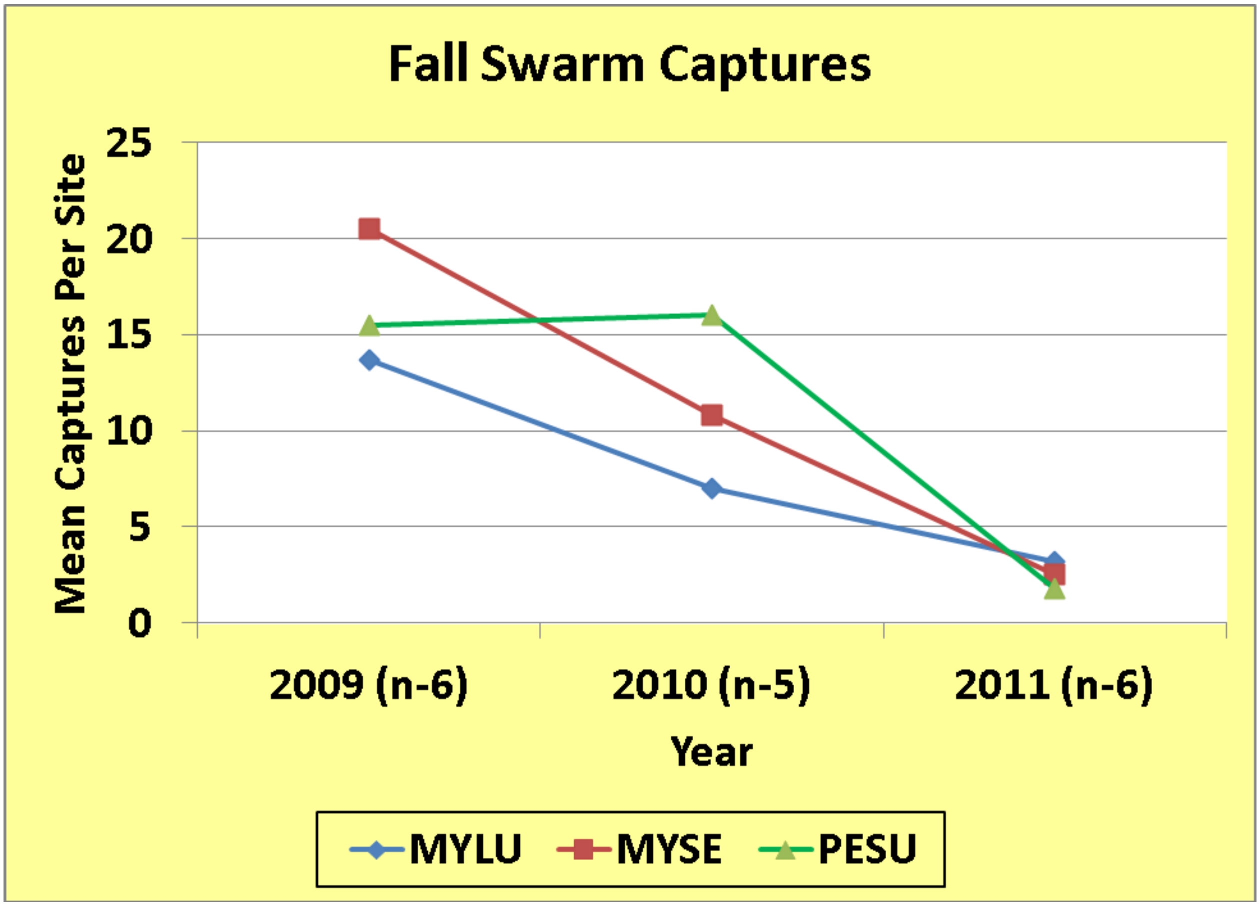

Figure 4. Fall swarm captures in Virginia. Work was predominately conducted in September and early October. MYLU = *Myotis lucifugus*, MYSE = *Myotis septentrionalis*, PESU = *Perimyotis subflavus*. The values within brackets (i.e. ‘n-6’) refers to number of sites sampled. (Figure courtesy of Rick Reynolds, Virginia State Biologist).

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