Environment and Climate Change Canada | Environnement et Changement climatique Canada

REQUEST FOR DECISION SUBMISSION TO THE NUNAVUT WILDLIFE MANAGEMENT BOARD

For

Information: **Decision: X**

Issue: Proposed Final *Recovery Strategy for Little Brown Myotis, Northern Myotis and Tri-coloured Bat in Canada* under the federal *Species at Risk Act*

Little Brown Myotis – an Endangered bat species

Range of Little Brown Myotis in Canada

Background:

- The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) emergency assessed the Little Brown Myotis, Northern Myotis and Tri-coloured Bat as Endangered in February 2012, and confirmed their assessment in November 2013.
- The COSEWIC Assessment and Status Report does not include Nunavut in the occurrence/range for Little Brown Myotis but states that it "occurs in every province and territory, with occasional records in southwestern Nunavut". The range map above uses '?' to indicate Nunavut records that are probable but unconfirmed, or may be extralimital.
- In 2014, all three bats were emergency listed under the federal *Species at Risk Act* (SARA).

Canada

- As required under the federal *Species at Risk Act (*SARA), a recovery strategy must be developed for species listed as Endangered and Threatened. Environment Canada's Canadian Wildlife Service (CWS) developed a combined recovery strategy for all three species.
- CWS conducted the first jurisdictional review on the draft recovery document in May 2015. Community consultations were conducted in June-July 2015. The second jurisdictional review and support to post on the Species at Risk Public Registry was done between September – October 2015. The proposed recovery document will be posted on the Species at Risk Registry (www.sararegistry.gc.ca) for a 60-day public comment period in the coming months. Environment Canada will then have 30 days to consider the comments and post the final recovery document on the Species at Risk Registry.
- Given the best available information on the species in the COSEWIC Assessment and Status Report, CWS did not conduct consultations in Nunavut.
- On December 1, 2015, CWS requested the NWMB consider if there are concerns with the approach taken for Little Brown Myotis and if so, to provide direction.
- On December 18, 2015 in a letter to the Minister of Environment and Climate Change Canada, the NWMB requested that a Proposal for Decision of the recovery strategy be presented to the NWMB following the 60-day public review period. Once the NWMB reviewed the Proposal for Decision, the NWMB would exercise its discretion under Section 5.2.34(d)(i) of the *Nunavut Land Claims Agreement* (NLCA) to either make a decision on the approval of the recovery strategy, or not perform its decision-making function.

Next Steps:

- Following the 60-day public comment period, Environment and Climate Change Canada is providing the Proposal for Decision to the NWMB which includes the proposed final recovery strategy.
- Environment and Climate Change Canada is now prepared to post the recovery document on the Species at Risk Registry as final.
- Environment Canada is providing the recovery document to the NWMB for final approval decision as per the NLCA s. 5.2.34.

Request to the Board:

That the NWMB considers whether or not they will make a decision on the approval of the recovery strategy, or to not perform its decision-making function.

That if the NWMB decides to make a decision on the approval of the recovery strategy, the NWMB considers whether or not they approve the final *Recovery Strategy for the Little Brown Myotis, Northern Myotis and Tri-coloured Bat in Canada* under the federal *Species at Risk Act* as per the NLCA s. 5.2.34.

Prepared by:
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2016-May-13

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The *Species at Risk Act* and You

PROPOSED FINAL RECOVERY STRATEGY FOR LITTLE BROWN MYOTIS, NORTHERN MYOTIS AND TRI-COLOURED BAT IN CANADA

Summary

This is a summary of the information provided in the proposed final recovery document for Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and Tri-coloured Bat (*Perimyotis subflavus*). Under the federal *Species at Risk Act*, the three different species were emergency listed in 2014 as Endangered. This summary will focus on the one species that may occur in Nunavut: Little Brown Myotis.

© *Hugh Broders*
Little Brown Myotis

The proposed final recovery document is a document that sets the goals and objectives for maintaining sustainable population levels for Little Brown Myotis.

This summary is based on the information in the full English version of the proposed final recovery document for Little Brown Myotis, Northern Myotis and Tri-coloured Bat. The original English copy of the proposed final recovery document has been provided for reference.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Assessment and Species Status Information

Canada

These pages provide the COSEWIC assessment table which is included here. It describes why COSEWIC has assessed Little Brown Myotis.

Date of assessment: November 2013

Common name (population): Little Brown Myotis

Scientific name: *Myotis lucifugus*

COSEWIC status: Endangered

Reason for designation: Approximately 50% of the global range of this small bat is found in Canada. Sub-populations in the eastern part of the range have been devastated by White-nose Syndrome, a fungal disease caused by an introduced pathogen. This disease was first detected in Canada in 2010, and to date has caused a 94% overall decline in known numbers of hibernating *Myotis* bats in Nova Scotia, New Brunswick, Ontario, and Québec. The current range of White-nose Syndrome has been expanding at an average rate of 200-250 kilometres per year. At that rate, the entire Canadian population is likely to be affected within 12 to 18 years. There is no apparent containment of the northward or westward spread of the pathogen, and proper growing conditions for it exist throughout the remaining range.

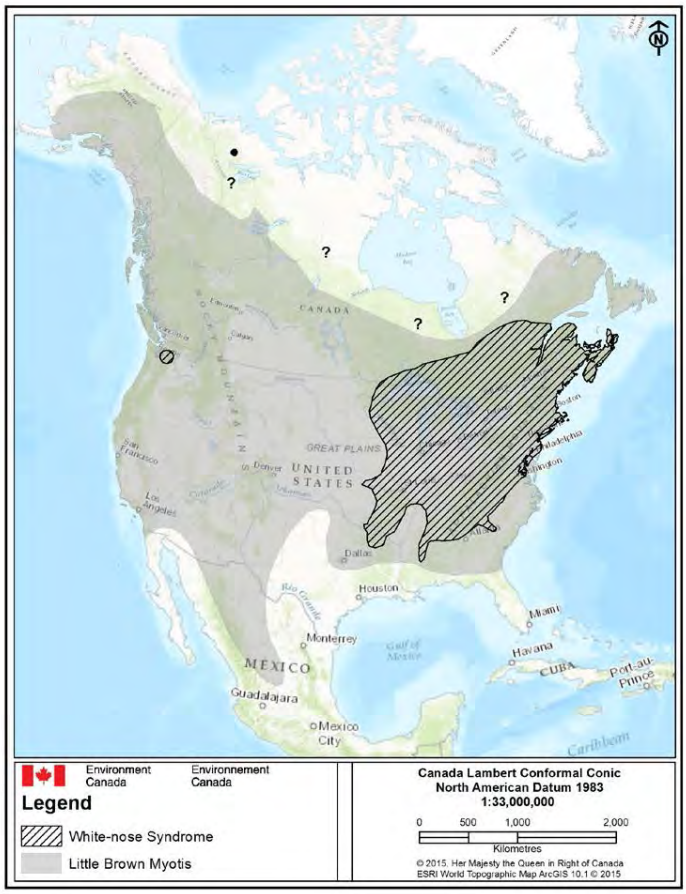
Canadian Occurrence: Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador

COSEWIC Status History: Designated Endangered in an emergency assessment on February 3, 2012. Status re-examined and confirmed in November 2013.

This section also provides information on the status of the species throughout Canada, how it is protected in the Provinces and Territories and what rank of protection it has, and other types of protection that are provided to the species.

Information about Little Brown Myotis

This section of the draft recovery document for Little Brown Myotis provides some information such as what they look like, where they live, their population, and what they need to survive.



This is Figure 1 from the draft recovery document. It shows the approximate distribution of Little Brown Myotis (grey) and white-nose syndrome (WNS) (black diagonal) in North America. Some records in Nunavut (as shown with a '?') indicate uncertainty in the northern limit of the range.

- Little Brown Myotis is a small brown bat with black ears, wings and tail membrane, and some individuals can live more than 30 years.
- With a wingspan of approximately 22-27cm, females tend to be larger than males.

- Confirmed in every province and territory, with the exception of Nunavut, where observations are unconfirmed.
- In general, Canadian distribution includes the boreal forest south of the treeline through to the U.S. border.
- Pre-WNS (prior to and including 2009), likely the most common bat in Canada with populations exceeding one million individuals.
- Post-WNS (2010 and onwards), the entire Canadian range expected to be impacted by WNS between 2025 and 2028. Some individuals may be surviving WNS, but survival rates are not enough to support population growth.
- Overwintering habitat consists of hibernacula (underground openings used to hibernate, such as caves) that are used year after year. Bats live off of their fat reserves in the winter.
- Little Brown Myotis uses buildings and other human structures (eg. bat boxes) as their roosts for their summering habitat, as well as natural structures like trees. Roosting sites are generally used annually, and natural roost sites can be used upwards of 10 years while human roost sites can be used upwards of 50 years.
- Swarming habitat is used in the late summer/early fall, and act as mating sites, stopovers during migration, social sites, or access to overwintering sites.
- Feed at night on insects and spiders in open areas such as ponds, roads, and open forests.
- Migrate short distances between overwintering and summering areas (average 463km).
- Long-lived and only produce one young, and survival of young is low.
- Social species, which can increase the spread of diseases.

Threats to Little Brown Myotis

This section of the draft recovery document describes the things that might cause Little Brown Myotis populations to drop. In Canada, there are 14 main threats:

- **White-nose Syndrom (WNS)** – the greatest threat. WNS is a fungus that is thought to come from Europe, and was found in Canada in 2010. WNS grows in the same conditions that are found in hibernaculas, and grows on the bat's skin. It damages the skin, sweat/oil glands, muscles and hair, among other things. The wings/ears develop white-grey blotches and the muzzle often turns fuzzy white. As it progresses, it can cause the bat to hyperventilate, and cause severe damage to the skin/muscles. Because of these issues, bats will wake up more often during hibernation and reduce their energy reserves, increasing their risk of dying over the winter. Bats that survive until spring may have damaged wings with numerous holes. It is thought that 17% of the Little Brown Myotis range is impacted by WNS, and WNS is transmitted from bat-to-bat contact, contact with contaminated hibernacula, and human-assisted activities (eg. spelunkers). The fungus is found in the soil and on the walls of hibernacula, and may remain active for years

or decades. Substantial research is occurring for WNS.

- **Feral and Free-roaming Cats** – often kill juvenile Little Brown Myotis that have recently learned to fly, or that roost within human structures.
- **Destruction/Degradation of Harmful Alteration of Hibernacula** –any activity that cause changes in temperature, humidity, etc. in hibernacula, or prevents bats from entering them. Activities can include industry, tourism, vandalism, etc.
- **Destruction/Degradation of Harmful Alteration of Roosts** – deterioration of available structures, landowners excluding bats, development activities that remove trees.
- **Destruction/Degradation/Conversion of Foraging Habitat** – human sources (eg. forestry, mining, residential development, land conversion, wetland removal, roads).
- **Collision with/Barotrauma from Wind Turbines** – direct collisions with turbines or drop in air pressure behind the blades.
- **Intentional Harm to Individuals** – sealing openings, chemical/electronic control, killing/relocating bats.
- **Recreational/Scientific Disturbance of Individuals** – visiting hibernacula when bats are hibernating, or handling hibernating bats.
- **Industrial Disturbance of Individuals** – noise/vibrations from industrial activities (eg. mining, forestry).
- **Mercury** – human activities can cause mercury to build up in aquatic habitats.
- **Other Toxic Chemicals** – pesticide spraying, neonicotinoid insecticides, toxic/harmful algal blooms.
- **Light Pollution** – artificial light sources.
- **Habitat/Prey Dynamic Alterations caused by Climate Change** – effects of climate change on bats are unknown, but may be sensitive to temperature changes, roost damage from increased storms, increased forest fires, impact to insect populations.
- **Collisions with Vehicles**

Population and Distribution Objectives, and Broad Strategies and Approaches

The draft recovery document has two population objectives:

- In the short term (12-18 years), maintain and increase (where feasible) the current population level.
- In the long term (many generations), the population is self-sustaining, resilient, redundant and representative.

There is one distribution objective:

- Maintain (or restore where applicable) the pre-WNS extent of occurrence (known geographic distribution of the species in Canada in Figure 1).

Five broad strategies are identified for Little Brown Myotis: monitoring and surveys; research; education and awareness, partnerships and stewardship; habitat and species conservation and management; and law and policy. A strategic direction has been

outlined that includes a number of research and management approaches. For example:

- Maintain an effective/coordinated WNS surveillance program across Canada
- Investigate techniques to prevent/reduce the spread, mitigate the effects of, and/or treat WNS
- Communicate the importance of bats to people, ecosystems, biodiversity and economies
- Implement all known precautionary measures to reduce the spread of WNS
- Develop, implement, and promote compliance with federal/provincial/municipal acts/policies related to reducing threats and encouraging conservation of these species, their prey and their habitat

A detailed list of the strategic direction approaches can be found in the proposed final recovery document.

Critical Habitat

Using the best information available, critical habitat is partially identified for Little Brown Myotis hibernacula based on the following:

- Occupancy: any site where Little Brown Myotis has been observed hibernating during the winter at least once between 1995 and April 2016.
- Biophysical Attributes: underground areas (eg. caves) where light and noise levels are low, with stable temperatures and stable, high humidity levels.
- Geographic Location: areas identified known to contain critical habitat can be found in the proposed final recovery document. At this time, no critical habitat sites have been identified in Nunavut.

Detailed information about critical habitat can be found in the proposed final recovery document. Maternity roosts and other habitat cannot be identified as critical habitat at this time due to the lack of information.

In the next ten years, the short term schedule of studies developed to identify critical habitat include some of the following activities:

- Conduct surveys in areas where hibernacula and maternity roosts are suspected but unconfirmed
- Work with researchers, provinces/territories, Aboriginal communities, and non-government organizations to determine how sensitive data can be made available and used for critical habitat identification

The proposed final recovery document also suggests the geographic range of the species, threats, and habitat of Little Brown Myotis should be identified at a landscape scale, which would permit the long-term management of habitat needed for the survival and recovery of the species. A list of schedule of studies for the landscape-scale can be found in the proposed final recovery document.

The proposed final recovery document identifies Activities Likely to Result in the Destruction of Critical Habitat, which are determined on a case-by-case basis. Destruction would result if part of the critical habitat were permanently/temporarily

degraded such that it would not serve its function when needed by the species. The destruction may result from single/multiple activities at one time, or from the cumulative effects of single/multiple activities over time. A list of some of the destructive activities can be found in the proposed final recovery document.

Success of the population and distribution objectives will be evaluated to determine if:

- The extent of occurrence of Little Brown Myotis is maintained (or restored where applicable) to the pre-WNS extent (to be verified every 5 years).
- In the short term (12-18 years) within WNS-affected areas, the population is maintained and increased (where feasible) at its current level.
- In the long term (many generations) within WNS-affected areas, the population is self-sustaining, resilient, redundant and representative.

One or more action plans for Little Brown Myotis will be posted on the Species at Risk Public Registry within 3 years of the final posting of the recovery document.

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Little Brown Myotis

For more information, please contact us directly at:

Canadian Wildlife Service – Northern Region
P.O. Box 1870
969 Federal Road
Iqaluit, NU X0A 0H0

You can also visit the following websites for more information:
SARA Public Registry (www.sararegistry.gc.ca)

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Recovery Strategy for Little Brown Myotis in Canada

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ᔪᓐ 2016

Species at Risk Program
Canadian Wildlife Service
Yellowknife, NT
June 2016

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Recovery Strategy for Little Brown Myotis in Canada - Background

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  Although the proposed final recovery strategy is for Little Brown Myotis, Northern Myotis, and Tri-coloured Bat, this summary will focus on the one species that may occur in Nunavut: Little Brown Myotis

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Recovery Strategy for Little Brown Myotis in Canada - Background

- ᑎᓯᐱᕆ 18, 2015−ᖑᑎᓪᓗᒍ, ᓄᓇᕗᒻᒥ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᑐᒃᓯᕋᓚᐅᕐᒪᑕ ᑕᐃᒃᑯᓂᖓ ᐱᒋᐊᖅᑎᑕᐅᔪᒪᔪᓄᑦ ᐃᓱᒪᓕᐅᕈᑕᐅᔭᕆᐊᓕᖕᓂᒃ ᐊᒥᓱᕈᖅᓰᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕈᑎᒃᓴᐃᑦ ᐅᓂᒃᑳᕐᕕᐅᔪᒪᓂᖅ ᑲᑎᒪᔨᖕᒋᓐᓄᑦ ᑭᖑᓂᐊᒍᑦ ᐃᓄᓕᒫᓄᑦ ᕿᒥᕐᕈᐊᖅᑕᐅᔪᓐᓇᖅᓯᓂᖕᒋᓐᓂᒃ 60−ᐅᓪᓗᐃᑦ ᖁᖕᒋᕐᒪᑕ.

  On December 18, 2015, the NWMB requested that a Proposal for Decision of the recovery strategy be presented to the NWMB following the 60-day public review period.

- ᑕᐃᒪᓕ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᑲᑎᒪᔨᖕᒋᑦ ᕿᒥᕐᕈᐊᓚᐅᕐᓗᑎᒃ ᑐᒃᓯᕋᐅᑎᓂᒃ ᐃᓱᒪᓕᐅᕈᑕᐅᕐᑯᔭᐅᔪᓂᒃ, ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯ ᐊᑐᓕᕋᔭᖅᐳᑦ ᐃᓱᒪᖅᓱᑎᒋᔪᓐᓇᖅᑕᖕᒋᓐᓂᒃ, ᑎᑎᕋᖅᓯᒪᔪᓂᒃ ᒪᓕᒃᓗᑎᒃ ᓈᓴᐅᑎᓖᑦ 5.2.34(d)(i)−ᒥ *ᓄᓇᕗᒻᒥ ᓄᓇᑖᕈᑎᓂᒃ ᐊᖏᕈᑎᓃᑐᓂᒃ* ᒪᓕᒃᓗᑎᒃ, ᐊᓱᒪᓕᐅᕈᓇᕐᓂᖕᒋᓐᓄᑦ ᐊᖏᖅᑕᐅᔪᓐᓇᕐᓂᖕᒋᓂ ᐊᒥᓱᕈᖅᓯᐊᓇᔭᐅᔪᒪᓂᖕᒋᓐᓄᑦ ᖃᓄᐃᓕᐅᕈᑎᒃᓴᐅᓂᐊᖅᑐᓂᒃ ᐅᕝᕙᓗᓐᓃᑦ ᐊᑐᕈᓐᓇᕐᓂᖕᒋᓐᓂᒃ ᐊᑐᖑᕈᓐᓇᕐᒥᔭᖕᒋᓐᓂᒃ ᐃᓱᒪᓕᐅᕈᑎᖃᕈᒪᖕᒋᓐᓂᖅ.

  Once the NWMB reviewed the Proposal for Decision, the NWMB would exercise its discretion under Section 5.2.34(d)(i) of the *Nunavut Land Claims Agreement* (NCLA) to either make a decision on the approval of the recovery strategy, or not perform its decision-making function.

ᑲᓇᑕᓕᒫᒥ ᐆᒪᔪᐃᑦ ᐊᒥᓱᖕᒋᓗᐊᓕᕐᓂᖕᒋᓐᓄᑦ ᒪᓕᒐᐃᑦ ᐊᑐᓕᖅᑎᑕᐅᓂᖕᒋᑦ – ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᓂᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ

Federal *Species at Risk Act* (SARA) Process – Little Brown Myotis

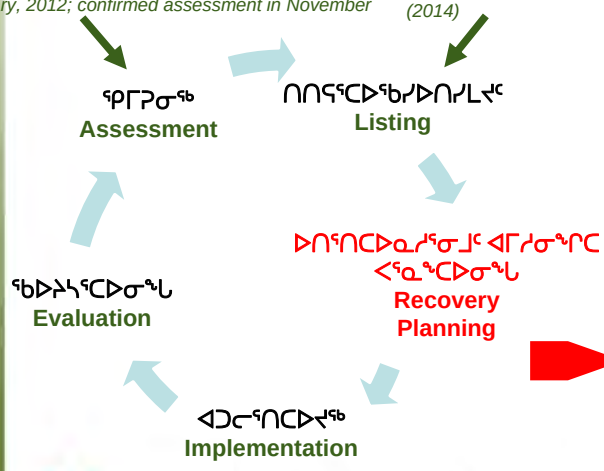
ᑲᑎᒪᔨᕐᓛᑦ ᖃᓄᐃᓕᖕᒐᓂᖕᒋᓐᓄᑦ ᐊᒥᓲᔪᓐᓃᖅᓯᒪᔪᑦ ᐆᒪᔪᐃᑦ ᑲᓇᑕᒥ COSEWIC−ᑯᑦ ᑕᒡᕙᓂ ᖃᓄᐃᓕᖕᒐᓕᕐᓂᖕᒋᓐᓄᑦ ᑲᓇᑕᒥ ᖃᐅᔨᓴᓚᐅᖅᓱᑎᒃ ᓇᓗᓇᐃᖅᓯᓚᐅᖅᑐᑦ ᓄᖑᓕᒫᓕᕈᓐᓇᕐᓂᕋᐃᓂᖅ ᕕᕗᐊᓇ 2012-ᒥ; ᓇᓗᓇᐃᖅᑕᐅᑦᑎᐊᒃᑲᓐᓂᓚᐅᖅᑐᑦ ᓄᕕᐱᓇ 2013-ᒥ.

COSEWIC emergency assessed as Endangered February, 2012; confirmed assessment in November 2013

ᒪᓕᒐᖅᑎᒍᑦ ᐃᓕᑕᓇᔭᐅᓯᒪᓕᖅᑐᑦ ᑕᐃᔭᐅᔪᒥᒃ ᐆᒪᔪᐃᑦ ᐊᒥᓱᖕᒋᓗᐊᓕᕐᓂᖕᒋᓐᓄᑦ ᒪᓕᒐᖅᑎᒍ (SARA−ᑯᕐ) (2014)

Listed as Endangered under SARA (2014)

ᓄᖑᓕᒫᓕᕐᓂᖕᒋᑦ ᐆᒪᔪᐃᑦ ᑐᑭᕐᑲᖅᑐᑦ ᐆᒪᔪᐃᑦ ᓄᖑᑐᐃᓐᓇᓇᐊᕐᑲᓕᕐᓂᖕᒋᓐᓂᒃ ᑕᒫᓂ ᑲᓇᑕᒥ ᐅᕝᕙᓗᓐᓂᑦ ᐱᑕᕐᑲᕈᓐᓃᑦᑎᐊᒻᒪᓇᒍᓐᓇᕐᓂᖕᒋᓐᓂᒃ ᑕᐃᒪᓐᓂ.



ᓄᖑᓕᒫᓕᕐᓂᖕᒋᑦ ᐆᒪᔪᐃᑦ ᑐᑭᕐᑲᖅᑐᑦ ᐆᒪᔪᐃᑦ ᓄᖑᑐᐃᓐᓇᓇᐊᕐᑲᓕᕐᓂᖕᒋᓐᓂᒃ ᑕᒫᓂ ᑲᓇᑕᒥ ᐅᕝᕙᓗᓐᓂᑦ ᐱᑕᕐᑲᕈᓐᓃᑦᑎᐊᒻᒪᓇᒍᓐᓇᕐᓂᖕᒋᓐᓂᒃ ᑕᐃᒪᓐᓂ.

Endangered species is a wildlife species facing imminent extirpation or extinction.

ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ– ᖃᓄᐃᑑᓂᖏᓐᓂᒃ ᐅᓂᒃᑳᕈᑏᑦ

Little Brown Myotis - Description

- ᒥᑭᑦᑐᑦ (7-9g ᒍᕋᒻᓂᒃ ᐅᖁᒪᐃᓐᓂᓛᑦ)
  Small (7-9 g)
- ᑲᔪᓗᑎᒃ ᕿᕐᓂᖅᑐᓂᒃ ᓯᐅᑎᖃᖅᑐᑦ ᐊᒻᒪᓗ ᐃᓴᕈᖃᖅᓱᑎᒃ
  Brown with black ears & wings
- ᐃᓴᕈᖏᑦ ᑕᑭᓂᖃᖅᑐᑦ 22-27 cm ᓴᓐᑎᒦᑕᓂᒃ
  Wingspan 22-27 cm
- ᐆᒪᔪᓐᓇᖅᑐᑦ ᐅᖓᑕᓅᑦ 30 ᐊᕐᕋᒍᐃᑦ
  Can live more than 30 years

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- ᐅᓐᓄᐊᒃᑯᑦ ᓂᕿᒃᓴᖅᓯᐅᖅᐸᒃᑐᑦ ᖁᐱᕐᕋᓂᒃ, ᑎᖏᕙᒃᑐᓂᒡᓗ, ᐊᓯᕙᖕᓂᒡᓗ ᓄᓇᓂ ᒪᒃᐲᖓᓂᖏᓐᓂ, ᓱᕐᓗ ᑕᓯᐊᕐᔪᖕᓂ, ᐊᖅᑯᑎᓂ ᐊᒻᒪᓗ ᒪᒃᐲᖓᓂᖏᓐᓂᒃ ᓇᐹᖅᑐᖃᕐᕕᐅᔪᓂ.
  Feed at night on insects and spiders in open areas such as ponds, roads, and open forests
- ᐊᑯᓂᐊᓗᒃ ᐆᒪᔫᓱᖕᒍᑦᓗᑎᒃ, ᐊᑕᐅᓱᓐᓇᕐᒥᒃ ᐱᐊᕋᖅᑖᖅᐸᒃᑐᑦ, ᐆᒪᐃᓐᓇᕈᓐᓇᕐᓂᖏᑦᓗ ᑕᒪᒃᑯᐊ ᐊᒥᓱᕙᖏᓚᑦ.
  Long-lived and only produce one young, and survival of young is low
- ᐊᓯᖃᐃᓐᓇᕆᐊᖃᕐᓂᖏᓐᓄᑦ (ᐃᓚᖃᐃᓐᓇᕆᐊᖃᕐᓂᕐᒥᓄᑦ) ᑖᒃᑯᐊ ᐃᓄᑑᒐᔪᐃᑐᑦ, ᖃᓂᒪᒍᑎᓂᒃ ᐋᓐᓂᐊᓕᕈᑎᒋᕙᒃᑕᖏᑦ ᐊᐃᑦᑐᖅᑕᐅᓴᕋᐃᑦᑑᕙᒃᐳᑦ ᑕᐃᒫᒃ ᐱᐅᓯᖃᕐᓂᖏᓐᓄᑦ.
  Social species, which can increase the spread of diseases

ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ – ᓇᔪᖅᐸᒃᑕᖏᑦ

Little Brown Myotis – Range

ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ
Little Brown Myotis

ᖃᑯᖅᓯᓕᕐᓇᖅᑐᒥᒃ ᐅᖁᒃᐸᑦᓕᐊᔪᔭᕐᓇᖅᑐᖅ ᐋᓐᓂᐊᓕᕈᑎᒋᕙᒃᑕᖓᑦ ᕿᖓᕐᒥᒍᑦ ᑎᒥᒥᒍᑦᓗ
White-nose Syndrome

?
ᓇᓗᓇᖅᑐᑦ ᐅᑭᐅᖅᑕᖅᑐᖅᐸᓯᖕᒥ ᐱᑕᖃᓱᖕᒍᓂᖏᑦ
Uncertain northern limit

•
ᓇᔪᖅᐸᒃᑕᖏᑦ ᑕᐅᕙᖕᒫᖃᑦᑕᕐᓂᖏᓐᓂᒃ ᖃᐅᔨᒪᔭᐅᓂᖏᑦ ᑎᑎᕋᖅᓯᒪᔪᑎᒍᑦ
Extralimital record

ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ – ᓇᔪᖅᑕᐅᕙᖕᓂᖕᒋᑦ

Little Brown Myotis - Habitat

- ᐅᑮᕕᒋᕙᒃᑕᖕᒋᑦ ᓇᔪᖅᐸᒃᑕᖕᒋᑦ
  Overwintering habitat
  - ᐊᑯᓂ ᓯᓂᑯᑖᒡᕕᐅᕙᖕᓂᖕᒋᓐᓄᑦ ᐃᓂᒋᔭᐅᔪᑦ: ᓄᓇᐅᑉ ᐃᓗᐊᓂ ᒪᒃᐲᖕᒐᔪᓂᒃ ᓯᓂᒡᕕᐅᕙᒃᑐᓂᒃ, ᓱᕐᓗ ᐅᔭᕋᐃᓇᐅᔪᓂ ᐃᓗᑐᓂᓕᖕᓂ
    Hibernacula: underground openings used to hibernate, such as caves
  - ᑕᒪᒃᑯᐊ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐆᒪᔪᓐᓇᓱᖑᕗᑦ ᐅᖅᓱᖃᕐᓂᕐᒥᓂᒃ ᑎᒥᒥᓂᖕᒑᖅᓯᒪᔪᓂᒃ ᐆᒪᔾᔪᑎᖃᖅᐸᒃᓯᑎᒃ ᐅᑭᐅᓕᒫᖅ ᐊᓯᐊᓄᐊᓚᐅᕋᑎᒃ
    Bats live off of their fat reserves in the winter

- ᐊᐅᔭᒃᑯᑦ ᓇᔪᖅᐸᒃᑕᖕᒋᑦ
  Summering habitat
  - ᓴᓇᔭᐅᓯᒪᔪᓐᓇᖅᑐᑦ ᐃᓄᖕᓄᑦ ᓱᕐᓗ ᐃᒡᓗᕐᑯᑎᒋᔭᐅᔪᑦ, ᐅᕝᕙᓗᓐᓂᑦ ᐊᕕᓐᖓᐅᔭᖃᕐᕕᓕᐊᕆᔭᐅᓯᒪᔪᓂᒃ ᐃᓄᖕᓄᑦ
    Can be on in human made structures such as buildings, bat boxes
  - ᓇᐹᖅᑐᕕᓃᑦ ᐃᓂᕕᓂᖕᒋᑦ, ᐅᔭᕋᐃᑦ ᐃᓂᕕᓂᖕᒋᑦ ᐊᒻᒪᓗ ᓄᓇᐅᑉ ᐃᓗᐊᒍ ᐅᔭᕋᐅᓂᖕᒋᑦ ᐃᓗᑐᓂᖃᖅᑐᑦ
    Tree cavities, rock crevices and caves

ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ – ᓇᔪᖅᑕᐅᕙᖕᓂᖕᒋᑦ

Little Brown Myotis - Habitat

- ᐊᒥᓱᒡᓗᑎᒃ ᓇᒧᖕᒐᐅᕙᒡᓕᐊᓂᖕᒋᑦ ᑲᑎᖕᒐᒡᓗᑎᒃ ᒪᓕᖃᑦᑕᐅᑎᕙᒃᓯᑎᒃ
  Swarming habitat
  - ᐃᓱᖅᐸᓯᐊᓂ ᐊᐅᔭᐅᓂᖕᒐᑕ/ᐅᑭᐅᒃᓵᕈᖅᐸᒡᓕᐊᓕᓵᕐᓂᖕᒐᓂᓗᓐᓃᑦ
    Late summer/early fall
  - ᓄᓕᐊᕐᕕᒃᓵᖕᒋᓐᓄᖕᒐᐅᓂᕐᒧᑦ, ᓄᕐᑲᖕᒐᕕᒋᑲᐃᓐᓇᕐᑲᑦᑕᖅᑕᖕᒋᑦ ᐊᒥᓱᒡᓗᑎᒃ ᓇᒧᖕᒐᐅᖕᒑᕐᓂᖕᒋᓐᓂᒃ ᐊᓯᐊᓄᑦ, ᐃᓅᑑᕙᖕᒋᓐᓂᖕᒋᑦ, ᑎᑭᒐᔪᒃᑕᖕᒋᓐᓄᖕᒐᐅᕙᖕᓂᖅ ᐅᕝᕙᓗᓐᓂᑦ ᐅᑮᕕᒋᕙᒃᑕᖕᒋᓐᓄᖕᒐᐅᓗᑎᒃ
    Mating sites, stopovers during migration, social sites, or access to overwintering sites

ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ – ᐊᒥᓲᓂᖏᑦ
Little Brown Myotis - Population

- ᓯᕗᓂᐊᒍᑦ ᖃᑯᖅᓯᓇᖅᑐᓂᒃ ᐅᖁᓐᓇᖅᑐᒥᒃ ᕿᖓᕐᒥᒍᑦ ᐋᓐᓂᐊᓕᕈᑎᖃᖅᐸᓚᐅᖏᓐᓂᖏᓐᓂ ᓯᓕ (ᓯᕗᓂᐊᒍᑦ ᐃᓚᐅᓪᓗᓂᓗ ᐊᕐᕋᒍᖓ 2009-ᒥᒃ), ᐊᒥᓲᓂᖃᖅᑎᒋᔫᖅᐸᓚᐅᖅᑐᑦ ᑲᓇᑕᒥ ᐊᕕᓐᖓᐅᔭᐃᑦ ᑕᒫᓂ ᐅᖓᑕᓃᑐᓂᒃ 1 ᒥᓕᔭᓐᓂᒃ.
  Pre-White Nose Syndrome (WNS) (prior to and including 2009), likely the most common bat in Canada with populations exceeding one million individuals.

- ᑭᖑᓕᐊᒍᑦ ᑎᑭᑕᐅᓯᒪᓕᕋᒥᒃ ᖃᑯᖅᓯᓕᕐᓇᖅᑐᒥᒃ ᐅᖁᒃᐸᓪᓕᐊᔫᕐᓇᖅᑐᖅ ᐋᓐᓂᐊᓕᕈᑎᒋᕙᒃᑕᖓᓂᒃ ᕿᖓᕐᒥᒍᑦ (2010–ᒥ ᐅᖓᑕᓄᓪᓗ), ᑕᒪᕐᒥ ᑲᓇᑕᒦᓐᓂᖏᑦ ᐊᒃᑐᖅᑕᐅᓂᐊᕋᓱᒋᔭᐅᔪᑦ ᑕᐃᒃᑯᓄᖓ ᖃᑯᖅᓯᓇᖅᑐᒥᒃ ᐅᖁᒃᐸᓪᓕᐊᔫᕐᓇᖅᑐᓂᒃ ᐋᓐᓂᐊᓕᕈᑕᐅᕙᒃᑐᓂᒃ ᐊᕐᕋᒍᐃᑦ ᐊᑯᓐᓂᖏᓐᓂ 2025 ᐊᒻᒪᓗ 2028. ᐃᓚᖏᑦ ᐊᓂᒎᑎᔪᓐᓇᖅᑐᒃᓴᐅᔪᑦ ᖃᑯᒃᓯᓕᕐᓇᖅᑐᒥᒃ ᑎᒥᖏᓄᑦ ᑭᓯᐊᓂ ᐆᒪᐃᓐᓇᕈᓐᓇᕐᓂᖏᑦ ᐊᒥᓲᖏᓗᐊᓕᕈᑕᐅᓂᐊᖅᑐᑦ ᐃᑲᔫᑕᐅᔪᓐᓇᕐᓂᕐᒧᑦ ᐊᒥᓱᕈᖅᐸᓪᓕᐊᖏᓐᓇᕈᓐᓇᕐᓂᖏᓐᓄᑦ.
  Post-WNS (2010 and onwards), the entire Canadian range expected to be impacted by WNS between 2025 and 2028. Some individuals may be surviving WNS, but survival rates are not enough to support population growth.

ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ – ᐅᓗᕆᐊᓇᕈᑕᐅᕙᓂᖏᑦ ᑲᓇᑕᒥ
Little Brown Myotis – Threats in Canada

- ᖃᑯᖅᓯᓕᕐᓇᖅᑐᒥᒃ ᐅᖁᒃᐸᓪᓕᐊᔫᕐᓇᖅᑐᖅ ᐋᓐᓂᐊᓕᕈᑎᒋᕙᒃᑕᖓᓂᒃ (WNS ᓇᐃᓈᕐᓗᒍ) – ᐱᒻᒪᕆᐅᔪᒥᒃ ᐅᓗᕆᐊᓇᕈᑕᐅᓂᖅᐸᖑᕙᖅ ᑕᒪᓐᓇ
  White-nose Syndrome (WNS) - the greatest threat
  - ᑕᒪᒃᑯᐊ ᖃᑯᖅᓯᓕᕐᓇᖅᑐᒥᒃ ᐅᖁᒃᐸᓪᓕᐊᔫᕐᓇᖅᑐᖅ ᐋᓐᓂᐊᓕᕈᑎᒋᕙᒃᑕᖏᑦ ᐃᓱᒪᒋᔭᐅᓯᒪᔪᖅ ᑎᑭᓯᒪᔪᕕᓂᐅᓂᖅ ᔪᐊᕆᐸᒥᖓᖅᓱᑎᒃ
    Fungus that is thought to come from Europe
  - ᐊᐃᑦᑐᖅᑕᐅᔪᓐᓇᖅᑐᑦ ᖃᑯᖅᓯᓕᕐᓇᖅᑐᑦ ᐋᓐᓂᐊᓕᕈᑎᓂᒃ ᐊᒃᑐᖅᑕᐅᓯᒪᔪᓄᑦ ᖃᑯᖅᓯᓕᕈᑎᖃᓕᐊᓂᒃᑐᓄᑦ ᐊᕕᓐᖓᐅᔭᕐᓂᒃᐊᕕᓐᖓᐅᔭᕐᓄᑦ ᐊᒻᒪᓗ ᐃᓄᖕᓄᑦ ᐃᑲᔫᑕᐅᔪᓂᒃ ᐊᐃᑦᑐᖅᑕᐅᕙᒃᓱᑎᒃ
    Transmitted by bat-to-bat contact and contact with contaminated hibernacula, but human-assisted spread also possible
  - ᐊᕕᓐᖓᐅᔭᐃᑦ ᑐᐸᒐᔪᓐᓂᖅᓴᐅᓕᖅᐸᒃᑐᑦ ᓯᓂᑯᑖᒐᕕᒋᕙᒃᑲᓗᐊᖅᑕᒥᓂᒃ, ᓄᑭᖃᑦᑎᐊᕈᓐᓃᕈᑕᐅᕙᒃᓱᑎᒃ ᐊᑐᖅᐸᓚᐅᖅᑕᕋᓗᐊᒥᓂᒃ ᓯᓂᑯᑖᒍᓇᖅᐸᓚᐅᕐᓂᖅ
    Bats awaken because of the fungus infection and deplete their energy reserves during hibernation
  - ᐊᐃᑦᑐᐃᕙᓪᓕᐊᔪᓐᓇᖅᑐᑦ ᐃᒪᓐᓇᑎᒋ ᐅᖓᓯᖕᓂᖃᖅᑎᒋᔪᓐᓇᖅᑐᓄᑦ 200-250 km ᑭᓛᒥᑕᓕᖕᓂᒃ/ᐊᕐᕋᒍᑕᒫᖅ
    Spreading at a rate of 200-250 km/year
  - ᑕᐃᒃᑯᐊ ᐱᕈᕈᓐᓇᕐᒪᑕ ᓲᕐᓗ ᐅᖁᓐᓇᖅᑐᑎᑐᑦ ᓄᓇᒥ ᐃᑉᔪᕐᒥ ᐊᒻᒪᓗ ᓴᓂᕋᖏᓐᓂ ᐅᔭᕋᐃᑦ ᐃᓗᑐᓂᖃᕐᕕᖏᓐᓂ ᓇᔪᖅᑕᐅᕙᒃᑐᓂ, ᐆᒪᔪᓂᒃᓗ ᖁᑉᐱᕐᕈᖃᕈᓐᓇᖅᓱᑎᒃ ᐋᓐᓂᐊᓕᕈᑎᖃᖅᑐᓂᒃ ᖁᓕᒐᓴᐅᓈᖅᑎᖅᓯᒪᔪᓂᒃ ᐊᕋᒍᒐᓴᒻᒪᕆᖕᓂ.
    Found in soil and on the walls of hibernacula, and may remain active for years or decades

ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ – ᐅᓗᕆᐊᓇᕈᑕᐅᕙᖕᓂᖕᒋᑦ ᑲᓇᑕᒥ

Little Brown Myotis – Threats in Canada

- ᖃᑯᖅᓯᓕᕐᓇᖅᑐᒥᒃ ᐅᕐᑯᒃᐸᓪᓕᐊᔪᔾᕐᓇᖅᑐᖅ ᐋᓐᓂᐊᓕᕈᑎᒋᕙᒃᑕᖕᒐᓂᒃ White-nose Syndrome
  - ᒥᑭᑦᑐᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ ᐆᒪᔫᓇᖅᑐᑦ ᐅᖓᑕᓃᑦᑐᓐᓇᖅᑐᓂᒃ 30–ᓂᒃ ᐊᕐᕋᒍᓂᒃ ᐊᒻᒪᓗ ᐊᕐᓇᓪᓗᐃᑦ ᐊᑕᐅᓯᑐᐃᓐᓇᕐᒥᒃ ᕿᑐᖕᒋᐅᓲᖑᓪᓗᑎᒃ/ᐊᕐᕋᒍᑕᒪᖅ; ᖃᓄᐃᑦᑐᓃᑦᑐᓐᓇᕐᓂᖕᒋᑦ ᐊᒥᓱᑐᖅᓯᐊᕆᔭᐅᔪᓐᓇᕐᓂᖕᒋᓐᓄᑦ ᑕᒪᒃᑯᐊ ᐊᒥᓲᔪᓐᓃᖅᓯᒪᓂᖕᒋᓐᓄᑦ ᐊᑯᓂᐊᓗᕐᓂᐊᖅᑐᑦ
    Little Brown Myotis can live for over 30 years and females have one pup/year; recovery from these declines will take a long time
  - ᑕᐃᒃᑯᐊ ᐃᓴᑐᖕᒋᑦ/ᓯᐅᑎᖕᒋᓪᓗ ᖃᑯᖅᓯᕙᓪᓕᐊᓕᖃᑦᑕᖅᑐᑦ ᓯᐊᕐᓇᑐᖅᐸᒃᓱᑎᒡᓗᓐᓃᑦ, ᑕᒪᓐᓇᓗ ᖃᓂᖓ ᖃᑯᒃᓯᔪᐊᓘᕙᒃᓯᓂ ᒥᖅᑯᓯᒪᔪᖅᑎᑐᑦ
    The wings/ears develop white-grey blotches and the muzzle often turns fuzzy white.

ᒥᑭᑦᑐᑦ ᑲᔪᐃᑦ ᓴᐅᒥᐊᓂ, ᖃᑯᖅᑎᓐᓇᖅᑐᐊᓗᖕᒥᒃ ᐋᓐᓂᐊᖃᖕᒋᓐᓂᖕᒋᓐᓂ, ᑕᐃᒃᑯᐊᓗ ᑕᓕᖅᐱᐊᓃᑦᑐᑦ ᖃᑯᖅᑎᓐᓇᖅᑐᐊᓗᖕᒥᒃ ᐋᓐᓂᐊᖃᓕᖅᑐᑦ.
Little Brown on the left with no WNS, on the right with WNS

ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ – ᐅᓗᕆᐊᓇᕈᑕᐅᕙᖕᓂᖕᒋᑦ ᑲᓇᑕᒥ

Little Brown Myotis – Threats in Canada

- ᓇᔪᖅᐸᒃᑕᖕᒋᑦ ᓱᕈᖅᑎᖅᑕᐅᓂᖕᒋᑦ, ᐱᐅᔾᓂᖅᓯᒪᓪᓗᑎᒃ ᐅᕝᕙᓗᓐᓃᑦ ᐊᑐᒐᒃᓴᐅᔪᓐᓃᖅᓯᒪᓪᓗᑎᒃ.
  Habitat loss, degradation or fragmentation
  - ᓱᕋᒃᑎᖅᑕᐅᓯᒪᓂᖕᒋᑦ ᐊᑯᓂ ᓯᓂᒃᕕᑎᑯᑖᒃᐸᒃᑕᖕᒋᑦ ᐅᕝᕙᓗᓐᓃᑦ ᕿᑐᖕᒋᐅᕐᓂᐊᓕᖅᑎᓪᓗᒋᑦ ᓇᔪᖅᐸᒃᑕᖕᒋᑦ ᐃᓂᖕᒋᑦ.
    Destruction of hibernacula or maternity roosting sites
  - ᓱᕈᖅᑎᖅᑕᐅᓯᒪᔪᑦ ᓇᐹᖅᑐᐃᔭᕐᕕᐅᓯᒪᓂᖕᒋᓐᓄᑦ
    Degradation of forest foraging areas

- ᐸᒃᕕᓴᒃᑕᐅᓯᒪᔪᑦ ᐅᕝᕙᓗᓐᓃᑦ ᐱᐅᔪᓐᓃᖅᑎᑕᐅᓯᒪᔪᑦ
  Disturbance or Harm
  - ᐊᑐᓂ ᐃᖕᒥᒍᕐᓂᖕᒋᓐᓂ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐋᓐᓂᖅᑕᐅᓯᒪᓂᖕᒋᑦ (ᐃᔭᖅᑕᐅᓪᓗᑎᒃ ᐃᒡᓗᕐᑯᑎᒋᔭᐅᔪᓂᒃ)
    Intentional harm to individuals (removal from buildings)
  - ᐃᕿᐊᖑᐃᔭᐅᑕᐅᓂᕐᒧᑦ/ᖃᐅᔨᓴᖅᑕᐅᓂᖕᒋᓐᓄᑦ/ᐊᖕᒋᔪᓂᒃ ᓴᓈᕐᖃᖅᑐᓄᑦ ᐸᒃᕕᒃᓴᖅᑕᐅᓯᒪᓂᖕᒋᑦ
    Recreational/scientific/industrial disturbance
  - ᐊᖕᒋᔾᑎᓂᒃ ᓴᓈᕐᖃᕐᕕᐅᔪᓄᑦ ᐸᒃᕕᒃᓴᒃᑕᐅᓯᒪᓂᖕᒋᑦ
    Industrial disturbance

ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ – ᐅᓗᕆᐊᓇᕈᑕᐅᕙᖕᓂᖕᒋᑦ ᑲᓇᑕᒥ

Little Brown Myotis – Threats in Canada

- ᐱᓂᕐᓗᑕᐅᓂᕐᒧᑦ ᐱᔾᕐᑯᑕᐅᖕᒋᑦᑐᓂᒃ ᑐᕐᑯᕋᖅᓯᒪᓂᖕᒋᑦ
  Accidental Mortality
  - ᐊᔾᑎᓯᒪᓂᖕᒋᑦ/ᐊᒃᑐᖅᑕᐅᓯᒪᓂᖕᒋᑦ ᐊᓄᕆᑐᖅᑐᓄᑦ ᐊᐅᓚᑕᐅᑎᓕᐊᓗᖕᓄᑦ ᓄᓇᒃᑰᕈᑎᓄᓪᓗᓃᑦ
    Collisions with wind turbines or vehicles
- ᓱᕈᕐᓇᖅᑐᓕᖕᓂᒃ
  Pollution
- ᐆᒪᔪᕐᓂᐊᖅᑕᐅᓯᒪᓂᖕᒋᓐᓄᑦ ᐆᒪᔪᓄᑦ
  Predation
- ᓯᓚᐅᑉ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖕᒐ
  Climate Change

ᑐᒃᑐᐃᑦ ᐊᒥᓲᓂᒃᓴᖕᒋᓐᓄᑦ ᐊᒻᒪᓗ ᓇᓃᓐᓂᖕᒋᓐᓄᑦ ᐱᓇᓱᐊᖅᑕᐅᒍᒪᔪᑦ ᐊᒥᓱᕈᖅᐸᓪᓕᐊᑎᑕᐅᔾᔪᑎᒃᓴᖕᒋᓐᓄᑦ ᐱᓕᕆᐊᕆᔭᐅᒐᓱᒃᑐᑦ, ᑐᒃᑐᐃᑦ

Population and Distribution Objectives

ᐊᒥᓲᓂᖕᒋᓐᓄᑦ ᑐᕌᒐᕆᔭᐅᔪᑦ

Population Objectives:

ᕿᓚᐅᒥᓂᐊᖅᑐᒧᑦ ᑐᕌᖕᒐᔪᑦ (12-18–ᓄᑦ ᐊᕐᕋᒍᓄᑦ) Short-term (12-18 years)	ᐊᑯᓂᐅᓂᐊᖅᑐᒧᑦ ᑐᕌᖕᒐᔪᑦ (ᐊᒥᓱᓂᒃ ᑲᔪᓯᔪᒥᒃ ᕿᑐᖕᒋᐅᖅᐸᓪᓕᐊᓯᒪᓕᕐᓗᑎᒃ) Long-term (many generations)
ᑕᐃᒪᐃᓕᖕᒐᐃᓐᓇᕐᑯᓪᓗᒋᑦ ᐊᒥᓱᓇᐊᖅᑕᐅᕐᑯᓪᓗᒋᓪᓗᓐᓂᑦ (ᖃᖕᒐᑐᐃᓐᓇᖅ ᐊᔪᕐᓇᖕᒋᓐᓂᖕᒐᓂ) ᒪᓐᓇᐅᓕᖅᑐᖅ ᐊᒥᓲᑎᒋᓂᖕᒋᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ To maintain or increase (where feasible) the current population level	ᑖᑯᐊ ᐆᒪᔪᐃᑦ ᐆᒪᐃᓇᕈᓐᓇᖅᓯᓂᐊᕐᓗᑎᒃ, ᑐᕐᑯᓴᕋᐃᖕᒋᑦᑐᓐᓇᖅᓯᓗᑎᒃ, ᐊᓂᒍᑎᔪᓐᓇᖅᓯᓗᑎᒃ ᐊᒻᒪᓗ ᐊᒥᓱᓂᖃᑦᑎᐊᕐᓕᕐᓗᑎᒃ ᐊᒥᓲᑎᒋᕙᓚᐅᕐᓂᖕᒋᓐᓂᒃ. The population is self-sustaining, resilient, redundant and representative

ᓇᓂ ᐱᑕᖃᓲᖑᓂᖕᒋᓐᓄᑦ ᑐᕌᒐᕆᔭᐅᔪᑦ

Distribution Objective:

ᐊᕕᓐᖓᐅᔭᐃᑦ ᑕᐃᒪᐃᓕᖕᒐᑎᑕᐅᔪᓐᓇᕈᑎᒃ (ᐅᕝᕙᓗᓐᓃᑦ ᐊᒥᓱᕈᖅᓯᐊᕆᔭᐅᒍᑎᒃ ᐊᔪᕐᓇᖕᒋᓐᓂᖕᒋᓐᓂ) ᑕᐃᒃᑯᑐᓇ ᐊᒥᓲᑎᒋᕙᓚᐅᕐᓂᖕᒋᓐᓄᑦ ᐊᓐᖑᑎᓗᑎᒃ ᓯᕗᓂᐊᒍᑦ ᓱᓕ ᑎᑭᑕᐅᓚᐅᖕᒋᓐᓂᖕᒋᓐᓄᑦ ᖃᑯᒃᓯᓕᕐᓇᖅᑐᒥᒃ ᐅᕐᑯᖑᖅᐸᓪᓕᐊᔫᕐᓇᖅᑐᒥᒃ ᐋᓐᓂᐊᓕᕈᑕᐅᕙᒃᑐᒥᒃ
Maintain (or restore where applicable) the pre-White-nose Syndrome extent of occurrence

ᖃᓄᐃᓕᐅᕈᑎᒃᓴᖏᓐᓂᒃ ᐱᓕᕆᐊᒃᓴᐃᑦ ᐊᒥᓱᕈᖅᓲᓂᕐᒧᑦ
Strategic Direction for Recovery

ᑕᑦᓕᒪᐅᑉᒪᑕ ᓂᕈᑐᓈᖅᑕᐅᒋᐊᖅᓯᒪᔪᓂᒃ ᖃᓄᐃᓕᐅᕈᑎᒃᓴᐃᑦ ᐃᓕᑕᕆᔭᐅᓯᒪᓕᖅᑐᑦ ᐊᒥᓱᕈᖅᓯᐊᕆᔭᐅᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᐱᑕᖃᓕᕐᑯᔭᐅᓂᖏᓐᓄᑦ ᑐᑖᒐᕆᔭᐅᔪᑦ:

There are five broad strategies identified for achieving the population and distribution objectives:

ᓂᕈᑐᓈᖅᑕᐅᓯᒪᓪᓗᑎᒃ ᖃᓄᐃᓕᐅᕈᑎᒃᓴᐃᑦ **Broad Strategy**	ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑕᕐᓂᖏᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᖃᓄᐃᓕᖏᒐᑎᑕᐅᓂᐊᖅᑐᑦ ᐆᒃᑑᑎᑐᐃᓐᓇᐃᑦ **Research and Management Approach Examples**
ᓇᐅᑦᑎᖅᑐᖅᑕᐅᖃᑕᕐᓂᖏᓐᓂᒃ ᐊᒻᒪᓗ ᓈᓴᖅᑕᐅᖃᑦᑕᕐᓂᖏ Monitoring and Surveys	ᐋᕿᐅᒪᑎᑦᑎᓂᖅ ᐊᑑᑎᖃᑦᑎᐊᕐᓂᐊᖅᑐᓂᒃ/ᑲᑐᔾᔨᖃᑎᒌᒍᑕᐅᓂᐊᖅᑐᓂᒃ ᖃᑯᖅᓯᓕᕐᓇᖅᑐᒥᒃ ᐅᕐᑯᒃᐸᓪᓕᐊᔫᕐᓇᖅᑐᖅ ᐋᓐᓂᐊᓕᕈᑎᒋᕙᒃᑕᖏᓂᒃ (WNS ᓇᐃᓈᕐᓗᒍ) ᓇᐅᑦᑎᖅᑑᑎᒃᓴᓂᒃ ᐱᓕᕆᐊᖑᑎᑦᑎᓗᑎᒃ ᑲᓇᑕᓕᒫᒥ ᑕᒪᐃᓐᓂ
Maintain an effective/coordinated WNS surveillance program across Canada	
ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑕᕐᓂᖏᑦ Research	ᖃᐅᔨᓴᕈᓯᖃᕐᓗᑎᒃ ᐱᑕᖃᓕᖅᑎᑦᑎᑕᐃᓕᔪᒪᓂᕐᒧᕐ/ᒥᑭᒡᓕᑎᕆᔪᒪᓂᕐᒧᑦ ᐊᐃᑦᑐᖅᑕᐅᔪᓐᓇᕐᓂᖏᓐᓂᒃ, ᐊᒃᑐᖅᑕᐅᓗᐊᓈᒃᑯᑎᒃᓴᖃᖅᑎᑦᑎᒋᐊᕐᓂᖅ ᐊᒃᑐᖅᑕᐅᓯᒪᔪᓐᓇᕐᓂᖏᓐᓂᒃ ᐊᒻᒪᓗ/ᐅᕝᕙᓗᓐᓃᑦ ᐃᑲᔪᖅᑕᐅᓗᑎᒃ ᐊᒃᑐᖅᑕᐅᓯᒪᔪᑦ ᖃᑯᖅᓯᓕᕐᓇᖅᑐᒥᒃ ᐅᕐᑯᒃᐸᓪᓕᐊᔫᕐᓇᖅᑐᖅ ᐋᓐᓂᐊᓕᕈᑎᖃᕐᓂᖏᑦ (WNS ᓇᐃᓈᕐᓗᒍ)
Investigate techniques to prevent/reduce the spread, mitigate the effects of, and/or treat WNS	

ᖃᓄᐃᓕᐅᕈᑎᒃᓴᖏᓐᓂᒃ ᐱᓕᕆᐊᒃᓴᐃᑦ ᐊᒥᓱᕈᖅᓲᓂᕐᒧᑦ
Strategic Direction for Recovery

ᓂᕈᑐᓈᖅᑕᐅᓯᒪᓪᓗᑎᒃ ᖃᓄᐃᓕᐅᕈᑎᒃᓴᐃᑦ **Broad Strategy**	ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑕᕐᓂᖏᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᖃᓄᐃᓕᖏᒐᑎᑕᐅᓂᐊᖅᑐᑦ ᐆᒃᑑᑎᑐᐃᓐᓇᐃᑦ **Research and Management Approach Examples**
ᐃᓕᓐᓂᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᒻᒪᓗ ᖃᐅᔨᒪᔭᐅᓕᖅᑎᑦᑎᓂᕐᒧᑦ, ᐃᓕᒌᒍᑕᐅᓕᕈᓐᓇᕐᓂᕐᒧᑦ ᑲᑐᔾᔨᖃᑎᒋᒍᑕᐅᓗᑎᒃ ᐊᒻᒪᓗ ᓴᐳᓐᓂᐊᖅᑎᐅᖃᑕᐅᔪᓐᓇᖅᓯᓗᑎᒃ ᐊᓯᖏᑦ Education and Awareness, Partnerships and Stewardship	ᑐᓴᐅᒪᑎᑦᑎᖃᑦᕐᓗᑎᒃ ᐱᒻᒪᕆᐅᓂᖏᓐᓂᒃ ᑕᒪᒃᑯᐊ ᐊᕕᓐᖓᐅᔾᔭᖅᑐᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ ᐃᓄᖕᓄᑦ, ᐊᕙᑎᒧᑦ, ᐊᕙᑎᒥᐅᑕᓕᒫᓄᓪᓗ, ᐊᔾᔨᖏᖏᑑᑎᐅᔪᓄᓪᓗ ᐆᒪᔪᕐᓄᑦ ᐊᒻᒪᓗ ᐆᒪᔾᔪᑕᐅᕙᓂᖏᓐᓄᑦ
Communicate the importance of bats to people, ecosystems, biodiversity and economies	
ᓇᔪᖅᐸᒃᑕᖏᓪᓗ ᐆᒪᔪᐃᓪᓗ ᓴᐳᓐᓂᐊᖅᑕᐅᓂᖏᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑕᐅᕙᓂᖏᑦ Habitat and Species Conservation and Management	ᐊᑐᓕᖅᑎᑕᐅᓂᖏᑦ ᑕᒪᕐᒥᒃ ᖃᐅᔨᒪᔭᐅᔪᑦ ᐅᔾᔨᖅᑑᑦᑎᐊᕈᑎᒃᓴᐅᕙᕆᖅᑐᑦ ᐊᐃᑦᑐᖅᑕᐅᖏᓐᓂᖅᓴᐅᔪᓐᓇᖅᓯᕐᑯᓪᓗᒋᑦ ᖃᓂᒪᓇᖅᑐᓂᒃ ᑕᐃᒃᑯᓂᖓ ᖃᑯᖅᓯᓕᕐᓇᖅᑐᓂᒃ
Implement all known precautionary measures to reduce the spread of WNS	
ᒪᓕᒐᖃᕐᓂᖅ ᐊᒻᒪᓗ ᐊᑐᐊᒐᖃᕐᓂᖅ Law and Policy	ᓴᓇᔭᐅᓗᑎᒃ, ᐊᑐᓕᖅᑎᑕᐅᓗᑎᒡᓗ, ᐱᕙᓪᓕᐊᑎᑕᐅᓗᑎᒡᓗ ᒪᓕᒃᑕᐅᔭᕆᐊᓖᑦ ᑲᓇᑕᒥ/ᑲᓇᑕᐅᑉ ᐊᕕᒃᑐᖅᓯᒪᓂᖏᓐᓂ/ᓄᓇᓕᖕᓂᓗ ᒪᓕᒐᐃᑦ/ᐊᑐᐊᒐᖏᓪᓗ ᐱᔾᔪᑎᖃᖅᑐᑦ ᐅᓗᕆᐊᓇᖅᑐᖃᕈᓐᓃᖅᑎᑦᑎᕙᓪᓕᐊᔪᒪᓂᖅ ᐊᒻᒪᓗ ᐱᔫᒥᓴᐃᓂᖅ ᓴᐳᓐᓂᐊᕈᑎᒃᓴᓂᒃ ᑕᒪᒃᑯᓂᖓ ᐆᒪᔪᓂᒃ, ᓂᕿᒃᓴᕆᕙᒃᑕᖏᓐᓂᒃ ᐊᒻᒪᓗ ᓇᔪᖅᐸᒃᑕᖏᓐᓂᒃ
Develop, implement, and promote compliance with federal/provincial/municipal acts/policies related to reducing threats and encouraging conservation of these species, their prey and their habitat	

ᐱᒻᒪᕆᐅᔪᓂᒃ ᓇᔪᖅᑕᐅᕙᒃᑐᑦ ᓄᓇᖕᒋᑦ ᐱᑕᖃᕆᐊᓕᑦ
Critical Habitat

- ᐱᑕᖃᕆᐊᖃᒻᒪᕆᖕᓂᖕᒋᑦ ᓇᔪᒐᕆᔭᐅᕙᒃᑐᑦ ᐃᓚᐃᓐᓇᖕᒋᓐᓂᒃ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᕗᑦ ᑕᐃᒃᑯᓄᖕᒐ ᑎᑎᕋᖅᑕᐅᕋᓂᓴᖅᓯᒪᔪᒥᒃ ᐊᒥᓱᕈᖅᓲᔪᒪᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕈᑎᒃᓴᓂ
  Critical Habitat is partially identified in the draft recovery strategy.
- ᑎᑎᕋᖅᑕᐅᓯᒪᓂᐊᖅᑐᑦ ᖃᖓᐅᓂᐊᖅᑐᖅ ᖃᐅᔨᓴᖅᑕᐅᕕᒃᓴᖃᕐᓂᐊᕐᒪᖔᑕ ᖃᐅᔨᔭᐅᑦᑎᐊᕈᒪᓂᖕᒋᓄᑦ ᓴᕿᑎᑕᐅᓂᐊᖅᑐᑦ ᐃᓕᑕᕆᔭᐅᔪᓐᓇᖅᓯᕐᑯᓪᓗᒋᑦ ᐱᑕᖃᕆᐊᖃᒻᒪᕆᖕᓂᖕᒋᓐᓂᒃ ᓇᔪᖅᑕᐅᕙᖕᓂᖕᒋᑦ
  A schedule of studies has been developed to provide the information necessary to complete the identification of critical habitat.
- ᐃᓗᓕᖕᒋᓐᓂ ᓇᔪᖅᑕᐅᕙᖕᓂᖕᒋᑦ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᓕᖅᑎᓪᓗᒋ ᐊᑯᓂᐅᔪᒥᒃ ᓯᓂᒃᕕᐅᕙᖕᓂᖕᒋᑦ ᐃᓱᒪᒋᔭᐅᖃᑕᐅᕙᒃᑭᕗᑦ ᐱᒻᒪᕆᐅᔪᓂᒃ ᓇᔪᒐᕆᔭᐅᕙᖕᓂᖅ.
  Within the areas identified, hibernacula are considered critical habitat.
- ᐱᑕᖃᕆᐊᖃᒻᒪᕆᒃᑐᑦ ᓇᔪᒐᕆᔭᐅᕙᖕᓂᖕᒋᑦ ᓄᑖᕈᕆᐊᖅᑕᐅᕙᖕᓂᐊᕐᒥᔪᑦ ᓄᑖᓂᒃ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᐃᑦ ᓴᕿᐸᐸᓪᓕᐊᓂᖕᒋᓐᓂ ᐊᑐᐃᓐᓇᐅᓕᕈᑎᒃ, ᐋᕿᒋᐊᖅᑕᐅᖃᑦᑕᕐᓗᑎᒡᓗᓐᓃᑦ ᐊᒥᓱᕈᖅᓲᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕈᑎᒃᓴᖕᒋᑦ ᐅᕝᕙᓗᓐᓃᑦ ᐱᓕᕆᐊᒃᓴᖕᒋᑦ ᐸᕐᓇᐅᑎᓕᐊᕆᓯᒪᓂᐊᖅᑕᖕᒋᑦ
  Critical Habitat may be updated as new information becomes available, either in a revised recovery strategy or action plan(s).

ᐱᓕᕆᐊᖑᓕᖅᐸᒃᑐᑦ ᓱᕈᖅᑎᕆᓕᕈᓐᓇᖅᑐᑦ ᐱᒻᒪᕆᐅᔪᓂᒃ ᐱᑕᖃᕆᐊᖃᖅᑐᓂᒃ ᓇᔪᖅᑕᐅᕙᒃᑐᓂᒃ ᑐᒃᑐᓄᑦ
Activities Likely to Destroy Critical Habitat

- ᐃᓱᒪᓕᐅᕈᑕᐅᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐊᑐᓂ ᐃᖕᒥᒍᖅᑎᑕᐅᖃᑦᑕᕐᓗᑎᒃ ᑐᑭᓯᒋᐊᖅᑕᐅᑦᑎᐊᖃᓚᕐᓗᑎᒃ
  Determined on a case-by-case basis

- ᓱᕋᖅᑎᖅᑕᐅᓂᕋᐃᓇᔭᖅᐳᑦ ᑕᐃᒃᑯᐊ ᐃᓚᐃᓐᓇᕋᓗᐊᖕᒋᑦ ᓇᔪᒐᕆᔭᐅᕙᖕᓂᖕᒋᑦ ᖃᖓᓕᒫᒧᑦ/ᐊᑯᓂᐅᖕᒋᑦᑐᒧᓗᓐᓃᑦ ᐱᐅᔪᓐᓃᖅᑎᑕᐅᒍᑎᒃ ᑕᐃᒫᒃ ᐊᑐᖅᑕᐅᔪᓐᓇᐃᓪᓕᐅᖃᓗᑎᒃ ᑕᒪᒃᑯᓄᖕᒐ ᐆᒪᔪᕐᓄᑦ ᐊᑐᖅᑕᐅᔭᕆᐊᖃᖅᑎᓪᓗᒋᑦ.
  Destruction would result if part of the critical habitat were permanently/temporarily degraded such that it would not serve its function when needed by the species

- ᑕᐃᒃᑯᐊ ᓱᕋᒃᑎᖅᑕᐅᓂᖕᒋᑦ ᓴᕿᑦᑐᓐᓇᕐᒥᔪᑦ ᒪᑯᓇᖕᒐᑦ:
  Destruction may result from:
  - ᐊᑕᐅᓯᐅᔪᒥᒃ/ᐊᒥᓱᓄᓪᓗᓐᓃᑦ ᐱᓕᕆᕕᐅᓂᖕᒋᓐᓄᑦ
    Single/multiple activities at one time
  - ᐱᕙᓪᓕᐊᔪᓂᒃ ᐊᒃᑐᖅᑕᐅᓯᒪᓂᖕᒋᓐᓄᑦ ᐊᑕᐅᓯᕐᒧᓪᓗᓐᓃᑦ/ᐊᒥᓱᓄᓪᓗᓐᓃᑦ ᐱᓕᕆᕕᐅᖃᑦᑕᖅᓯᒪᓂᖕᒋᓐᓄᑦ ᖃᖓᑐᐃᓐᓇᖅ
    Cumulative effects of single/multiple activities over time

ᒥᑭᔪᑦᑏᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ - ᐆᒃᑐᕋᐅᑏᑦ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᐃᑦ ᑲᔪᓯᓯᒪᑦᑎᐊᕐᒪᖔᑕ

Little Brown Myotis – Measuring Success

- ᑲᔪᓯᑦᑎᐊᕈᓐᓇᕐᓂᖏᑦ ᐆᒪᔪᐃᑦ ᐊᒥᓲᓂᖏᑦ ᐊᒻᒪᓗ ᓇᓂ ᐱᑕᖃᓲᖑᓂᖏᓐᓄᑦ ᑐᕌᒐᓇᔭᐅᔪᑦ ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑕᕐᓂᐊᖅᑐᑦ, ᓇᓗᓇᐃᔭᐃᔪᓐᓇᕐᓂᕐᒧᑦ ᐃᒪᓐᓇᐃᓕᖓᔪᖃᖅᐸᑦ:
  Success of the population and distribution objectives will be evaluated to determine if:
  - ᐱᑕᖃᕐᓂᖏᑦ ᒥᑭᑦᑐᑦ ᑲᔪᐃᑦ ᐊᕕᓐᖓᐅᔭᐃᑦ ᑕᐃᒪᐃᓕᖓᑎᑕᐅᔪᓐᓇᕈᑎᒃ (ᐅᕝᕙᓗᓐᓃᑦ ᐊᒥᓱᕈᖅᓯᐊᕆᔭᐅᒍᑎᒃ ᐊᔪᕐᓇᖏᓐᓂᖏᓐᓂ) ᑕᐃᒃᑯᓄᖓᑎᒋ ᐊᒥᓲᑎᒋᕙᓚᐅᕐᓂᖏᓐᓄᑦ ᐊᓐᖑᑎᓗᑎᒃ, ᓯᕗᓂᐊᒍᑦ ᓱᓕ ᑎᑭᑕᐅᓚᐅᖏᓐᓂᖏᓐᓄᑦ ᖃᑯᖅᓯᓕᕐᓇᖅᑐᒥᒃ ᐅᕐᑯᒃᐸᓪᓕᐊᔫᕐᓇᖅᑐᖅ ᐋᓐᓂᐊᓕᕈᑎᒋᕙᒃᑕᖏᓂᒃ (WNS ᓇᐃᓈᕐᓗᒍ---ᓇᓗᓇᐃᖅᑕᐅᑦᑎᐊᒃᑲᓐᓂᖃᑦᑕᕐᓂᐊᖅᑐᓂᒃ ᑕᓪᓕᒪᐃᑦ 5 ᐊᕐᕋᒍᑕᒫᖅ ᓇᔭᕌᖓᑕ)
  The extent of occurrence of Little Brown Myotis is maintained (or restored where applicable) to the pre-WNS extent (to be verified every 5 years).
  - ᕿᓚᒥᐅᓂᖅᓴᐅᓂᐊᖅᑐᒥ (12-18-ᓄᑦ ᐊᕐᕋᒍᓂᒃ), ᐃᓗᐊᓂ ᖃᑯᖅᓯᓕᕐᓇᖅᑐᒥᒃ ᐅᕐᑯᒃᐸᓪᓕᐊᔫᕐᓇᖅᑐᖅ ᐋᓐᓂᐊᓕᕈᑎᕐᑲᖅᓯᒪᔪᓂ, ᐋᕿᐅᒪᔪᓐᓇᕈᑎᒃ ᐊᒻᒪᓗ ᐊᒥᓱᕈᓇᐊᖅᑎᑦᑎᓗᑎᒃ (ᐊᔪᕐᓇᖏᓂᖏᓐᓂᒃ) ᒫᓐᓇᐅᔪᖅ ᐱᑕᖃᖅᑎᒋᓂᖏᓐᓂᒃ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐅᓐᓄᐊᖅᓯᐅᑏᑦ.
  In the short term (12-18 years) within WNS-affected areas, the population is maintained and increased (where feasible) at its current level.
  - ᐊᑯᓂᐊᓂᐊᖅᑐᒧ (ᐊᒥᓱᓂᒃ ᐃᕐᓂᐅᖅᐸᓪᓕᐊᓯᒪᓂᖏᓐᓄᑦ ᕿᑐᖏᐅᖅᐸᓪᓕᐊᔫᒪᕐᒥᔪᓂᒃ ᐊᕕᓐᖓᐅᔭᐃᑦ) ᐃᓗᐊᓂ ᖃᑯᖅᓯᓕᕐᓇᖅᑐᒥᒃ ᐅᕐᑯᒃᐸᓪᓕᐊᔫᕐᓇᖅᑐᖅ ᐋᓐᓂᐊᓕᕈᑎᕐᑲᖅᓯᒪᔪᓂ, ᑖᒃᑯᐊ ᐊᕕᓐᖓᐅᔭᐃᑦ ᐃᖏᓂᒃ ᐆᒪᐃᓇᕈᓐᓇᖅᓯᓂᐊᕐᓗᑎᒃ, ᑐᕐᑯᓴᕋᐃᖏᑦᑐᓐᓇᖅᓯᓗᑎᒃ, ᐊᓂᒎᑎᔪᓐᓇᖅᓯᓗᑎᒃ ᐊᒻᒪᓗ ᐊᒥᓱᓂᖃᑦᑎᐊᕐᓕᕐᓗᑎᒃ ᐊᒥᓲᑎᒋᕙᓚᐅᕐᓂᖏᓐᓂᒃ.
  In the long term (many generations) within WNS-affected areas, the population is self-sustaining, resilient, redundant and representative.

ᑭᖑᓕᕐᒥ ᖃᓄᐃᓕᒋᐊᕐᓃᑦ

Next Steps

- ᑭᖑᓂᐊᒍᑦ ᐊᓯᐃᓛᒃ 60-ᓂᒃ ᐅᓪᓗᓂᒃ ᐃᓄᓕᒫᓂᑦ ᐅᖃᐅᓯᒃᓴᖃᕐᕕᐅᑎᑕᐅᓚᐅᖅᑐᓂᒃ, ᐊᕙᑎᓕᕆᔨᒃᑯᑦ ᓯᓚᐅᓪᓗ ᐊᓯᔾᔨᖅᐸᓕᐊᓂᖓᓂᒃ ᑲᓇᑕᒥ ᑐᓂᓯᓕᖅᐳᑦ ᑕᐃᒃᑯᓂᖓ ᐱᒋᐊᖅᑎᑦᑐᒪᔭᖏᓐᓂᒃ ᐃᓱᒪᓕᐅᕈᑕᐅᕐᑯᔨᓂᕐᒥᓂᒃ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᑲᑎᒪᔨᖏᓐᓄᑦ, ᐃᓚᖃᖅᑐᓂᒃ ᐱᒋᐊᖅᑎᑦᑐᒪᔭᖏᓐᓂᒃ ᑭᖑᓪᓕᖅᐸᕆᔭᐅᓂᐊᖅᑐᓂᒃ ᐊᒥᓱᕈᖅᓯᐊᕆᔭᐅᓂᖏᓐᓄᑦ ᖃᓄᐃᓕᐅᕈᑎᒃᓴᐅᓇᔭᖅᑐᓂᒃ.
  Following the 60-day public comment period, Environment and Climate Change Canada is providing the Proposal for Decision to the NWMB which includes the proposed final recovery strategy.
- ᐊᕙᑎᓕᕆᔨᒃᑯᑦ ᓯᓚᐅᓪᓗ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖓᓄᑦ ᑲᓇᑕᒥ ᐱᓕᕆᔨᖏᑦ ᒫᓐᓇᐅᓕᖅᑐᖅ ᐸᕐᓇᒃᓯᒪᓕᖅᑐᑦ ᓴᕿᑎᑦᑎᔪᓐᓇᖅᓯᓂᖅ ᐊᒥᓱᕈᖅᓲᔪᑎᒃᓴᖏᓐᓂᒃ ᑎᑎᕐᑲᓂᒃ ᐱᓪᓗᒋᑦ ᐆᒪᔪᐃᑦ ᐊᒥᓲᖏᓗᐊᓕᕐᓂᖏᓐᓄᑦ ᐃᓕᑕᕆᔭᐅᓯᒪᕝᕕᖏᓐᓂᒃ ᑎᑎᕋᕐᕕᐅᕙᒃᑐᓂᒃ, ᑭᖑᓪᓕᖅᐹᖅᖑᓂᐊᓕᖅᑐᓂᒃ.
  Environment and Climate Change Canada is now prepared to post the recovery document on the Species at Risk Registry as final.
- ᐊᕙᑎᓕᕆᔨᒃᑯᑦ ᓯᓚᐅᓪᓗ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖓᓄᑦ ᑲᓇᑕᒥ ᑐᓂᓯᓕᖅᐳᑦ ᑕᐃᒃᑯᐊ ᐊᒥᓱᕈᖅᓲᔪᑎᒃᓴᓄᑦ ᑎᑎᕐᑲᕐᑯᑎᖏᓐᓂᒃ ᓄᓇᕗᒻᒥ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᑦ ᑲᑎᒪᔨᖏᓐᓄᑦ, ᑭᖑᓪᓕᖅᐹᕐᒥᒃ ᐊᖏᖅᑕᐅᓂᖏᓐᓄᑦ ᐃᓱᒪᓕᐅᕈᑎᒃᓴᓄᑦ, ᒪᓕᒋᐊᖃᕋᒥᒃ ᓄᓇᕗᒻᒥ ᓄᓇᑖᕈᑎᓂᒃ ᒪᓕᒐᖏᓐᓂᒃ ᓈᓴᐅᑎᓕᖓᓂᒃ 5.2.34-ᒥᒃ.
  Environment and Climate Change Canada is providing the recovery document to the NWMB for final approval decision as per the NLCA s. 5.2.34.

ᑐᒃᓯᕋᕐᓂᖅ ᑲᑎᒪᔨᑯᓂᑦ
Request of the Board

- ᓄᓇᕗᒻᒥ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᑲᑎᒪᔨᖏᑦ ᐃᓱᒪᒃᓴᖅᓯᐅᕈᑎᕐᑲᕐᓂᐊᕐᒪᖔᑖ ᐊᖏᖅᑕᐅᓂᐊᕐᒪᖔᑕ ᐊᒥᓱᕈᖅᓲᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕈᑎᒃᓴᐃᑦ ᐅᕝᕙᓗᓐᓂᑦ ᐊᑐᕈᒪᔾᔭᖏᓐᓂᖅ ᐃᓱᒪᓕᐅᕈᑎᕐᑲᕈᓐᓇᕐᓂᕐᒥᓂᒃ.
  That the NWMB considers whether or not they will make a decision on the approval of the recovery strategy, or to not perform its decision-making function.

- ᓄᓇᕗᒻᒥ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᑲᑎᒪᔨᖏᑦ ᐃᓱᒪᓕᐅᖅᓯᒪᓕᕈᑎᒃ ᐃᓱᒪᓕᐅᕈᑎᕐᑲᕈᒪᓚᖔᓂᖅ ᐊᖏᖅᑕᐅᕐᑯᔨᓂᖅ ᐊᒥᓱᕈᖅᓲᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕈᑎᒃᓴᓕᐊᕆᔭᐅᓯᒪᔪᓂᒃ, ᑲᑎᒪᔨᖏᑦ ᐃᓱᒪᒃᓴᖅᓯᐅᕈᑎᕐᑲᕆᐊᕐᑲᖅᐳᑦ ᐊᖏᖅᑕᐅᓂᐊᕐᒪᖔᑕᔫᓐᓃᑦ ᐊᖏᖅᑕᐅᓂᐊᖏᒻᒪᖔᑕᓗᓐᓃᑦ ᑭᖑᓪᓕᖅᐹᒥᒃ ᐊᒥᓱᕈᖅᓲᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕈᑎᒃᓴᓄᑦ ᒥᑭᔪᓂᒃ ᑲᔪᕐᓂᒃ ᐊᕕᓐᖓᐅᔭᕐᓂᒃ, ᐅᑭᐅᖅᑕᖅᑑᓂᕐᒥ ᐊᕕᓐᖓᐅᔭᕐᓂᒃ ᐊᒻᒪᓗ ᐊᒥᓱᒐᓴᖕᓂᒃ ᑕᖅᓴᓕᖕᓂᒃ ᐊᕕᓐᖓᐅᔭᕐᓂᒃ ᑲᓇᑕᒥ ᒪᓕᒃᑕᐅᓗᑎᒃ ᑲᓇᑕᒥᐅᑕᓕᒫᓄᑦ ᐆᒪᔪᐃᑦ ᐊᒥᓲᖕᒋᓗᐊᓕᕐᓂᖕᒋᓐᓄᑦ ᒪᓕᒐᐃᑦ, ᒪᓕᒃᑕᐅᓗᑎᒃ ᓄᓇᕗᒻᒥ ᓄᓇᑖᕈᑎᓄᑦ ᐊᖏᕈᑏᑦ ᐃᓗᓕᖏᑦ 5.2.34-ᒥᑦᑐᑦ.
  That if the NWMB decides to make a decision on the approval of the recovery strategy, the NWMB considers whether or not they approve the final *Recovery Strategy for the Little Brown Myotis, Northern Myotis and Tri-coloured Bat in Canada* under the federal *Species at Risk Act* as per the NLCA s. 5.2.34.

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and Tri-colored Bat (*Perimyotis subflavus*) in Canada

Little Brown Myotis
Northern Myotis
Tri-colored Bat

2016

Government of Canada
Gouvernement du Canada

Canada

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For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustrations: Left: Northern Myotis, © Jordi Segers; Center: Little Brown Myotis, © Hugh Broders; Right: Tri-colored Bat © Hugh Broders

Également disponible en français sous le titre
« Programme de rétablissement de la petite chauve-souris brune (*Myotis lucifugus*), de la chauve-souris nordique (*Myotis septentrionalis*) et de la pipistrelle de l'Est (*Perimyotis subflavus*) au Canada »

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[1] http://www.registrelep-sararegistry.gc.ca

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of the Environment and Minister responsible for Parks Canada Agency is the competent minister under SARA for the Little Brown Myotis, Northern Myotis, and Tri-colored Bat and has prepared this recovery strategy, as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the provinces of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, and Newfoundland and Labrador, as well as the territories of Yukon and Northwest Territories, and the Sahtu Renewable Resources Board, and Wek'èezhìi Renewable Resources Board.

Success in the recovery of these species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment and Climate Canada and the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Little Brown Myotis, Northern Myotis, and Tri-colored Bat and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment and Climate Canada, the Parks Canada Agency, and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When the recovery strategy identifies critical habitat, there may be future regulatory implications, depending on where the critical habitat is identified. SARA requires that critical habitat identified within federal protected areas be described in the *Canada Gazette*, after which prohibitions against its destruction will apply. For critical habitat located on federal lands outside of federal protected areas, the Minister of the Environment must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies. For critical habitat located on non-federal lands, if the Minister of the Environment forms the opinion that any portion of critical

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2

habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, and not effectively protected by the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to extend the prohibition against destruction of critical habitat to that portion. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

Acknowledgments

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Executive Summary

Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and Tri-colored Bat (*Perimyotis subflavus*) are small, insectivorous species of the Family Vespertilionidae. The three species were emergency listed as Endangered on Schedule 1 of the federal *Species at Risk Act* (SARA) in 2014 because of sudden and dramatic declines across the eastern portions of the ranges of Little Brown Myotis and Northern Myotis, and throughout the entire Canadian range of Tri-colored Bat. These declines are the direct result of white-nose syndrome (WNS).

Little Brown Myotis and Northern Myotis have been confirmed in every province and territory except Nunavut. Approximately 50% and 40% of their global ranges occur in Canada, respectively. Tri-colored Bat has been recorded in Ontario, Quebec, New Brunswick, and Nova Scotia, and 10% of its global population is estimated to occur in Canada.

The single greatest threat to Little Brown Myotis, Northern Myotis, and Tri-colored Bat is WNS. Because of the significance of WNS, where appropriate, this recovery strategy differentiates between areas affected by WNS and those not yet affected (e.g., within threats, and recovery approaches). In areas already affected by WNS, the significance of other threats to the three species of bats is heightened because the mortality of a small number of the remaining individuals (particularly adults) has the ability to impact the survival of local populations, their recovery, and, perhaps, the development of resistance to the fungus that causes WNS. Threats other than WNS include habitat loss and degradation (e.g., destruction or degradation of hibernacula, maternity roosts, and foraging areas), disturbance or harm (e.g., collisions with or barotrauma[3] from wind turbines, intentional harm to individuals, recreational or scientific disturbance, and industrial disturbance), pollution, and climate change.

The feasibility of recovery for Little Brown Myotis, Northern Myotis, and Tri-colored Bat in Canada is unknown. In keeping with the precautionary principle, this recovery strategy has been prepared as per section 41(1) of SARA.

The short-term (12-18 years) population objective for both Little Brown Myotis and Northern Myotis is to maintain and increase (where feasible) the current population level. The long-term (many generations) population objective is a self-sustaining, resilient, redundant and representative population (see section 5: *Population and Distribution Objectives* for further details and definitions). The distribution objective for both the Little Brown Myotis and Northern Myotis is to maintain (or where applicable restore to) the pre-WNS extent of occurrence.

The short-term population objective for Tri-colored Bat is to maintain and increase (where feasible) the population compared to its current level over the next 10 years. The

[3] Barotrauma is injury resulting from a change in air pressure.

long-term population objective is a self-sustaining, resilient, redundant and representative population. The distribution objective is to restore (then maintain) the pre-WNS extent of occurrence.

Broad strategies aimed at supporting the survival and recovery of Little Brown Myotis, Northern Myotis, and Tri-colored Bat are presented in section 6.2: *Strategic Direction for Recovery*. Approaches required to meet population and distribution objectives will be different in areas where WNS has already caused dramatic declines, compared to areas not yet affected by WNS.

Critical habitat for these three species is partially identified in this recovery strategy. A schedule of studies is included to obtain the information needed to complete the identification of critical habitat.

One or more action plans for Little Brown Myotis, Northern Myotis, and Tri-colored Bat will be posted on the Species at Risk Public Registry within three years following the final posting of this recovery strategy.

Recovery Feasibility Summary

Based on the following four criteria that the Government of Canada uses to determine recovery feasibility, the feasibility of recovery for Little Brown Myotis, Northern Myotis, and Tri-colored Bat is unknown. In keeping with the precautionary principle, a recovery strategy has been prepared as per section 41(1) of SARA, as would be done when recovery is determined to be feasible. This recovery strategy addresses the lack of knowledge related to the feasibility of recovery. Tri-colored Bat's recovery feasibility is assessed separately because, unlike Little Brown Myotis and Northern Myotis, WNS encompasses Tri-colored Bat's entire Canadian range.

Little Brown Myotis and Northern Myotis

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Yes. In the provinces and territories where WNS has not been detected, these species are apparently abundant throughout much of their range. At present, it is believed that there are currently adequate numbers of breeding individuals in the Prairies and western Canada to sustain the species in Canada or increase their abundances. The number of individuals remaining in most parts of eastern Canada and the United States (U.S) is very small. Hence, rescue from outside populations (i.e., the U.S.) is not considered likely. However, there are early indications in some portions of their range that a very small proportion of individuals may survive WNS.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Unknown. Sufficient suitable summering habitat (i.e., roosting and foraging habitat) is likely available, and it is possible that more could be made available through management or restoration. However, not all locations are known. Suitable wintering habitat (i.e., hibernacula) that is free of the spores that cause WNS is probably sufficient in the Prairies and western and northern Canada, but has substantially declined in many areas of eastern Canada. Although the habitat characteristics of hibernacula are generally known in eastern Canada, the locations of some hibernacula there remain unknown. In the Prairies, western Canada, and northern Canada, the habitat characteristics and locations of hibernacula are not well understood. Currently, it is not possible to identify available, but currently unoccupied wintering habitat that may be needed for recovery for either of these two species.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Unknown. The primary threat to these species is WNS which is caused by an invasive fungus (*Pseudogymnoascus destructans*). Spores that cause WNS are introduced to uninfected hibernacula. Limiting the human-assisted spread of WNS by avoiding

activities that can cause the spores to spread to uninfected hibernacula may be possible through education and adherence to handling protocols and beneficial management practices (BMPs). Nevertheless, WNS is predicted to continue to spread across Canada from bat-to-bat contact. It is unknown if natural barriers (e.g., Rocky Mountains) may halt or slow the spread of the disease by bats. No widely tested treatment for WNS exists, but intensive research is currently focused on potential treatment and mitigation measures. New research has found substances from certain bacterium and yeast that inhibit the growth of *P. destructans* in the laboratory. This research is still in early stages of development and the effectiveness of its application in the field is unknown.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Unknown. Although WNS has primarily spread through Canada by bats, habitat management and stewardship to prevent (or slow) the human-assisted spread of the spores that cause WNS may be effective at delaying loss of individuals while potential treatments and mitigation measures are researched. Conservation of maternity roosts where bats are known to raise young is likely to aid in the recovery of these species. Appropriately designed and tested habitat enhancement techniques that increase the availability of optimal roosting locations for bats to raise young may additionally aid in the recovery of these species. In addition, limiting access and disturbance to hibernacula can have positive effects on population growth.

<u>Tri-colored Bat</u>

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Yes. In eastern Canada, where this species and WNS are present, Tri-colored Bat continues to persist at very low population levels. Populations also continue to exist in the U.S., although rescue from outside populations is not considered likely. There are no reliable Canadian estimates of population size. At present, it is believed that there are individuals, albeit limited, capable of reproduction available to increase population abundances.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Unknown. Sufficient suitable summering habitat (i.e., roosting and foraging habitat) is likely available, although not all locations are known. Suitable wintering habitat (i.e., hibernacula) that is free of the fungus that causes WNS may be non-existent because Tri-colored Bat's entire Canadian range overlaps with the areas affected by WNS. Not all locations of hibernacula are known for this species. It is currently not possible to identify available but currently unoccupied habitat that may be needed for recovery.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Unknown. The primary threat to these species is an invasive fungus (*Pseudogymnoascus destructans*). No widely tested treatment for WNS exists, but intensive research is currently focused on potential treatment and mitigation measures. New research has found substances from certain bacterium and yeast that inhibit the growth of *P. destructans* in the laboratory. This research is still in early stages of development and its effectiveness of application in the field is unknown.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Unknown. Because it is presumed that WNS encompasses the entire range of Tri-colored Bat in Canada, it will be challenging to conduct the necessary research for the treatment of WNS within a reasonable timeframe for recovery. This is an area of intensive ongoing research.

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1. COSEWIC* Species Assessment Information

Date of Assessment: November 2013

Common Name (population): Little Brown Myotis

Scientific Name: *Myotis lucifugus*

COSEWIC Status: Endangered

Reason for Designation: Approximately 50% of the global range of this small bat is found in Canada. Sub-populations in the eastern part of the range have been devastated by White-nose Syndrome, a fungal disease caused by an introduced pathogen. This disease was first detected in Canada in 2010, and to date has caused a 94% overall decline in known numbers of hibernating *Myotis* bats in Nova Scotia, New Brunswick, Ontario, and Québec. The current range of White-nose Syndrome has been expanding at an average rate of 200-250 kilometres per year. At that rate, the entire Canadian population is likely to be affected within 12 to 18 years. There is no apparent containment of the northward or westward spread of the pathogen, and proper growing conditions for it exist throughout the remaining range.

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

COSEWIC Status History: Designated Endangered in an emergency assessment on February 3, 2012. Status re-examined and confirmed in November 2013.

Date of Assessment: November 2013

Common Name (population): Northern Myotis

Scientific Name: *Myotis septentrionalis*

COSEWIC Status: Endangered

Reason for Designation: Approximately 40% of the global range of this northern bat is in Canada. Sub-populations in the eastern part of the range have been devastated by White-nose Syndrome, a fungal disease caused by an introduced pathogen. This disease was first detected in Canada in 2010 and to date has caused a 94% overall decline in numbers of known hibernating *Myotis* bats in Nova Scotia, New Brunswick, Ontario, and Québec hibernacula compared with earlier counts before the disease struck. Models in the northeastern United States for Little Brown Myotis predict a 99% probability of functional extirpation by 2026. Given similar life history characteristics, these results are likely applicable to this species. In addition to its tendency to occur in relatively low abundance levels in hibernacula, there is some indication this species is experiencing greater declines than other species since the onset of White-nose Syndrome. The current range of White-nose Syndrome overlaps with approximately one third of this species' range and is expanding at an average rate of 200 to 250 kilometres per year. At that rate, the entire Canadian population will likely be affected within 12 to 18 years. There is no apparent containment of the northward or westward spread of the pathogen, and proper growing conditions for it exist throughout the remaining range.

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

COSEWIC Status History: Designated Endangered in an emergency assessment on February 3, 2012. Status re-examined and confirmed in November 2013.

Date of Assessment: November 2013

Common Name (population): Tri-colored Bat

Scientific Name: *Perimyotis subflavus*

COSEWIC Status: Endangered

Reason for Designation: This bat is one of the smallest bats in eastern North America. Approximately 10% of its global range is in Canada, and it is considered rare in much of its Canadian range. Declines of more than 75% have occurred in the known hibernating populations in Québec and New Brunswick due to White-nose Syndrome. This fungal disease, caused by an invasive pathogen, was first detected in Canada in 2010, and has caused similar declines in Little Brown Myotis and Northern Myotis in eastern Canada and the northeastern United States. Most of the Canadian range of the species overlaps with the current White-nose Syndrome range, and further declines are expected as more hibernacula continue to become infected.

Canadian Occurrence: Ontario, Quebec, New Brunswick, Nova Scotia

COSEWIC Status History: Designated Endangered in an emergency assessment on February 3, 2012. Status re-examined and confirmed in November 2013.

*COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

2. Species Status Information

Approximately 50%, 40%, and 10% of the global ranges of Little Brown Myotis, Northern Myotis, and Tri-colored Bat, respectively, occur in Canada (COSEWIC 2013).

Little Brown Myotis, Northern Myotis, and Tri-colored Bat were listed as Endangered in Canada under Schedule 1 of the *Species at Risk Act* (SARA, c. 29) in November 2014 by an emergency listing order. Little Brown Myotis and Northern Myotis were listed as Endangered in January 2013 on the Species at Risk in Ontario (SARO) List (O. Reg. 230/08) under Ontario's *Endangered Species Act*, *2007* (OMNRF 2015). The three species also receive protection under Ontario's *Fish and Wildlife Conservation Act*, *1997* as specially protected mammals. All three species were listed as Endangered by the New Brunswick *Species at Risk Act* in June 2013 and were added to the list of animals protected under the Nova Scotia *Endangered Species Act* in July 2013. Little Brown Myotis and Northern Myotis were listed as Endangered under Manitoba's *Endangered Species and Ecosystems Act* in June 2015.

These species are not listed under the provincial and territorial endangered species legislations of Yukon, British Columbia, Northwest Territories, Alberta, Saskatchewan, Quebec, or Newfoundland and Labrador, although they are afforded protections under the Wildlife Acts of these provinces and territories. In Quebec, the three species are on the *Liste des espèces susceptibles d'être désignées menacées ou vulnérables* (list of wildlife species likely to be designated threatened or vulnerable). This list is produced according to the *Loi sur les espèces menacées ou vulnérables* (RLRQ, c E-12.01) (Act respecting threatened or vulnerable species) (CQLR, c E-12.01), but it does not afford any extra protection to the species. In Saskatchewan, *The Wildlife Amendment Regulation*, 2013 removed all Chiroptera in Saskatchewan from the list of unprotected wildlife, thereby granting them protection from all harm. These species are not listed, nor do they receive protection under the *Wildlife Conservation Act* in Prince Edward Island. The Province of Newfoundland and Labrador are in the process of assessing the bat species for inclusion on their *Endangered Species Act*. There are no confirmed records of these species in Nunavut, but there has been limited survey coverage.

NatureServe (2015) ranks for Canada and the United States (U.S.) are presented in Table 1.

Table 1. Global, national, and sub-national NatureServe ranks for Little Brown Myotis, Northern Myotis, and Tri-colored Bat as of June 2015 (based on personal communications with provincial Conservation Data Centres (CDC) and/or available online data).

	Little Brown Myotis	***Northern Myotis***	***Tri-colored Bat***	***Presence of WNS (winter discovered)***
Global	G3G4	G1G2	G3G4	
United States	N3	N1N2	N3N4	√ (2006-2007)
Canada	N3	N2N3	N2N3	
Newfoundland	S4	S2S3	Not Applicable	
Labrador	S4	SNR	Not Applicable	
Nova Scotia	S1	S2	S1	√ (2010-2011)
PEI	S1	S1	Not Applicable	√ (2012-2013)
Quebec	S1	S1	S1	√ (2009-2010)
New Brunswick	S1	S1	S1	√ (2010-2011)
Ontario	S4	S3	S3?	√ (2009-2010)
Manitoba	S2N, S5B	S3S4N, S4B	Not Applicable	
Saskatchewan	S5B, S5N	S4B, SNRN	Not Applicable	
Alberta	S5	S2S4	Not Applicable	
British Columbia	S4	S3S4	Not Applicable	
NT	S2	S2	Not Applicable	
Yukon	S1S3	S1S2	Not Applicable	

Types of ranks: G = global conservation status rank, N = national conservation status rank, and S = sub-national (provincial or territorial) ranks.
Definitions of rank: 1 = critically imperiled; 2 = imperiled; 3 = vulnerable; 4 = apparently secure; 5 = secure; SNR = unranked; SU = unrankable; B = breeding; N = non-breeding.

3. Species Information

3.1 Species Description

Little Brown Myotis

Little Brown Myotis is a small (7-9 g) brown bat with black ears, black wings, and a black tail membrane (van Zyll de Jong 1985). Its wingspan is approximately 22-27 cm. Females tend to be slightly larger than males (Harvey et al. 2011). Compared to other mammals, Little Brown Myotis has a long lifespan; some individuals live more than 30 years (Davis and Hitchcock 1995). When acoustically recorded in treed or otherwise cluttered environments, Little Brown and Northern Myotis produce echolocation calls that are very similar and can be confused with other *Myotis* species.

Northern Myotis

Northern Myotis, also known as Northern Long-eared Bat, is a small bat (5-8 g) similar in size and colouration to Little Brown Myotis, but is generally distinguishable by its longer ears that extend beyond the nose when pressed forward, longer tail, and larger wing area (Caceres and Barclay 2000, Harvey et al. 2011). It can also be distinguished by its tragus[4], which is long and thin with a pointed tip (van Zyll de Jong 1985). Northern Myotis has similar life history characteristics to Little Brown Myotis; the longevity record in the wild is 18.5 years (Caceres and Barclay 2000).

Tri-colored Bat

Tri-colored Bat, formerly known as Eastern Pipistrelle (*Pipistrellus subflavus*), has a distinct colouration; each hair is black at the base, yellow in the middle, and brown at the tip giving the bat an overall reddish-brown to yellowish-brown colour (Harvey et al. 2011). Its ears and face are brown, forearms are orange-red or pinkish, and its wings and flight membranes are blackish (Fujita and Kunz 1984, Naughton 2012). Tri-colored Bat is similar in size and weight (5-9 g) to Little Brown Myotis and Northern Myotis (Fujita and Kunz 1984, van Zyll de Jong 1985, Farrow and Broders 2011).

3.2 Population and Distribution

DISTRIBUTION

Little Brown Myotis

Little Brown Myotis has been confirmed in every province and territory throughout Canada with the exception of Nunavut where no known observations meeting

[4] Tragus is a prominence on the inner side of the external ear.

evidentiary standards exist (i.e., recorded but not confirmed) (COSEWIC 2013). In general, its Canadian distribution includes the boreal forest south of the treeline through to the U.S. border (van Zyll de Jong 1985, Grindal et al. 2011, Burles et al. 2014) (Figure 1).

The northern limit of its distribution is difficult to define because of limited survey effort and difficulties related to survey logistics (e.g., large area, few roads – see Jung et al. 2014 for a more comprehensive explanation). Few maternity roosts or hibernacula have been located in the northern portions of the range (COSEWIC 2013); however, Wilson et al. (2014) observed reproductive females and maternity colonies of Little Brown Myotis in southwest and south central Northwest Territories. The species is also found south of 64° in Yukon (Slough and Jung 2008). Hibernacula have been confirmed in the Northwest Territories though no hibernacula have been found in Yukon (Slough and Jung 2008, Wilson et al. 2014). Scattered records from Nunavut and northern Northwest Territories exist (i.e., north of the defined range in Figure 1); however, it is unclear if these records represent resident breeding individuals or extralimital[5] observations (COSEWIC 2013).

[5] Extralimital observations refer to observations that occur outside the defined range of the species.

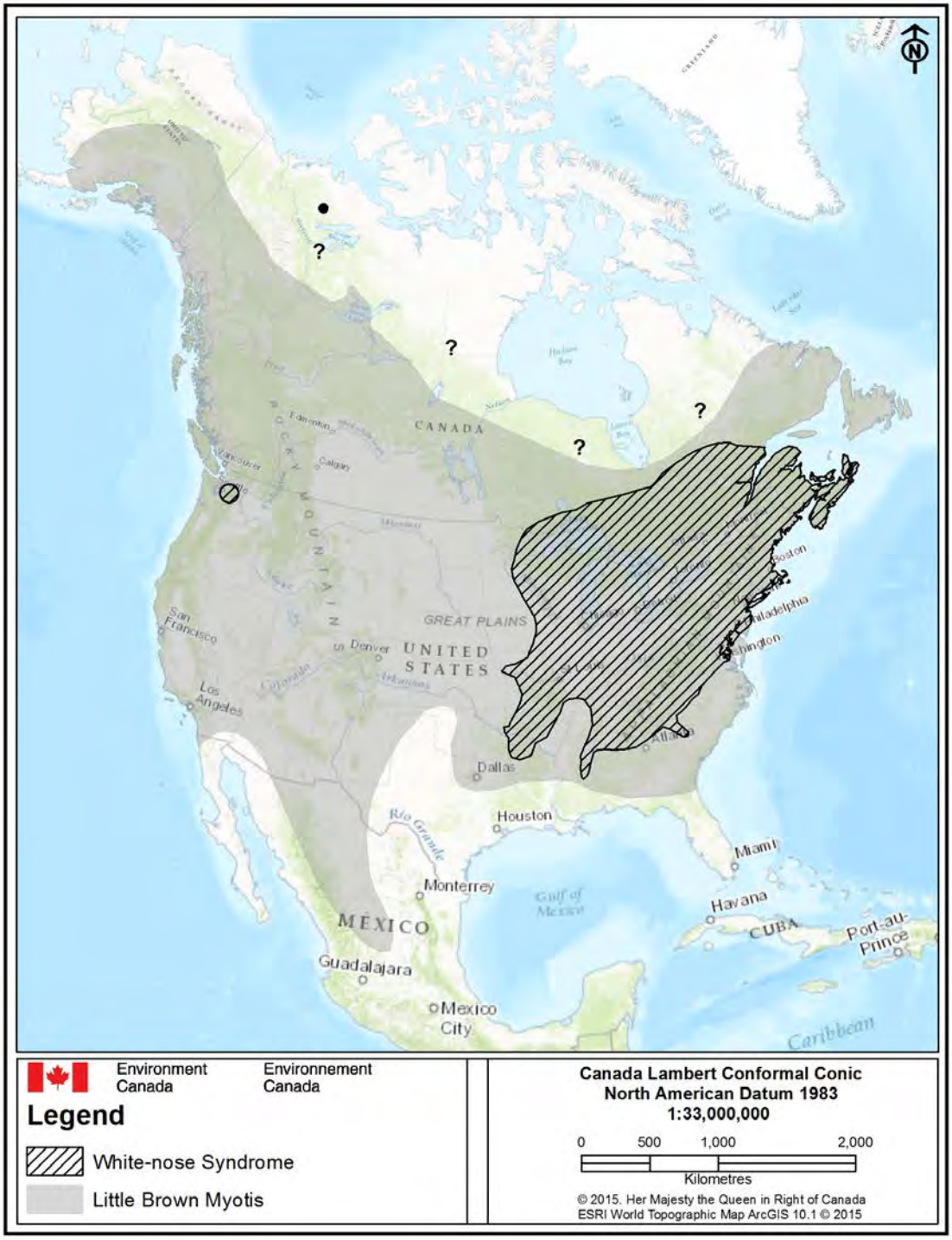

Figure 1. Approximate distribution of Little Brown Myotis and white-nose syndrome (WNS), as of April 2016 (Naughton 2012, COSEWIC 2013, Wilson et al. 2014, GNWT 2015a, CWHC 2016). Some records in Northwest Territories and Nunavut (as shown with a '?') indicate uncertainty in the northern limit of the range. The black dot represents an extralimital record. The WNS polygon (black diagonal) encompasses locations of confirmed *Pseudogymnoascus destructans* presence and where clinical WNS characteristics have been observed.

Northern Myotis

Northern Myotis has been confirmed in every province and territory throughout Canada with the exception of Nunavut (van Zyll de Jong 1985, Brown et al. 2007, Henderson et al. 2009, Park and Broders 2012, Broders et al. 2013, Reimer and Kaupas 2013) (Figure 2). Its Canadian distribution includes the boreal forest south of the treeline and into the montane forests of the west and deciduous and mixedwood forests of the east. It is mostly absent from the Canadian Prairies, and when it is found outside of forested regions, it is found in forest remnants or at hibernacula (Turner 1974).

Similar to Little Brown Myotis, the northern limit of Northern Myotis' range is difficult to determine due to limited survey effort and difficulties related to survey logistics (e.g., large area, few roads). However, Northern Myotis has been confirmed breeding in Yukon (Lausen et al. 2008) and the Northwest Territories (Wilson et al. 2014). Hibernation sites have not been recorded in Yukon (Jung et al. 2006, Slough and Jung 2007), but likely exist in the Northwest Territories (Wilson et al. 2014).

Figure 2. Approximate distribution of Northern Myotis and white-nose syndrome (WNS), as of April 2016 (Naughton 2012, COSEWIC 2013, Wilson et al. 2014, GNWT 2015b, CWHC 2016). The WNS polygon (black diagonal) encompasses locations of confirmed *Pseudogymnoascus destructans* presence and where clinical WNS characteristics have been observed.

Tri-colored Bat

The Canadian range of Tri-colored Bat encompasses mainland Nova Scotia, southern New Brunswick, Quebec and Ontario (van Zyll de Jong 1985, Fraser et al. 2012) (Figure 3), although some populations may be isolated within this range (Broders et al. 2003). Breeding records for Tri-colored Bat have been confirmed in Nova Scotia (Broders et al. 2003) though breeding was not observed in New Brunswick (Broders et al. 2001). Although detections of Tri-colored Bat have been recorded from Ontario and Quebec in the summer (COSEWIC 2013), it is unclear if breeding has been confirmed. It has been recorded in hibernacula in all provinces within its range, albeit rarely and/or in relatively small numbers (COSEWIC 2013).

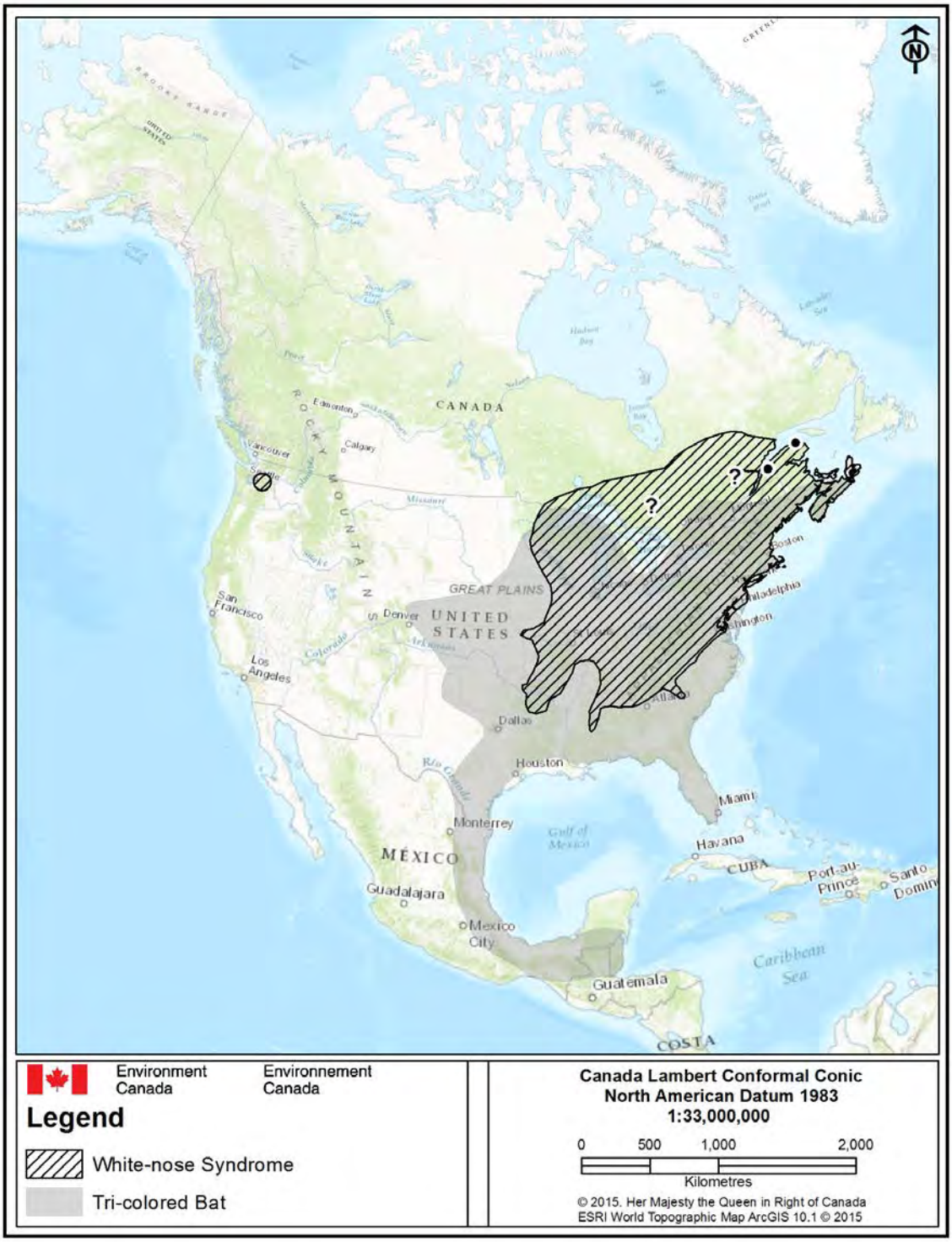

Figure 3. Approximate distribution of Tri-colored Bat and white-nose syndrome (WNS), as of April 2016 (Naughton 2012, COSEWIC 2013, CWHC 2016). Some records in Quebec and Ontario (as shown with a '?') indicate uncertainty in the northern limit of the range. The black dots represent extralimital records. The WNS polygon (black diagonal) encompasses locations of confirmed *Pseudogymnoascus destructans* presence and where clinical WNS characteristics have been observed.

POPULATION

This recovery strategy defines two periods relevant to the discussion of bat populations in Canada: the period prior to the arrival of WNS in Canada (up to and including 2009) and the period after the arrival of WNS in Canada (2010 and onwards). However, it should be noted that the population sizes and the relative abundance of the three bat species in Canada are unknown pre- and post-WNS (both in Canada and in North America) and, therefore, it is challenging to obtain accurate estimates of abundance and consequently species-specific declines in the Canadian populations.

In the northeastern U.S., Langwig et al. (2012) estimated that bat populations (all species) in general, prior to the arrival of WNS, were growing at an average rate of 8% per year. Population trend analyses of hibernacula data from across the U.S. indicated these three species of bat specifically were relatively stable (i.e., a positive or negative trend was unable to be detected) (Ellison et al. 2003, Frick et al. 2010a, Frick et al. 2010b). Count data at hibernacula during the winter are often used to determine relative abundance and infer population trends. Substantial intra- and inter-annual variation in the number of hibernating bats (and species) can exist within a hibernaculum (Trombulak et al. 2001); nonetheless, winter hibernacula data are likely an accurate reflection of the population status in all three bat species' populations (COSEWIC 2013). In addition, summer survey data corroborate observations collected at hibernacula (COSEWIC 2013, Natureserve 2015).

Since the arrival of WNS to North America in 2006, the most precipitous declines in North American wildlife in recorded history have been observed (Kunz and Tuttle 2009). An estimated one million bats (multiple species) died in the northeastern U.S. within three years of the arrival of WNS (Kunz and Tuttle 2009), and an estimated 5.7 to 6.7 million bats died within six years of its arrival (U.S. Fish and Wildlife Service 2012). In Canada, the total number of *Myotis* spp. bats recorded in Nova Scotia, New Brunswick, Ontario, and Quebec hibernacula declined by approximately 94% between 2010 and 2012 (COSEWIC 2013). In Quebec, Nova Scotia, and New Brunswick, following the arrival of WNS, some hibernacula no longer have any individuals of these species of bats present (McAlpine and Vanderwolf, unpub. data in COSEWIC 2013, Mainguy and Desrosiers 2011, H. Broders pers. comm. 2015).

There is limited information related to the proportion of bat populations found in eastern Canada versus western Canada. In Canada, 95% of records of hibernating *Myotis* spp. bats are from Nova Scotia to Manitoba, while relatively few had been recorded west of Manitoba (COSEWIC 2013). Fewer hibernacula have been found in the western provinces and northern territories as compared to the east (excluding Newfoundland and Labrador where few hibernacula are also known); furthermore, hibernacula in the east tended to have more individuals per site (>10,000) compared to hibernacula in the north and west (<1000 per site) (Nagorsen and Brigham 1993, Olson et al. 2011). Some researchers suggest that a large proportion of the Little Brown Myotis population prior to WNS resided in the northeastern United States (Kunz and Reichard 2010). Genetic evidence also exists to suggest populations in the east were larger than populations in

the west (Wilder 2014). However, bats in northern and western Canada may not necessarily be less abundant but instead tend to overwinter singly or in small numbers, making it more difficult to obtain accurate population estimates (i.e., many sites with small numbers of bats in the north and west compared to few sites with large numbers in the east). Comparisons between eastern and western population levels should be interpreted with caution because of the survey limitations previously mentioned for the north in addition to issues in the west (i.e., British Columbia) in differentiating Little Brown Myotis from Yuma Myotis (*Myotis yumanensis*) (COSEWIC 2013).

Little Brown Myotis

Pre-WNS

Evidence from multiple surveys suggests that Little Brown Myotis was probably the most common bat throughout much of Canada, and still is in many areas outside of those impacted by WNS (COSEWIC 2013). Little Brown Myotis is thought to be relatively common in the northern limits of its range, although abundance is difficult to estimate because of previously discussed issues with surveying populations in the north (COSEWIC 2013, Jung et al. 2014).

The Canadian population size of Little Brown Myotis prior to the arrival of WNS is unknown but likely exceeded one million individuals (COSEWIC 2013). Frick et al. (2010a) estimated the population was 6.5 million individuals in the northeastern U.S. as of 2006 which further supports numbers in excess of 1 million for Canada. NatureServe (2015) estimated the global population size to be 100,000 to >1,000,000 individuals prior to WNS. Data from known hibernacula are incomplete but, prior to the arrival of WNS, some known hibernacula were used by thousands to tens of thousands of bats in southern Ontario, Quebec, Nova Scotia, New Brunswick, and Manitoba (Fenton 1970, Scott and Hebda 2004, Mainguy and Desrosiers 2011).

Post-WNS

NatureServe (2015) states that the current global population size is unknown but likely still exceeds 100,000 individuals. Model results predicted that Little Brown Myotis will be functionally extirpated[6] (i.e., 1% of pre-WNS population or 65,000 individuals) in the northeastern U.S. by 2026 (Frick et al. 2010a). However, new evidence suggests that some individuals are surviving the infection and survival rates have increased at locations previously decimated by WNS; however, the increased rates of survival are not sufficient to support a positive population growth trend (Maslo et al. 2015). The entire Canadian range of Little Brown Myotis is expected to be impacted by WNS between 2025 and 2028 (COSEWIC 2013).

[6] Functionally extirpated populations are those of which there are so few remaining numbers that there are not enough individuals or habitat in suitable condition to support a fully functional population (NOAA 2015).

Northern Myotis

Pre-WNS

Evidence suggests that Northern Myotis is less common than Little Brown Myotis, in part, because they have a more restricted distribution within Canada and are reliant on forested areas (COSEWIC 2013). Observations made during summer indicate that the species is relatively common in the southern Northwest Territories and uncommon at the western and northern edges of their range (Jung et al. 2014, Wilson et al. 2014). At some eastern sites (e.g., Newfoundland and Labrador, Prince Edward Island, and Nova Scotia), numbers were more or less equal to Little Brown Myotis (Park and Broders 2012). However, counts obtained from individual hibernacula in the winter indicate relatively few (i.e., <100) Northern Myotis (Barbour and Davis 1969, Amelon and Burhans 2006). This may be a result of difficulties in detecting Northern Myotis in hibernacula because they are often found in deep cracks (COSEWIC 2013). In addition, it is difficult to distinguish between Little Brown Myotis and Northern Myotis while conducting visual winter hibernacula counts.

The Canadian population size of Northern Myotis is unknown but is believed to have also exceeded one million individuals before the arrival of WNS (COSEWIC 2013). In contrast, NatureServe (2015) estimated that the global population size was relatively small prior to WNS (2,500 to 100,000 individuals). However, NatureServe notes that this estimate is supported by low counts at hibernacula (which may be related to issues with detectability). In addition, the NatureServe estimate appears to be primarily based on counts within the U.S. part of the range. Based on Harvey (1992) and D. Morningstar (pers. comm. 2015), the species is probably more common and abundant in the northern part of its global range (i.e., boreal) than in the south (COSEWIC 2006).

Post-WNS

Declines of Northern Myotis populations in the northeastern U.S. have occurred at the same rate as Little Brown Myotis; an expected result given the two species have similar life history traits and often share same hibernacula. Thus, it was predicted that Northern Myotis will likely also be functionally extirpated (i.e., 1% of pre-WNS population) in the northeastern U.S. by 2026 (Frick et al. 2010a). However, new evidence for Little Brown Myotis suggests that low numbers of individuals are surviving the infection and survival rates have increased at locations previously decimated by WNS, a trend which may also apply to Northern Myotis. The entire Canadian range of Northern Myotis is expected to be impacted by WNS between 2025 and 2028 (COSEWIC 2013).

Tri-colored Bat

Pre-WNS

Although too little data exist to reliably estimate the population size of Tri-colored Bat, the species was relatively rare in the Maritimes, Quebec, and in parts of Ontario

(COSEWIC 2013). It is also rare in the adjacent states of Vermont (Darling and Smith 2011) and Maine (Zimmerman and Glanz 2000). In addition to being uncommon, Tri-colored Bats tend to hibernate solitarily within hibernacula, often within the deepest parts of the cave where human access is limited, and thus, may be more difficult to detect during hibernation than other species (Hitchcock 1949, Fujita and Kunz 1984, Sandel et al. 2001, COSEWIC 2013).

The Canadian population size of Tri-colored Bat prior to WNS is unknown; however, the COSEWIC (2013) status report provides <20,000 individuals in Canada as a rough estimate. NatureServe (2015) estimated that the global population size was between 10,000 to 1,000,000 individuals prior to WNS. In Nova Scotia, it was estimated that between 1,000 and 2,000 adult females existed (H. Broders, pers. comm. in COSEWIC 2013). Across the Canadian range, the species accounted for between 0.2 to 4.5% of individuals counted at various hibernacula (Hitchcock 1949, 1965, Mainguy and Desrosiers 2011, Vanderwolf et al. 2012).

Post-WNS

The Tri-colored Bat population declines in areas affected by WNS in Canada and the U.S. are likely similar to that observed in Little Brown Myotis and Northern Myotis, though the declines observed in this species are less straightforward (COSEWIC 2013). In part, this is because of the small numbers of Tri-colored Bats that have been recorded from monitored Canadian hibernacula and because the species shows evidence of a seasonal latitudinal migration (Fraser et al. 2012), both of which may affect interpretation of Canadian population trends.

Declines observed since the arrival of WNS have been variable. The average population decline in five northeastern states was 75% (range 16 to 95%) between 2006 and 2010, with 13 of 36 hibernacula declining 100% (Turner et al. 2011). Acoustic monitoring during the summers of 2007-2009 in New York yielded similar population declines to those listed above (i.e., 78% between 2008 and 2009) (Dzal et al. 2011). In eastern Ontario, Quebec, and Nova Scotia there are indications the Tri-colored Bat population may have declined by as much as 94% compared to pre-WNS populations (Mainguy and Desrosiers 2011, L. Hale, pers. comm. in COSEWIC 2013). In southern Ontario, significant declines were also noted at eight locations where acoustic monitoring was performed prior to the arrival of WNS and again in 2014 (D. Morningstar, pers. comm.). In New Brunswick, declines at individual hibernacula have ranged from 30% to more than 75% (D. McAlpine and K. Vanderwolf, unpub. data in COSEWIC 2013, D. McApline pers. comm. in COSEWIC 2013). NatureServe (2015) states that the current global population size is unknown but likely still exceeds 10,000 individuals.

3.3 Needs of Little Brown Myotis, Northern Myotis, and Tri-colored Bat

The habitat requirements of temperate-region bats vary by season. The habitat is composed of (1) overwintering habitat (i.e., hibernacula, such as caves, abandoned mines, and wells) used for hibernation and overwinter survival, (2) summering habitat that includes roosting habitat (for maternity roosts and males) and foraging habitat within commuting range of the roosts (Sasse and Perkins 1996, Norquay et al. 2013), and (3) swarming habitat used in the late summer and early fall for mating and socializing (Fenton 1969, Randall and Broders 2014). Swarming sites are also typically used as hibernacula (Fenton 1969, Randall and Broders 2014).

Overwintering and Swarming Habitat

Hibernating bats survive the winter using stored fat reserves accumulated during the summer and autumn (Jonasson and Willis 2011). Hibernation allows year-round resident, insect-eating bats to persist in a region when ambient temperature declines and insects are not available in winter. Hibernating bats minimize use of fat reserves by decreasing metabolic rate and body temperature to within a few degrees of the ambient temperature in the hibernaculum (i.e., they enter torpor[7]) (Henshaw and Folk 1966).

Hibernacula for Little Brown Myotis, Northern Myotis, and Tri-colored Bat are generally underground openings, including caves, abandoned mines, wells, and tunnels, but at some sites only specific sections of the site will be used for hibernation. The sections used for hibernating typically have a temperature range between 2˚C and 10˚C (Fenton 1970, Anderson and Robert 1971, Vanderwolf et al. 2012), and relative humidity levels > 80% to reduce evaporative water loss (Cryan et al. 2010, but see Kurta 2014). Structural features, such as number of openings, cave size and length, and angle of chambers can influence the stability and levels of humidity and temperature (Davis 1970, Raesly and Gates 1987). Because of the specific, stable microclimates required by bats, hibernacula are typically used year after year by overwintering bats.

Stable microclimates are preferred by bats because temperature fluctuations can cause arousals from torpor. Bats will arouse from torpor to access water, groom, and mate (Whitaker and Rissler 1993, Thomas 1995), but they consume a significant portion of their limited energy reserve during arousals (Thomas et al. 1990). Relocating to more suitable sites can accelerate the depletion of limited energy reserves, but may also be used as an adaptation for long-term energy conservation.

Where their distributional ranges overlap, all three bat species may occur in the same hibernaculum, but may be found in different sections. Northern Myotis and Tri-colored Bat do not typically overwinter in buildings, but Little Brown Myotis may overwinter in buildings in western Canada (C. Lausen, pers. comm.), where winter temperatures are relatively high. Little is known regarding the overwintering habitat of Little Brown Myotis and Northern Myotis in western Canada.

[7] Torpor is a state of physical inactivity (reduced body temperature and metabolic rate).

Bats congregate in swarming habitat in the late summer and early fall. Swarming sites may function as mating sites, stopover locations during migration, social sites for information transfer, and/or allow individuals to assess potential sites for overwintering (Fenton 1969, Randall and Broders 2014). Swarming behaviour often occurs in and around entrances or openings of hibernacula. Both Little Brown Myotis and Northern Myotis often swarm and hibernate at the same locations (Randall and Broders 2014), but the proportion of bats that visit a swarming site in relation to those that stay at the site for hibernation is unknown (Johnson et al. 2015), and possibly quite low in some cases (M. Davis, pers. comm.). Swarming groups of Little Brown Myotis and Northern Myotis in eastern Canada are comprised of individuals from various summering sites and therefore gene pools may span relatively large areas (Burns et al. 2014, Johnson et al. 2015, Segers and Broders 2015).

Few studies have attempted to characterize external habitat features that predict selection of hibernacula and swarming sites by bats. In Nova Scotia, a survey of natural and anthropogenic swarming sites (abandoned mines), also assumed to be hibernacula, revealed that the amount of entrance shelter (i.e., canopy cover and/or rock faces that provide protection from weather elements), watercourse length within a 2 km radius of the site, and total chamber length of the hibernaculum were significant predictors of Little Brown Myotis and Northern Myotis swarming activity (Randall and Broders 2014). Generally, swarming sites had more exposed entrances, greater total length of rivers, creeks, and streams within a 2 km radius, and deeper / longer chamber lengths, than sites surveyed where swarming activity levels were low or absent (Randall and Broders 2014). For example, an 10% increase in the degree of entrance shelter resulted the probability of swarming declining by 50% and the probability of swarming doubled with an increase of 10 km of stream length within a 2 km radius (Randall and Broders 2014).

Little Brown Myotis

Little Brown Myotis appear to derive energetic and water conservation benefits from clustering while hibernating. In Michigan, Kurta and Smith (2014) found that 78% of individuals hibernated in clusters and were more likely to be found in clusters (rather than solitarily) at lower temperatures. In western Canada, the number of Little Brown Myotis hibernating together may be substantially less than in northeastern North America, although clusters as large as 52 individuals have been observed in a hibernaculum containing 3000 individuals in southwestern Northwest Territories (Lausen 2011); bats likely hibernate singly or in small groups west of the Rocky Mountains (Jung et al. 2014). A recent radio-telemetry study in the temperate rainforest of southeast Alaska found Little Brown Myotis hibernating solitarily in rock scree on steep, forested hillsides and beneath root wads of trees and stumps (K. Blejwas, pers. comm.). Little Brown Myotis exhibit high fidelity to hibernacula (Norquay et al. 2013). A mark-recapture study in Manitoba and northwestern Ontario found only 4% of marked individuals relocated to an alternate hibernaculum within the study period (Norquay et al. 2013).

Northern Myotis

Northern Myotis may hibernate in cooler sections of a cave, compared to Little Brown Myotis (Barbour and Davis 1969). In a study of abandoned mines in northern Michigan, Northern Myotis and Little Brown Myotis co-occurred in 92% of the mines occupied by *Myotis* spp., but 75% of Northern Myotis individuals hibernated alone (Kurta and Smith 2014). Northern Myotis will generally return to the same hibernaculum, but not always in consecutive years (Caceres and Barclay 2000). Naughton (2012) noted that “they are loyal to a group of hibernacula rather than a single one”.

Tri-colored Bat

Tri-colored Bat is considered to have the most rigid overwintering habitat requirements of the three species. They often select the deepest part of caves or mines where temperature is the least variable, have strong humidity level preferences, and use warmer walls than other species (Fujita and Kunz 1984, Raesly and Gates 1987, Briggler and Prather 2003, Kurta and Smith 2014). A study of hibernacula in New Brunswick noted Tri-colored Bats hibernating low on the cave walls (Vanderwolf et al. 2012). Although Tri-colored Bats tend to use the same hibernacula as Little Brown Myotis and Northern Myotis, relatively few (i.e., ≤10) Tri-colored Bats have been recorded within any one hibernacula in Canada, possibly because they tend to hibernate solitarily (i.e., not in clusters) in the deepest sections of the caves/mines. Tri-colored Bats exhibit high fidelity to hibernacula (Sandel et al. 2001, Damm and Geluso 2008).

Summering Habitat

Roosting habitat

Roosts provide thermal regulation, shelter from weather and predation, and can be sites for social interaction (Kunz 1982, Barclay and Kurta 2007). Individuals may switch roosts regularly and therefore, may use a network of roosts in a roosting area (Barclay and Brigham 1996, Sasse and Perkins 1996, Caceres and Barclay 2000). The tendency to switch roosts may depend on species, sex, age, reproductive status, and roost type (e.g., natural or anthropogenic) (Garroway and Broders 2008, Randall et al. 2014).

Roost selection is a function of numerous characteristics occurring at a range of spatial scales (Fabianek et al. 2011). For example, at the scale of the roosting structure, tree species, diameter, height, stage of decay, availability of roosting medium, sun exposure, and other characteristics may affect roost selection (Garroway and Broders 2008, Slough 2009, Poissant et al. 2010, Olson and Barclay 2013). At the stand scale, roost selection may be a function of canopy gaps, number of available snags, tree density, proximity to water, etc. (Kalcounis-Rüppell et al. 2005, Garroway and Broders 2008, Henderson and Broders 2008). At the landscape scale, characteristics such as forest age, composition, and degree of fragmentation may affect roost selection (Henderson and Broders 2008, Fabianek et al. 2011). The species may also use treed and forested

habitat in urban and suburban areas for roosting, in addition to man-made structures found within urban and suburban landscapes (Little Brown Myotis, in particular).

Many bat species (including Little Brown Myotis, Northern Myotis, and Tri-colored Bat) preferentially roost in older forest stands, compared to young forests (Barclay and Brigham 1996). Older forests likely provide increased snag availability for roosting (Crampton and Barclay 1996, Krusic et al. 1996) and foraging habitat under a relatively closed canopy (Jung et al. 1999).

Females generally give birth and raise pups in maternity colonies in the spring/summer. Because of roost switching behavior, a colony can be defined as an assemblage of roosting groups comprised of individuals that regularly associate and groups that intermix (Olson and Barclay 2013). Roosting in groups likely aids social thermoregulation and energy savings (Willis and Brigham 2007).

Males of all three species roost during the daytime in a variety of structures, and often switch sites during the summer. Male roosting habitat includes rock crevices, raised bark, foliage, and tree cavities (Fenton and Barclay 1980, Caceres and Barclay 2000, Broders and Forbes 2004, Huynh 2009, Randall et al. 2014, Fabianek et al. 2015). Male Little Brown Myotis and Northern Myotis often roost in tall snags with large diameters in the early to middle stages of decay and located in or near small open patches within mature to over mature forest (Broders and Forbes 2004, Jung et al. 2004, Fabianek et al. 2015).

Little Brown Myotis

Little Brown Myotis is one of the few bat species that uses buildings and other anthropogenic structures (e.g., bat boxes, bridges, and barns) to roost (particularly for maternity roosting), but it will also use cavities of canopy trees, foliage, tree bark, crevices on cliffs, and other structures (Fenton and Barclay 1980, Slough 2009, Coleman and Barclay 2011, Randall et al. 2014).

Maternity colonies may include hundreds of females with young. Females show a strong tendency to roost in large-diameter trees, although roost properties may vary significantly throughout the summer (Olson & Barclay 2013). Females are thought to select a preferred maternity roost at the expense of travelling longer distances to forage, possibly indicative of a limited number of suitable maternity roosting sites (Broders et al. 2006, Randall et al. 2014). Female Little Brown Myotis show a relatively high degree of philopatry[8] (Frick et al. 2010b). Roosting areas are generally used annually and individual natural roost sites can be used for upwards of 10 years (M. Brigham, pers. comm.). Little Brown Myotis are particularly loyal to anthropogenic structures and sites may be used for 50 years or more (M. Brigham, pers. comm.). They also exhibit strong within-year site fidelity to anthropogenic structures; Randall et al. (2014) found that most females using anthropogenic structures in Yukon did not switch roosts throughout the

[8] Philopatry is the tendency to return to the home area.

summer. Nevertheless, Little Brown Myotis have been documented switching anthropogenic sites between and within years to meet their needs (e.g., thermoregulation) (e.g., Syme et al. 2001). For example, using passive integrated transponder tags, a mix of use was documented at an anthropogenic maternity roost in Ontario; some individuals remained at the roost for several nights, others visited the roost on occasion, and many only visited the roost at night, but did not stay throughout the day, suggesting that individuals were also using other roosts in the area (D. Morningstar, unpub. data.).

Males roost individually or in small groups and periodically switch roosts. In Quebec, males switched roosts approximately every 2 days (Fabianek et al. 2015). Males use a variety of roost structures, including buildings, rock crevices, foliage, raised bark, and tree cavities (Huynh 2009, Randall et al. 2014). In New Brunswick and Quebec, male Little Brown Myotis primarily roosted in coniferous or conifer-dominated mixedwood stands with a large number of snags (Broders and Forbes 2004, Fabianek et al. 2015).

Northern Myotis

Northern Myotis roost singly or in small groups and favour tree roosts (under raised bark and in tree cavities and crevices), but they can also be found in anthropogenic structures (e.g., under shingles) (Sasse and Perkins 1996, Foster and Kurta 1999, Caceres and Barclay 2000, Carter and Feldhamer 2005).

Northern Myotis' maternity roosts are strongly associated with forest cover, streams, and tree characteristics (e.g., species, height, diameter, age, and decay) (Caceres and Barclay 2000, Broders and Forbes 2004, Broders et al. 2006). Females prefer to roost in tall, large diameter trees in early- to mid-stages of decay (Sasse and Perkins 1996, Caceres and Barclay 2000, Silvis et al. 2015a). Maternity colonies in Newfoundland and Labrador, Nova Scotia, and New Brunswick were generally in larger-than-average trees (Broders and Forbes 2004, Garroway and Broders 2008, Park and Broders 2012). In New Brunswick and Prince Edward Island, female Northern Myotis primarily roosted in trees in the mid-stages of decay within mature, shade-tolerant deciduous stands (Broders and Forbes 2004, Henderson and Broders 2008). Broders and Forbes (2004) attributed this preference to these tree species' susceptibility to limb breakage and decay (creating available habitat for roosting), long-lived characteristics (permitting repeated use by bats), and their upland habitats with increased solar radiation (reducing energy costs to maintain the bat's body temperature). Female Northern Myotis are more likely to resort to anthropogenic structures where habitat is fragmented and few potential roost trees exist (Henderson and Broders 2008). In Nova Scotia, Northern Myotis maternity colonies consisted of females with a high degree of maternal relatedness, likely caused by female philopatry (Patriquin et al. 2013). Females switch maternity roost trees approximately every 1-5 days, but roosts are commonly clustered in roosting areas (Sasse and Perkins 1996, Caceres and Barclay 2000, Carter and Feldhamer 2005, Broders et al. 2006, Olson 2011). The largest roosting area recorded in Canada was 300 ha in Alberta (Olson 2011).

Males generally roost alone under raised bark or within cavities of trees in mid-stages of decay (Broders and Forbes 2004). In New Brunswick and Quebec, male Northern Myotis roosted in coniferous or conifer-dominated mixedwood stands within the study area (Broders and Forbes 2004, Fabianek et al. 2015). In Quebec, males switched roosts approximately every 2 days (Fabianek et al. 2015).

Tri-colored Bat

Less is known about roosts of Tri-colored Bats. Most roost sites are found within forested habitats, where this species also forages. Tri-colored Bats may roost in clumps of dead foliage and lichens (Veilleux et al. 2003, Perry and Thill 2007, Poissant et al. 2010). In Nova Scotia, 30 radio-tagged bats had roosts in large clumps of arboreal lichens (*Usnea* spp.) that grew on coniferous or deciduous trees relatively close to water features (Poissant et al. 2010).

Females roost alone or in small colonies. In Nova Scotia, as many as 18 Tri-colored Bats were found in a cluster (Poissant et al. 2010). In more anthropogenically-modified landscapes, maternity roosts may be barns or similar human-made structures (Fujita and Kunz 1984). In Nova Scotia, Tri-colored Bats exhibit fidelity to small (<78 ha) roosting areas within and between years (Poissant 2009). In Indiana, females returned to the same area (0.4 ha) each summer and used the same 4-6 trees each year, suggesting value in familiar (and possibly limited) structures (Veilleux and Veilleux 2004).

Males roost individually (Veilleux and Veilleux 2004, Perry and Thill 2007, Poissant 2009). A single male tracked in Nova Scotia roosted alone in arboreal lichen (*Usnea trichodea*) (Poissant 2009). In Arkansas, males preferentially roosted in dead leaves of oak trees (*Quercus* spp.) in sites with less canopy cover, more midstory hardwoods, and more overstory large pines than randomly available (Perry and Thill 2007).

Foraging Needs

Little Brown Myotis, Northern Myotis, and Tri-colored Bat are insect predators and will exploit locally abundant patches of prey that may be temporally and spatially scattered. Identification of foraging areas for bats is complicated by sex biases, differences between species, seasonal variations of habitat use by females (e.g., pregnant, lactating, or non-reproducing), and foraging habitat availability and configuration (Henry et al. 2002, Owen et al. 2003, Broders et al. 2006, Randall et al. 2014).

Little Brown Myotis

Little Brown Myotis feed nocturnally on insects (e.g., moths, mayflies, flies, beetles, and caddisflies) and spiders (Moosman et al. 2012, Thomas et al. 2012, Clare et al. 2014). Nevertheless, the diet of Little Brown Myotis can vary significantly based on seasonal, geographic, and environmental factors (Moosman et al. 2012, Clare et al. 2014). On a successful night during peak summer activity, males eat approximately half of their body

weight and lactating females may eat their entire body weight in insects (Anthony and Kunz 1977). Peak foraging activity occurs several hours after dusk and often again before sunrise (Fenton 1970, Kunz 1973, Broders et al. 2003). In northern areas (above 60°N) where summer night length is short, pregnant females appeared to alter their foraging behavior by exhibiting only one bout of peak activity. In addition, they foraged for fewer hours than their southerly counterparts though they compensated for reduced time foraging by exhibiting a higher rate of insect capture (Talerico 2008, Reimer 2013).

Foraging Little Brown Myotis are most often associated with open habitats, such as ponds and roads and open canopy (0-50%) forests (Segers and Broders 2014), but have also been recorded gleaning[9] prey within forests (Ratcliffe and Dawson 2003, Jung et al. 2014) and using vegetation along lake and stream margins (Fenton and Barclay 1980). Little Brown Myotis in Yukon boreal habitat travelled 3.8 ± 0.7 km from their daytime roosts to foraging areas, with females travelling significantly farther than males (Randall et al. 2014). In Quebec, lactating females had home ranges 42% smaller (mean: 17.6 ha) than pregnant females (mean: 30.1 ha) (Henry et al. 2002).

Northern Myotis

Northern Myotis feed on insects (e.g., moths, beetles, wasps, and flies) and spiders (Lacki et al. 2009, Dodd et al. 2012, Thomas et al. 2012) that are primarily terrestrial in origin (Broders et al. 2014). Unlike Little Brown Myotis, which most often forage over water and are aerial hawkers, Northern Myotis forage more frequently along and within forests and although they feed on flying insects, they also glean prey (Caceres and Barclay 2000, Ratcliffe and Dawson 2003).

Female Northern Myotis foraged along forest-covered creeks in Prince Edward Island (Henderson and Broders 2008). In West Virginia, female Northern Myotis mainly foraged in 70-90 year-old hardwood stands with road corridors (Owen et al. 2003), and in Kentucky, Northern Myotis were found foraging along ridges and midslopes, rather than lower slopes (Lacki et al. 2009). In an intensively managed forest of West Virginia, the mean home range for lactating or pregnant Northern Myotis was 65 ha (Owen et al. 2003). In New Brunswick, Broders et al. (2006) found males and females travel significantly different distances between roost sites and foraging areas. The distance travelled by females between successive roosts was twice as far as males on average (457 m vs. 158 m) (Broders et al. 2006). The authors suggested that females travelled farther because suitable maternity sites were located in poor foraging habitat (Broders et al. 2006).

Tri-colored Bat

Similar to Little Brown Myotis, Tri-colored Bats feed on insects (e.g., flies, beetles, wasps, and moths) after dusk and before dawn using echolocation (Fujita and Kunz 1984, Naughton 2012). Each night, males consume at least half of their body weight in

[9] Gleaning is the act of taking prey off a substrate rather than in the air or water.

insects and pregnant and nursing females may eat more than their body weight (Naughton 2012).

Foraging predominately occurs in forested riparian areas, over water (e.g., ponds and rivers), and in relatively open areas (Ethier and Fahrig 2011). In Nova Scotia, Farrow and Broders (2011) found Tri-colored Bats foraging at river sites, but found more activity in areas with greater forest cover at a landscape scale, suggesting that this species may avoid landscapes that are cleared for agriculture, urban development, and forest harvesting. The distances between roost sites and foraging areas are generally unknown, but in some locations may be up to 5 km (Quinn and Broders 2007).

Migration

Little Brown Myotis, Northern Myotis, and Tri-colored Bat are considered short-distance migrants, radiating annually from overwintering areas to summering areas in any direction (Fraser et al. 2012, COSEWIC 2013). In Manitoba and Ontario, Little Brown Myotis migrated regionally 35 to 554 km (median 463 km) (Fenton 1970, Dubois and Monson 2007, Norquay et al. 2013). Migratory movements by Northern Myotis are not well understood, but are likely similar to the Little Brown Myotis. Tri-colored Bat have been recorded moving 53-780 km (Griffin 1940, COSEWIC 2013). In addition, Fraser et al. (2012) found that some Tri-colored Bats engage in annual latitudinal migrations, especially those at the northern extent of the range, which may be related to their need to keep warm since they often hibernate individually (COSEWIC 2013). This is further supported by Thorne (2015), who found increased detections of Tri-colored Bats later in the season (i.e., August – September) on islands in the Great Lakes of Ontario.

As noted above, swarming sites may serve as migratory stopover locations (Fenton 1969) and are likely used annually (Rydell et al. 2014). When travelling over large waterbodies, peninsulas and islands may function as stopover sites (Dzal et al. 2009, Thorne 2015). For example, Tri-colored Bats may use Amherst Island, Lake Ontario and Long Point, Lake Erie for migration and stopover (Dzal et al. 2009, Thorne 2015).

Limiting Factors

All three species are long-lived and females produce only one (Little Brown Myotis and Northern Myotis) or two (Tri-colored Bat) young annually. Such life-history traits heighten the vulnerability of these bat populations to increases in adult mortality rates. In addition, yearling survival is low (0.23 to 0.46) (Frick et al. 2010b). In a recent pre-WNS study from New Hampshire, the annual population growth rate of Little Brown Myotis over 16 years was estimated to be 1.008 (Frick et al. 2010b). In 22 subpopulations in the northeastern U.S, the population growth rate was estimated to be 0.98-1.2 (Frick et al. 2010a). Similarly, the population growth rates of Northern Myotis and Tri-colored Bat were estimated to be 1.03 and 1.04, respectively (Langwig et al. 2012). Predicted population growth rates for Little Brown Myotis in the northeastern U.S. post-WNS was 0.95 (Maslo et al. 2015).

These species are socially gregarious which increases their susceptibility to the spread of diseases (such as WNS) (Langwig et al. 2012). It is unknown whether the colonial and social nature of these species creates subpopulation or colony size thresholds below which the survival or reproductive success of individuals decline and /or the population will be unable to recover.

It is also unknown if available overwintering sites with suitable microclimatic conditions are limiting in Canada.

4. Threats

4.1 Threat Assessment

In areas where local bat populations have significantly declined as a result of WNS, the relative magnitudes of other threats increase because the mortality of a small number of the remaining individuals (particularly adults) has the ability to impact the survival of local populations, their recovery, and, perhaps, the development of resistance to the fungus that causes WNS. Therefore, the level of concern and severity of the impact on bat populations from threats other than WNS will generally be elevated in areas of Canada affected by WNS, compared to areas that have not yet been affected by WNS. These dissimilarities in the threat assessments are identified in Table 2.

Table 2. Threat assessment table for Little Brown Myotis, Northern Myotis, and Tri-colored Bat

Threat		Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
Exotic, Invasive, or Introduced Species/Genome							
White-nose syndrome (*Pseudogymnoascus destructans*)	Known WNS-affected areas	Very High	Widespread	Current	Continuous	High	High
	Areas not yet known to be affected by WNS	Very High	Widespread	Imminent	Continuous	High	High
Feral and free-roaming cats		Unknown	Localized	Current	Continuous	Unknown	Low
Habitat Loss or Degradation							
Destruction, degradation or harmful alteration of hibernacula	Known WNS-affected areas	High	Localized	Current	Continuous	High	High
	Areas not yet known to be affected by WNS	High	Localized	Current	Continuous	High	High
Destruction, degradation or harmful alteration of roosts	Known WNS-affected areas	High	Localized	Current	Continuous	High	High
	Areas not yet known to be affected by WNS	Medium	Localized	Current	Continuous	Moderate	High
Destruction, degradation, or conversion of foraging habitats	Known WNS-affected areas	Medium	Widespread	Current	Continuous	Unknown	Medium

Threat		Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
	Areas not yet known to be affected by WNS	Medium-Low	Widespread	Current	Continuous	Unknown	Medium
Disturbance or Harm							
Collisions with or barotrauma from wind turbines[4]	Known WNS-affected areas	High	Localized	Current	Seasonal (spring, summer, fall)	High	High
	Areas not yet known to be affected by WNS	Medium-Low	Localized	Current	Seasonal (spring, summer, fall)	Moderate-Low	Medium
Intentional harm to individuals	Known WNS-affected areas	High	Localized	Current	Continuous	High	High
	Areas not yet known to be affected by WNS	Medium	Localized	Current	Continuous	Moderate-Low	Medium
Recreational or scientific disturbance of individuals	Known WNS-affected areas	Medium-High	Localized	Current	Continuous	High	Medium
	Areas not yet known to be affected by WNS	Medium	Localized	Current	Continuous	Moderate	Medium
Industrial disturbance of individuals (e.g., mining and forestry practices)	Known WNS-affected areas	Medium-Low	Localized	Current	Continuous	Moderate	Low
	Areas not yet known to be affected by	Low	Localized	Current	Continuous	Low	Low

Threat		Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
	WNS						
Pollution							
Mercury		Unknown	Widespread (Eastern Canada)	Current	Continuous	Unknown	Low
Other toxic chemicals		Unknown	Widespread	Current	Continuous	Unknown	Low
Light pollution		Unknown	Widespread	Current	Continuous	Unknown	Low
Climate and Natural Disasters							
Habitat or prey dynamic alterations resulting from climate change		Unknown	Widespread	Current	Continuous	Unknown	Low
Accidental Mortality							
Collisions with vehicles		Unknown	Widespread	Current	Continuous	Unknown	Low

[1] *Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the recovery of the species, consistent with the population and distribution objectives. This criterion considers the assessment of all the information in the table.*

[2] *Severity: reflects the population-level effect (High: very large population-level effect, Moderate, Low, and Unknown).*

[3] *Causal certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; Medium: there is a correlation between the threat and population viability e.g., expert opinion; Low: the threat is assumed or plausible).*

[4] *The level of concern of this threat varies geographically, so its assessment considers eastern Canada and the Prairies, western, and northern Canada separately. Because this geographic distinction is similar to the WNS invasion front, the geographic variation is embedded within the two WNS categories.*

4.2 Description of Threats

Threats are listed here in the order in which they are presented in Table 2.

4.2.1 White-nose Syndrome (Pseudogymnoascus destructans)

White-nose syndrome (WNS), caused by the dermatophyte[10] fungus *Pseudogymnoascus destructans* (formerly called *Geomyces destructans*), is the greatest threat to the survival and recovery of Little Brown Myotis, Northern Myotis, and Tri-colored Bat. Most of the known hibernacula in the northeastern United States and eastern Canada (except in Newfoundland and Labrador) have experienced massive declines resulting from WNS (U.S. Fish and Wildlife Service 2016).

The fungus is believed to have originated in Europe (Lindner et al. 2011, Pikula et al. 2012, Ren et al. 2012, Warnecke et al. 2012, Leopardi et al. 2015) and was first detected in the U.S. in 2006 (Lorch et al. 2011) and in Canada in 2010 (U.S. Fish and Wildlife Service 2016). The fungus grows in the same microclimate conditions that occur within the hibernacula where the three species of bats overwinter. The fungus colonizes the bat's skin, causes erosions of the epidermis, and damages sweat glands, oil-producing glands, muscles, connective tissue, blood vessels, and hair follicles (Meteyer et al. 2009, Cryan et al. 2010). The wings and ears develop white-grey blotches on their surfaces and the muzzle often turns fuzzy white.

The early stages of WNS may not be visible in all affected individuals. WNS is characterized by an elevated metabolic rate associated with the epidermal fungal growth, stimulating hyperventilation, and results in increased arousals from torpor that contribute to dehydration and electrolyte loss (Warnecke et al. 2012, Warnecke et al. 2013, Verant et al. 2014). Later stages of WNS are associated with more extensive and severe tissue lesions, further increasing arousal frequency, water loss, and energy use (Warnecke et al. 2012, Warnecke et al. 2013, Verant et al. 2014). Energy reserve depletion is accelerated by reduced torpor bout lengths and through acute physiological changes as WNS pathology progresses, eventually leading to mortality (Frank et al. 2014, Verant et al. 2014). WNS-infected bats are more likely to fly (and fly erratically) during winter (Carr et al. 2014). Bats that survive until spring may have damaged wings with numerous holes, and may exhibit signs of physiological stress, and reduced reproductive success (Reeder and Turner 2008, Meteyer et al. 2009, Reichard and Kunz 2009, Powers et al. 2012). However, almost all of the identified mortality associated with WNS has been during hibernation when the immune functions of bats are reduced (Cryan et al. 2010). Additionally, Fuller et al. (2011) tracked individual Little Brown Myotis and found wing damage caused by WNS healed to some degree throughout the summer. Prevalence decreases during the summer months, likely as a result of body temperatures above that required for *P. destructans* (Langwig et al. 2015b).

[10] Fungi that can cause infections of the skin, hair, and nails due to their ability to utilize keratin.

In eastern Canada and the northeastern United States, WNS mortality rates are typically low (i.e., 20%) in the first year of detection, followed by high levels (i.e., >70%) within two years (Frick et al. 2010a). At known hibernacula in eastern Canada, the number of hibernating Little Brown Myotis and Northern Myotis bats has declined by an estimated 94% (COSEWIC 2013). The number of Tri-colored Bats has also shown a precipitous decline of approximately 75% at known hibernacula (Turner et al. 2011, COSEWIC 2013).

Rate of spread

From the epicenter in Albany, New York, the rate of spread of WNS in Canada has been approximately 200 to 250 km per year (COSEWIC 2013). As of 31 March 2016, WNS was recorded in 28 states and 5 provinces; the presence of *P. destructans* was confirmed in 4 additional states (U.S. Fish and Wildlife Service 2016) (Figure 1; Table 1). This represents approximately 20% of the Canadian range of Little Brown Myotis, 30% of Northern Myotis and 100% of Tri-colored Bat that have been impacted by WNS (Figures 1-3). Additional sites are being detected each year in Canada, with the most recent (i.e., 2015) western detection of *P. destructans* in northwestern Ontario, near Atikokan (U.S. Fish and Wildlife Service 2016). WNS was confirmed in Washington State in March 2016, approximately 150 km from the Canadian border, and represents a 1300 mile jump from the previously-known westernmost detection of the fungus (U.S. Fish and Wildlife Service 2016). It is believed that the fungus may have gone unnoticed for several years and suggests caution in defining areas as not yet affected by WNS.

It is uncertain if WNS has spread to Labrador, as well as the northern-most parts of Ontario and Quebec because there is limited information related to the hibernacula in these regions. To date, testing of hibernacula on the island of Newfoundland has shown negative results (S. Pardy-Moores, pers. comm. 2015). The Côte-Nord region of Quebec is also currently believed to be WNS-free.

Transmission

Transmission occurs as a result of bat-to-bat contact and contact with contaminated hibernacula, as well as human-assisted mechanisms (e.g., tourists, spelunkers, and researchers that do not follow proper decontamination protocols) (Lorch et al. 2011, Lorch et al. 2013). The amount of physical contact among hibernating bats varies by species, and does not correlate well with infection rates (Kilpatrick 2013, Langwig et al. 2015b). Transmission of *P. destructans* does not appear to be associated with winter colony sizes or influx of susceptible individuals after the mating season (Langwig et al. 2015b).

Pseudogymnoascus destructans spores in the soil and on the walls of hibernacula may remain viable for years, if not decades, potentially impeding recovery of these species (Langwig et al. 2012, Hoyt et al. 2014).

Infection of the remaining Canadian range of Little Brown Myotis and Northern Myotis

If WNS continues to spread at its current rate, all hibernacula in Canada and the U.S. will be infected by 2025 to 2028 (Maher et al. 2012, COSEWIC 2013, O'Regan et al. 2014).

In Canada, as WNS approaches less forested regions of southwestern Manitoba, the relative dryness and few trees in the Prairies suggests that transmission may occur at a slower rate. But it is possible that WNS may spread westward using alternative routes: from the south and /or from forested regions north of the Prairies. Moreover, despite some evidence that the Rocky Mountains historically restricted bat gene flow between eastern and western areas, mixing exists and therefore it is unlikely that the mountains will be a physical barrier that prevents WNS from reaching the western coastline (Russell et al. 2012).

Samples of Little Brown Myotis collected from insular-Newfoundland exhibited genetic differentiation and less genetic connectivity when compared to other samples collected in eastern Canada, indicating few movements of bats between Newfoundland and other areas (McLeod et al. 2015). This suggests that the probability of transmission is lower to the island than it is between other sampling sites. Nevertheless, bats from other regions separated by similarly-wide oceanic straits are not genetically isolated and therefore bat-assisted spread to Newfoundland remains possible (McLeod et al. 2015).

WNS may reach WNS-free populations faster than would be expected from bat-to-bat transmission because of human-assisted transmission of the *P. destructans* spores. *Pseudogymnoascus destructans* was probably brought to North America on the clothing of tourists who had visited caves in Europe (Okoniewski et al. 2010). People who visit multiple caves without decontaminating their clothing or gear substantially increase the risk that *P. destructans* will be transmitted to WNS-free hibernacula. In addition, bats can be inadvertently transported. For example, there are reports of bats being transported to British Columbia within the cargo hold of a ship (P. Govindarajulu, pers. comm.) and in the awnings of camper vans (D. Hobson and G. Horne, pers. comm). Such incidences have the ability to greatly increase the rate at which WNS spreads.

Resistance and treatment

A small percentage of individuals may have a genetically-based resistance or immunity to the effects of *P. destructans* that would be passed to their offspring. In Central Europe, *P. destructans* has been recorded in approximately 63% of sampled hibernacula, and on several bat species, yet mortality due to WNS has not been observed suggesting that populations of European species may be resistant to, or tolerant of, WNS (Wibbelt et al. 2010, Horacek et al. 2012). Reichard et al. (2014) found a small number (113 / 2095 banded individuals) of Little Brown Myotis in New England survived 1 to 6 winters since the arrival of WNS and some showed signs of reproductive

success. Researchers in Ontario have also documented small numbers of Little Brown Myotis surviving WNS infection and reproducing (D. Morningstar, pers. comm.).

Substantial research is ongoing into the ultimate causes, treatment, and mitigation of WNS. The major molecular component responsible for the effects of *P. destructans* has been identified and could represent a target for WNS intervention (O'Donoghue et al. 2015). Promising new research has also isolated an enzyme that naturally occurs on the skin of bats that appears to inhibit the invasion of tissue by *P. destructans* in laboratory tests (Hoyt et al. 2015). Additionally, research has demonstrated that substances produced by the soil bacterium *Rhodococcus rhodochrous* and yeast *Candida albicans* may have potential as biological control agents of *P. destructans* (Cornelison et al. 2014, Raudabaugh and Miller 2015).

4.2.2 Feral and Free-roaming Cats

Domestic and feral cats are known to prey upon a substantial number of birds (Calvert et al. 2013), small mammals (Loss et al. 2013), reptiles, and amphibians (Loyd et al. 2013). Ancillotto et al. (2013) suggested that cats may be a significant threat to bats. The Community Bat Programs of British Columbia regularly receives calls and anecdotal reports of cats killing bats in British Columbia (J. Craig, pers. com.). Species that roost within anthropogenic structures (e.g., barns), such as Little Brown Myotis, are likely more susceptible to this threat because of their potential close proximity to cats. In Italy, adult female bats in rural or sparsely urban areas were most likely to be preyed upon by cats (Ancillotto et al. 2013). In Yukon, cats tend to kill juvenile Little Brown Myotis that have recently become capable of flying (T. Jung, pers. com.).

4.2.3 Destruction, Degradation of Harmful Alteration of Hibernacula

Little Brown Myotis, Northern Myotis, and Tri-colored Bat require specific microclimatic conditions throughout hibernation. Therefore, any activity that results in a hibernaculum being inaccessible to bats or alters a hibernaculum's temperature, humidity, airflow, or other microclimatic characteristics may destroy or degrade the habitat.

The practice of sealing the entrances of mines, caves, and dug wells has become increasingly common during the past few decades, likely because of health and safety concerns and potential associated liabilities. If the structures are being used as hibernacula, sealing the entrance can represent a potentially significant source of habitat loss. For example, when a hibernaculum in Kentucky was blocked by a new gift shop, thousands of Indiana Bats (*Myotis sodalis*) clung to the walls of the building, rather than search for an alternative hibernaculum (Murphy 1987). Even blockages of small entrances can alter airflow patterns and change internal temperatures (U.S. Fish and Wildlife Service 2007).

Industrial activities, such as quarrying, mining exploration and development, agriculture, dam construction, and forestry outside of hibernacula can also cause, exacerbate, or accelerate blockages of airflow, create changes to hydrology or microclimatic

conditions, potentially cause flooding, or directly degrade the habitat (McAlpine 1983, U.S. Fish and Wildlife Service 2007). Also, mine or cave entrances may collapse if heavy machinery (e.g., timber harvesting equipment or mining equipment) is used near weak areas of the hibernaculum (McAlpine 1983, U.S. Fish and Wildlife Service 2007). Once bats are blocked from entry, the hibernaculum can no longer be used. Rehabilitation activities (e.g., backfilling, removal of head frames) at old mine sites can affect the suitability of hibernacula and disturb the bats using them if activities are carried out during hibernation period. Conversely, the decommissioning of active or semi-active mines (e.g., shutting off water pumps) can result in flooding of hibernacula. Mining companies may reactivate previously abandoned mines for extraction purposes as a result of fluctuations in mineral prices, but there is little information on the frequency of this practice in Canada. The prevalence is assumed to be low, but may be a concern for particular areas of the country.

Modifications for tourists (e.g., observation platforms), intentional vandalism, or the erection of physical barriers (e.g., gates) can cause restricted or altered airflow or modify other microclimatic characteristics of the hibernaculum (U.S. Fish and Wildlife Service 2007). A well-known cave system in Ontario, which was used as a hibernaculum by these three species of bats (Fenton 1969, Thomas et al. 1979), underwent extensive modifications (e.g., lighting, gates/doors at entrances, paved stairways and floor) to turn it into a commercial tourist attraction (Petrick 2015). Gates are often considered the most efficient and effective technique to control human access to hibernacula, but even so-called bat-friendly gating may cause bats to avoid the hibernaculum, collide with the gate, or cause significant changes in bat behaviour (Spanjer and Fenton 2005, U.S. Fish and Wildlife Service 2007, Derusseau and Huntly 2012, Diamond and Diamond 2014). Gating should be completed using well-supported designs in conjunction with bat monitoring to ensure no negative impacts to bats.

4.2.4 Destruction, Degradation of Harmful Alteration of Roosts

Of the three species of bats, Little Brown Myotis most regularly uses buildings and bat boxes for maternity colonies. The number of bat colonies in buildings may be declining as a result of the deterioration of structures and attempts by landowners to exclude bats (Kunz and Reynolds 2003). Renovations or alterations to buildings used as maternity roosts may change the microclimate characteristics (e.g., air flow, temperature) of the roost. Because females tend to show a relatively high degree of fidelity, excluding bats from previously occupied maternity roosts in anthropogenic structures would be considered habitat loss, particularly when alternative roosting sites in the area do not exist. Similarly, habitat loss would occur if a previously occupied bat box is removed from a site.

Any type of development activity that results in the removal of trees or forested landscapes (e.g., land development, geological, exploration, and oil and gas wells) has the potential to destroy or degrade roosts for the three bat species. For example, forestry and timber harvesting operations (e.g., salvage logging) may remove tracts of

mature forests, as well as individual snags that may be used by male and female bats for roosting.

The effects of tree removal or roost exclusion may depend on the availability of other suitable habitat, timing, bat species, bat sex, and other factors. Roost exclusions may lower reproductive success, alter home range size, change mean colony size, and decrease site fidelity (Brigham and Fenton 1986, Neilson and Fenton 1994, Borkin et al. 2011, Chaverri and Kunz 2011). Little Brown Myotis may abandon roosting areas after being excluded from roost sites (Neilson and Fenton 1994). However, depending on habitat availability, bats may use another tree for roosting if a previous roosting tree is removed outside the breeding season (Silvis et al. 2015b). For Northern Myotis roosting in Kentucky, the number of roosts, roost site characteristics, and overall space used did not change after single highly-used roosts and 24% of secondary roosts were experimentally removed prior to roosting (Silvis et al. 2015b). However, the distances bats moved between sequential roosts doubled within areas where secondary roosts were removed (Silvis et al. 2015b). Nevertheless, Silvis et al. (2015b) noted that tolerance limits of roost loss may be influenced by local forest conditions and the social / behavioral characteristics of the species using the roost.

4.2.5 Destruction, Degradation, or Conversion of Foraging Habitat

The removal, degradation, and fragmentation of foraging habitat (e.g., forests, wetlands and riparian areas) can be caused by a variety of anthropogenic sources, including (but not limited to) forestry practices, agriculture, oil and gas development, mining exploration and development, and urban and residential development. Harvest rates associated with forestry practices in Canada are highest in Quebec, British Columbia, and Ontario. The harvest rates were relatively stable in Canada from the 1980s to 2008 (Masek et al. 2011), but have been lower since 2008 (NFD 2014). Land conversion has been intensive in some portions of these species ranges. For example, 73% of the boreal hardwood transition zone in Saskatchewan has been converted to agriculture, with 25% lost between 1966 and 1994 (Hobson et al. 2002). Young et al. (2006) calculated an annual rate of change in forest cover along the southern boreal edge of Alberta to be -0.82% per year. Wetland loss in Canada is estimated at approximately 70% within settled areas, with draining for agriculture accounting for the majority (85%) of known conversions (Haak 2008).

In general, many bat species avoid large clearcuts and open areas (e.g., Henderson and Broders 2008), but forested and vegetated edges may provide foraging opportunities for some bats (Krusic et al. 1996, Grindal and Brigham 1998). These edges may provide protection from predators and wind and/or concentrate prey (Swystun et al. 2001, Henderson and Broders 2008). Little Brown Myotis, Northern Myotis, and Tri-colored Bat are all associated with forests or trees for at least some portion of their annual cycles and therefore are likely affected by activities that result in forest fragmentation, degradation, and removal. However, research findings related to potential effects vary in relation to species, amount of available habitat, cause of forest degradation, spatial scale examined, and availability of insects (Grindal and Brigham

1999, Swystun et al. 2001, Henderson et al. 2008, Ethier and Fahrig 2011, Segers and Broders 2014, Pauli et al. 2015).

Forest fragmentation can create linear elements beneficial for Little Brown Myotis, but may decrease the availability of habitat for Northern Myotis (Broders and Forbes 2004, Broders et al. 2006, Segers and Broders 2014). Conversely, Ethier and Fahrig (2011) found that forest fragmentation (independent of forest amount) was positive for both Little Brown Myotis and Northern Myotis. In Alberta, Little Brown Myotis and Northern Myotis were active along forest edges and residual patches, but activity was significantly reduced in the center of cutblocks (Hogberg et al. 2002). In Prince Edward Island, Northern Myotis exhibited a significant preference for commuting and foraging under forest cover compared to open areas (Henderson and Broders 2008). In Quebec, *Myotis* spp. and Tri-colored Bat were most active in green spaces within the least-fragmented forested areas (Fabianek et al. 2011). In Ontario, the abundance of Tri-colored Bat was negatively related to the amount of forest cover (Ethier and Fahrig 2011), but in Nova Scotia, Tri-colored Bats were less active in forest-cleared landscapes (e.g., cleared for agriculture, settlements, and timber production) (Farrow and Broders 2011). Farrow and Broders (2011) concluded that Tri-colored Bat is a forest-associated species negatively impacted by practices that reduce the extent of forests on a landscape scale.

In agriculturally-dominated landscapes, some species follow linear forest features for commuting and foraging (Henderson and Broders 2008). Northern Myotis traveled following a hedgerow of trees in a agriculturally dominated landscape in Prince Edward Island (Henderson and Broders 2008). *Myotis* spp. and Tri-colored Bat were not directly observed using open areas (such as cultivated and fallow fields and golf courses) in Quebec, but were active in the wooded areas adjoining these features (Fabianek et al. 2011). Agricultural intensification that removes hedgerows and field margins could be reducing foraging and commuting habitat (Wickramasinghe et al. 2003).

Wetlands and areas around waterbodies (e.g., riparian areas and forest edges) are important foraging habitat for Little Brown Myotis, Northern Myotis and Tri-colored Bat. Activities that degrade or remove wetlands have the potential to have negative impacts to foraging habitat availability and quality. Wetland loss in southern Ontario, where all three species occur, has been extensive and continues (additional losses of 3.5% between 1982 and 2002) (Federal Provincial and Territorial Governments of Canada 2010). Within the range of Little Brown Myotis, estimates of wetland losses in the Prairie Pothole region of Canada vary between 40 to 71% (Federal Provincial and Territorial Governments of Canada 2010). Wetland loss and degradation continues within this region mainly due to agricultural intensification.

Roads can also act as barriers to bats by restricting movements and changing habitat use (Abbott et al. 2012, Bennett and Zurcher 2013, Kitzes and Merenlender 2014, Abbott et al. 2015). Bats are less likely to fly across a road as traffic noise increases (Bennett and Zurcher 2013). Traffic noise may also reduce flight activity and foraging efficiency by interfering with echolocation and hearing (Abbott et al. 2015).

4.2.6 Collisions with or Barotrauma from Wind Turbines

Bats can be killed either through direct collisions with turbine blades (Horn et al. 2008) or barotrauma caused by the sudden drop in air pressure behind the blades (Baerwald et al. 2008, Grodsky et al. 2011, Rollins et al. 2012). Wind turbines represent one of the largest sources of anthropogenic mortality documented for bats (Cryan and Brown 2007, Cryan 2011, O'Shea et al. 2016). Results from mortality studies at various sites in the United States and Europe suggest that annual bat mortality ranges from 0 to over 50 deaths per turbine, but data collection protocols, experimental design, and analysis methods varied substantially among wind farms (Kunz et al. 2007, Arnett et al. 2008, Cryan 2011, Hayes 2013, Smallwood 2013). Kunz et al. (2007) predicted that by 2020 as many as 110,000 bats may be killed annually in the United States based on an average of 2.3 bats / turbine / year. Cryan (2011) suggested that this may be a considerable underestimate, and provided an estimate of 450,000 bats annually based on an average published mortality rate of 11.6 bats / megawatts / year. Smallwood (2013) estimated approximately 888,000 bats killed each year.

Relative to long-distance migrants, such as Hoary Bat (*Lasiurus cinereus*), Eastern Red Bat (*Lasiurus borealis*), and Silver-haired Bat (*Lasionycteris noctivagans*), *Myotis* species are killed by turbines at lower rates (e.g., 0 to 13% of fatalities) (Arnett et al. 2008). This is likely because they migrate shorter distances and generally fly below turbine height during summer (Reynolds 2006).

Using data pre- and post-WNS from 64 wind farms across Canada, it is estimated that 15.5 ± 3.8 bats per turbine are killed annually (Zimmerling and Francis 2015). Based on 4019 installed turbines (the number installed in Canada as of December 2013), an estimated 47,400 bats are killed per year (95% C.I.[11] 32,100 – 62,700) (Zimmerling and Francis 2015). Little Brown Myotis accounted for 13% of all documented bat mortalities from wind turbines (approximately 6,000 individuals), with most (87%) mortality occurring in Ontario (Zimmerling and Francis 2015). At one wind power facility in Ontario, bat mortality was dominated by Little Brown Myotis; this species accounted for 46% of all bat mortality in July and 38% over the period of April to September (OMNRF, unpublished data). Northern Myotis accounted for 0.01% of all documented mortality from wind turbines (approximately 465 individuals) in Canada (Zimmerling and Francis 2015). At a wind power facility in British Columbia, Little Brown Myotis and Northern Myotis comprised 44% of all bat mortalities recorded with most fatalities occurring in July and August (Hemmera 2011). At some wind facilities in the eastern United States, Tri-colored Bats accounted for as many as 25.4% of fatalities (Arnett et al. 2008), whereas in Canada, fewer than five carcasses (i.e., less than 0.01% of all carcasses) have been found during carcass searches (Zimmerling and Francis 2015). It is unknown if these species are less vulnerable to impacts from wind turbines because of

[11] Confidence Interval (C. I.) - a range of values presented with a specified probability that the actual value of the parameter lies within the range. In this case, there is a 95% probability that the actual number of bats killed annually by wind turbines in Canada is between 32,100 and 62,700.

differences in flight, foraging behavior, or habitat, or if they simply have smaller populations and are therefore generally uncommon around wind farms. Nevertheless, even low rates of mortality have the potential to be biologically significant for relatively rare species; it is possible that future wind farms, if inadvertently located near important concentration areas such as along migration routes or near maternity roosts, swarming sites or hibernacula, could cause high mortality.

Mortality rate is anticipated to increase as the number of turbines increases. In WNS affected areas, the biological significance of any mortality could increase considerably. The mortality of a few individuals has the potential to impact the ability of local populations to recover and develop resistance to the fungus.

Presently, mitigation measures to reduce bat mortality related to wind turbine development may include the feathering of wind turbine blades or increasing the cut-in speed when the risk to bats is particularly high (e.g., at night during peak migration) (Baerwald et al. 2009). Baerwald et al. (2009) demonstrated that these mitigation techniques reduced bat fatalities by approximately 60% at a site in southwestern Alberta. Arnett et al. (2009, 2013b) found that increasing the speed at which the turbine starts to rotate and generate power reduced bat mortalities by approximately 73% (range 44% to 93%) at a wind farm in Pennsylvania with a marginal (~1%) loss in annual power. The use of ultrasonic broadcasts may also reduce bat fatalities at wind turbines by deterring bats from approaching the sound source (Arnett et al. 2013a). In some circumstances, operational mitigation techniques may include the periodic shutdown of select turbines during the highest risk periods.

4.2.7 Intentional Harm to Individuals

Some species of bats, including Little Brown Myotis, often use anthropogenic structures as maternity roosts or hibernacula. Noise, the accumulation of feces (guano), and fears of contracting histoplasmosis[12] and rabies may cause maternity colonies of bats to be exterminated. Approaches to eliminate bats from buildings may include: physical exclusion (e.g., sealing openings), chemical control, electronic control (e.g., lights and ultrasonic devices) and killing or relocating individuals (Kunz and Reynolds 2003). Few data are available to determine the prevalence and impact of maternity colony removals; most data are anecdotal because not all jurisdictions have reporting requirements for nuisance wildlife control companies (COSEWIC 2013). Sealing the entrance(s) of an occupied maternity roost will most likely result in the death of all individuals inside the roost site. Some maternity colonies may contain most of the breeding females and offspring within a large area, so colony removal can have a significant impact on local populations.

Intentional harm to individuals within hibernacula has also been reported. For example, all bats (~800 Little Brown Myotis and Northern Myotis) were removed for incineration from the only known hibernaculum of Northern Myotis on Prince Edward Island in 1989

[12] Histoplasmosis is an infection caused by a fungus that can be found in bat feces.

(Brown et al. 2007). Although the bats were rescued from incineration, attempts to keep them over winter failed and they all perished (Brown et al. 2007).

Some provinces and territories have taken measures to reduce the risk of intentional harm. For example, New Brunswick Department of Natural Resources has removed these species from the list of nuisance wildlife under the *New Brunswick Fish & Wildlife Act*, thereby providing support for non-lethal alternatives in their management. Saskatchewan's removal of all Chiroptera from the list of unprotected wildlife under The Wildlife Amendment Regulation 2013 protects bats from all harm, providing support for non-lethal alternatives in their management. See section 2: *Species Status Information* for more legislation protecting individuals.

4.2.8 Recreational or Scientific Disturbance of Individuals

Visitation by people (Thomas 1995) or handling of hibernating bats can result in arousal from torpor (Speakman et al. 1991). When in deep torpor, bats are generally unaffected by ambient noise (Harrison 1965), but some individuals may respond to noise and light, arouse from torpor, and begin to fly (Thomas 1995). These individuals can then cause a cascade of arousals in nearby bats, resulting from their tactile activities (e.g., attempted copulation, rejoining the cluster of bats) (Thomas 1995). Even non-intrusive visitations can cause severe fat consumption (premature energy depletion), starvation, reduced energy reserves for reproduction, and death (Gaisler et al. 1981, Boyles and Brack 2009, Olson et al. 2011). The population of Little Brown Myotis significantly increased in an Alberta cave after winter and autumn access was restricted to reduce disturbance during hibernation and swarming (Olson et al. 2011). Disturbance tolerance is related to the length of winter and number and rate of visits; repeated visits over several consecutive days have the most severe impacts (Boyles and Brack 2009). Because bats with WNS have more frequent arousal episodes (Reeder et al. 2012), the additive effect of human-caused arousals within WNS-affected hibernacula may be significant.

Tourists, spelunkers, recreational users, and researchers are the main visitors to hibernacula. Visitation in the summer (when most occur) likely has less direct impact on bats because the site is not being used or bats can replenish fat reserves. To minimize visitation, year-round gates have been installed at some hibernacula, spelunking societies have posted guidelines (e.g., Manitoba Speleological Society) (SSM 2015), and bat researchers have minimized the number and duration of their visits.

Activities in a maternity roost may be a concern if the activities disturb bats, or result in the bats abandoning the roost and relocating to other sites. Handling bats for research may also have energetic or fitness consequences, however, data on the extent of such activities are unavailable and the significance of this activity is unknown, but assumed to be small.

4.2.9 Industrial Disturbance of Individuals

Mining exploration activities, forestry operations, or other industrial activities may threaten bats if the activities cause noise, light, and vibrations near hibernacula that disturb hibernating bats and cause them to arouse from torpor.

Similarly, noise and vibrations in areas where maternity colonies are found may result in reduced reproductive success, roost abandonment, and relocation to other sites (McCracken 2011). Since bats rely on echolocation or prey-generated sounds to forage, anthropogenic noise could also interfere with foraging and affect prey detection (Bunkley et al. 2015). However, a study of compressor stations associated with natural gas extraction in New Mexico revealed no significant difference in the activity level of Little Brown Myotis at loud compressor sites compared to quieter well pads (Bunkley et al. 2015).

4.2.10 Mercury

Mercury is a naturally occurring element that is enriched in the environment by human activities. Long-range atmospheric transport and deposition is the dominant source of mercury to many aquatic habitats over much of the landscape (Fitzgerald et al. 1998, U.S. Geological Survey 2000). Bio-available mercury is also mobilized within watersheds by forestry activities, hydroelectric reservoir creation, and various industrial-related activities (Porvari et al. 2003, Vuori et al. 2003, Wiener et al. 2003). Mercury concentrations in aquatic food webs are usually correlated with low pH levels, and as a result mercury concentrations increase from west to east across Canada, along with pH levels, in freshwater food webs (Depew et al. 2013).

Bat species appear to be particularly susceptible to heavy metal accumulation because most species are long-lived, occupy high trophic levels, feed on aquatic emergent insects, and sustain high metabolic rates and food intake. Recent studies in the northeastern United States found significantly higher accumulation of mercury in blood and fur samples in Little Brown Myotis and Northern Myotis in all age classes near WNS contaminated sites than in non-contaminated locations (Karouna-Renier et al. 2014, Yates et al. 2014). However, Karouna-Renier et al. (2014) did not find significant differences in the genotoxic effects (i.e., DNA damage) of mercury between contaminated and non-contaminated sites. Mercury concentrations in Little Brown Myotis sampled across Nova Scotia varied among colonies in relation to nearby lake acidity, and 48% of the individuals sampled had concentrations in excess of a threshold associated with neurochemical changes in other bat species from Virginia (Little et al. 2015b). Of 344 Little Brown Myotis individuals sampled from maternity roosts across Atlantic Canada (Nova Scotia, Prince Edward Island, and Newfoundland and Labrador), 37% had concentrations exceeding the neurochemical threshold (Little et al. 2015a). These recent studies raise concerns regarding the effects of mercury and other environmental contaminants on reproductive success, physiological responses (e.g., immune system responses), and survival.

4.2.11 Other Toxic Chemicals

Reported sub-lethal effects of chemical contaminants in bats include impairment of flight and foraging ability, resulting in higher predation risk and lower energy accumulation, immunosuppression, reduced reproductive success, and change in metabolic activity (Clark and Lamont 1976, Eidels et al. 2007, Kannan et al. 2010). The effect of sub-lethal contamination on the resulting susceptibility of bats to WNS is still unclear, but high concentration of organic contaminants in Little Brown Myotis fat tissues were found both in healthy populations and populations affected by WNS (Kannan et al. 2010).

Pesticide spraying in agricultural or forested landscapes has the potential to reduce the abundance of insects on which bats feed. Widespread and/or continuous application of pesticides (such as that which might occur for Spruce Budworm - *Choristoneura fumiferana*, Mountain Pine Beetle - *Dendroctonus ponderosae*, or on agricultural landscapes) could potentially have substantial impacts on food availability and physiology. Even at local scales in the United Kingdom, bat activity was significantly higher in aquatic habitats of organic farms versus conventional farms, suggesting greater prey availability in areas with lower levels of agrochemical use (Wickramasinghe et al. 2003).

Neonicotinoid insecticides were introduced in the 1990s, are currently the most widely used class of insecticides globally, and their use is continuing to increase (Sparks 2013, Douglas and Tooker 2015). They are generally used on agricultural lands, but have been detected in wetlands (Main et al. 2014) and watercourses in Canada (Environment Canada 2011, Xing et al. 2013) and are frequently found at levels that exceed water quality guidelines (Morrissey et al. 2015). Neonicotinoids adversely affect insect populations (and therefore potential prey of bats) (Goulson 2013); some of the most important prey (flies, caddisflies, and mayflies) of Little Brown Myotis, Northern Myotis, and Tri-colored Bats are among the most sensitive aquatic insects to neonicotinoids (Morrissey et al. 2015). Reduced prey availability could potentially result in increased time spent foraging, less fat stores and/or increased time spent in torpor, ultimately leading to poor body condition and resulting in reduced reproductive and/or survival rates (Talerico 2008, Reimer 2013). In addition to reduced prey populations, neonicotinoids also cause direct sub-lethal effects on the reproductive success, development, immune function, and growth in numerous vertebrates (Gibbons et al. 2015). Mason et al. (2013) hypothesized that the thousands of invertebrates consumed by bats would inevitably expose bats to small cumulative doses of these toxins. To date, no research has explored the direct or indirect effects of neonicotinoids on bats.

Increased incidence of seasonal algal blooms may also pose a threat to these species. Algal blooms can be a natural occurrence, however, there appears to be an escalation in the global occurrence of blooms that are harmful or toxic (Hallegraeff 1993, Anderson et al. 2002). Algal blooms occur as a result of increased nutrient inputs to waterbodies; phosphorus and nitrogen from industrial, agricultural and sewage sources are the two most important human-derived inputs (Anderson et al. 2002). These inputs allow for the production of harmful and/or toxic algae, including a chemical called microcystin. Microcystin is known to cause skin irritations, vomiting, cancer of the liver and death in humans, livestock, pets and many aquatic organisms (Kuiper-Goodman et al. 1999,

Sivonen and Jones 1999). Researchers have found the transfer of microcystin from aquatic to terrestrial ecosystems, namely through the emergence of aquatic insects (Smith et al. 2008) which in turn are ingested by bats. Microcystin was detected in all fecal samples (n=20) of Little Brown Myotis near a lake in Michigan that experiences seasonal algal blooms (Woller-Skar et al. 2015). Further study is required to understand the impacts to individual bats and populations, however, this toxin may represent a previously unrecognized threat to bat populations (Woller-Skar et al. 2015). Another toxin associated with algal blooms (*Anabaena flos-aquae*) was implicated in a mass mortality event of bats (including *Myotis* spp.) in Alberta (Pybus et al. 1986).

4.2.12 Light Pollution

The alteration (e.g., timing, spatial extent, and spectral signature) of natural light regimes from artificial light sources can impact species in various direct and indirect ways related to foraging, reproduction, communication, habitat use, and movement behavior (Stone et al. 2009, Gaston et al. 2013, Mathews et al. 2015). Impacts may be beneficial (e.g., increased foraging opportunities), neutral, or detrimental (e.g., increased susceptibility to predation, collisions with lighted structures) (Kyba et al. 2011).

For bats in particular, when insect prey becomes concentrated around light sources, foraging efficiency can increase which has been viewed as beneficial to some species (Entwistle et al. 2001, Lacoeuilhe et al. 2014, Mathews et al. 2015). In southwestern Ontario, Furlonger (1987) found all species of bats encountered exploited concentrations of insects around artificial light sources though this was not significant for *Myotis* spp.; Tri-colored Bats were not encountered. In general, it has been found that bats with high or medium wing-loading and fast flight exploit insects at street lamps while gleaners and flutter-detectors[13] rarely, if ever, forage at street lights (Mathews et al. 2015). Similarly, in France, aerial hawkers[14] were light-tolerant, while slow fliers would experience a high predation risk at high light levels and thus do not use lit areas to forage (Lacoeuilhe et al. 2014). Little Brown Myotis are aerial hawkers and efficient, maneuverable fliers, and are therefore expected to benefit from foraging opportunities provided by lights; Northern Myotis are slow fliers that often hover hunt and Tri-colored Bats are slow, erratic, flutter fliers, and are therefore not expected to forage at lights (Naughton 2012).

Though seemingly beneficial to some species of bats, light pollution has been attributed to reductions in many insect populations that are attracted to lights, including moths, aquatic insects, and other terrestrial insects (Frank 1988, Perkin et al. 2014, MacGregor et al. 2015). Many insects are attracted to artificial lights, affecting their dispersal and

[13] Flutter-detectors use high duty cycles of echolocation to locate fluttering insect prey. Species that use high duty cycles are able to separate pulse and echo by frequency; species that use low duty cycles separate pulse and echo by time.
[14] Aerial hawkers catch flying insects while on the wing (i.e., flying). In bats, echolocation is used to locate prey.

navigation as well as reproduction, mating, crypsis, and ability to evade predators. Individuals experience direct mortality from flying to exhaustion, burning to death, or becoming trapped in light receptacles (Frank 1988, Horváth et al. 2009, Perkin et al. 2014). This in turn reduces the biomass and abundance, and can change the relative composition of insect populations, creating implications in the food chain through disruption of predator-prey relationships, pollination services, and ecosystem function (Hölker et al. 2010, Kyba et al. 2011).

In Hungary, illumination of the roosts of house-dwelling *Myotis* species resulted in the collapse of entire colonies and reduced growth rates of juveniles (Boldogh et al. 2007). This was due to delayed emergence from roosts resulting in missed opportunities for foraging during peak insect activity; presumably, the avoidance of lighted areas is due to increased predation risk and/or negative effects on the bats' orientation ability (Boldogh et al. 2007, Lacoeuilhe et al. 2014).

The impacts of artificial light appear to be variable and species-specific. Little direct research dedicated to understanding the effects of light pollution has been done on these three species of bats in Canada and further study is required.

4.2.13 Habitat or Prey Dynamic Alterations resulting from Climate Change

The effects of climate change on bats are unknown. Bats (particularly lactating females) are more susceptible to evaporative water loss than other mammals, suggesting that they may be vulnerable to increased temperatures associated with climate change (Webb et al. 1995, Chruszcz and Barclay 2002, Adams and Hayes 2008). Adams (2010) found significant reproductive declines in Little Brown Myotis in years that mimicked predicted conditions related to future climate change scenarios (i.e., reduced availability of water) for western North America,.

Other direct effects include the destruction of roosts and/or hibernacula as a result of increased storm frequency that is predicted to occur in the future (Jones and Rebelo 2013). Although warmer temperatures as a result of climate change could benefit hibernating bats in Canada, it may also lead to a disruption of hibernation, a reduction in water, and increased disease (Sherwin et al. 2012). Humphries et al. (2002) predicted climate change to cause a northward range expansion of Little Brown Myotis within 80 years.

The extent, intensity, and frequency of forest fires are projected to further increase because of warmer and drier springs and summers (Flannigan et al. 2009, de Groot et al. 2013, Girardin et al. 2013). Similarly, forest insect outbreaks (e.g., Spruce Budworm, and Mountain Pine Beetle) may intensify with the changing climate (Mattson and Haack 1987). These processes have the ability to alter large forested areas and cause whole tree mortality (Fleming et al. 2002), but may also create available snags for bat roosting and/or increase local prey availability (Wilson and Barclay 2006). Therefore, the ultimate impacts on bat populations and their habitats are unknown.

In addition to direct effects, climate change is predicted to indirectly affect bat survival through its effect on insect populations (Arlettaz et al. 2001). In northeastern regions of the continent, climate change is expected to cause wetter winters and drier summers (Hayhoe et al. 2007, Huntington et al. 2009). Adult female Little Brown Myotis have reduced annual survival in dry years, presumably related to the link between moisture availability and emergent insect availability (Frick et al. 2010b). The timing of peak abundances in some insects have also become earlier (Both et al. 2009). This may affect the synchronicity of peak prey densities and bat breeding (Jones et al. 2009) and therefore pup survival; sufficient prey is needed for pups to gain the fat tissue that is necessary for overwinter survival (Kunz et al. 1998).

4.2.14 Collisions with Vehicles

Collisions with vehicles can cause direct mortality to bats (Medinas et al. 2013). Seasonal timing, surrounding habitat, and level of vehicular traffic affect the number of collisions with vehicles (Lesiński et al. 2011, Medinas et al. 2013). Mortality rates are highest near roosts and active foraging areas (Medinas et al. 2013) and forest-adapted species, such as Northern Myotis and Tri-colored Bat, have the highest risk due to their characteristic low and slow flight (Abbott et al. 2015). There are also anecdotal reports of bats colliding with non-traditional / recreational vehicles and devices, such as water crafts (e.g., boats, personal watercrafts, and wind surfers), fishing lines, and all-terrain vehicles. The severity of this threat on the populations of Little Brown Myotis, Northern Myotis, and Tri-colored Bat in Canada is unknown.

5. Population and Distribution Objectives

There are no reliable current or past population estimates for Little Brown Myotis, Northern Myotis, or Tri-colored Bat in Canada. As such, population trends will be estimated using data from known and previously surveyed hibernacula and roosts throughout the species' Canadian range (as presented in COSEWIC 2013) as an index of the total population trends, and augmented by surveys and monitoring presented in section 6.2: *Strategic Direction for Recovery* of this recovery strategy.

<u>Little Brown Myotis and Northern Myotis</u>

Area-specific population objectives are defined based on the current (2016) status of WNS across the country: known WNS-affected areas and areas that are not yet known to be affected by WNS (see Figure 1). The current western invasion front[15] in Canada is in northwestern Ontario, near Atikokan while the eastern invasion front is in Cape Breton, Nova Scotia (as of 6 April 2016) (CWHC 2016, U.S. Fish and Wildlife Service 2016).

[15] The invasion front is where *P. destructans* has just arrived, but prevalence is low, or where arrival is imminent (Langwig et al. 2015a).

Distribution objective:

- The distribution objective for both the Little Brown Myotis and Northern Myotis is to maintain (or where applicable restore to) the pre-WNS extent of occurrence (the area that encompasses the known geographic distribution of the species in Canada as depicted in Figures 1 and 2).

Population objectives:

- The short-term (12-18 years) population objective is to maintain and increase (where feasible) the current level[16] of the population.

- The long-term (many generations) population objective is a self-sustaining[17], resilient[18], redundant[19], and representative[20] population.

The range of WNS overlaps with approximately 28% and 17% of Little Brown Myotis and Northern Myotis' Canadian ranges, respectively, and is expanding at an average rate of 200 to 250 kilometers per year (COSEWIC 2013). Since conditions suitable for *P. destructans* growth exist in areas not yet known to be affected by WNS, without mitigation, the entire Canadian population of both species will likely be affected by 2025 to 2028 years (COSEWIC 2013). Therefore, a 12-18 year timeframe was deemed appropriate for the short-term population objective.

The long-term population objective is based on the slow population growth rate of these two species, which implies that populations would require many generations (i.e., hundreds of years) to recover (see *Limiting Factors* section). The degree to which the Canadian (and continental) populations of Little Brown Myotis and Northern Myotis will ever be able to fully recover to their historical levels in known WNS-affected areas is uncertain. The short-term objective recognizes that increasing populations (where feasible) will improve the species' recovery potential, both within known WNS-affected areas and those not yet known to be affected by WNS (e.g., ability to re-populate areas affected by WNS, increased likelihood of finding individuals with resistance to WNS).

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[16] The current baseline for areas not yet known to be affected by WNS will be defined within 2-5 years (and prior to WNS establishment) using the surveys and monitoring presented in section 6.2: *Strategic Direction for Recovery* of this recovery strategy. The current baseline for areas known to be affected by WNS is 2016 levels.

[17] The term self-sustaining refers to a population that does not require human intervention for long-term persistence.

[18] The term resilient refers to a population that is of sufficient size to recover from periodic disturbance and avoid genetic collapse.

[19] The term redundant refers to a population with sufficient subpopulations available to withstand catastrophic events and facilitate rescue if necessary.

[20] The term representative refers to a population with presence across the diversity of ecosystems it inhabits and of the species roles in ecosystem processes.

Preventing the introduction of WNS to hibernacula in areas not yet known to be affected (e.g., Prairies, northern Canada, western Canada) is the most important factor for preventing further loss of individuals. In Canada, as WNS approaches less forested regions of southeastern Manitoba, the lower density of trees suggests that westward transmission of WNS by Northern Myotis may occur at a slower rate. Davy et al. (2015) suggests that the potential spread of the fungus that causes WNS into north-central Canada may be retarded by the opposing direction of gene flow of Little Brown Bats in central Canada. Nevertheless, it is acknowledged that it may not be possible to prevent the spread of WNS.

Tri-colored Bat

Distribution objective:

- The distribution objective for Tri-colored Bat is to restore (then maintain) the pre-WNS extent of occurrence (the area that encompasses the known geographic distribution of the species in Canada as depicted in Figure 3).

Short-term (10 years) population objective:

- The short-term population objective is to maintain and increase (where feasible) the population at its current (2016) level over the next 10 years.

The 10-year time frame was deemed appropriate for the short-term population objective because determining if a population has stabilized or is increasing will take multiple years of data acquisition. During this timeframe, it is expected that extensive research into treatments for WNS on individuals or in hibernacula will be explored. Furthermore, the COSEWIC criteria for assessment include reviewing population change within 10-year windows.

Long-term population objective:

- The long-term population objective is a self-sustaining, resilient, redundant and representative population.

The degree to which the Tri-colored Bat population will be able to fully recover to its historical levels is uncertain. The long-term population objective is based on the expectation that, even if individuals develop resistance or a treatment for WNS is found, the slow population growth rate of this species means populations would require many generations (i.e., hundreds of years) to recover (see *Limiting Factors* section).

Because the Canadian population of Tri-colored Bat occurs at the northeastern part of its continental range, and the vast majority of its population and distribution occurs in the United States to the eastern coast of Central America, population changes at the continental level will have a significant effect on recovery feasibility in Canada.

These objectives will be reviewed during the development of the report required within five years after this strategy is posted on the Species at Risk Public Registry to assess the implementation of this strategy and the progress towards meeting its objectives (s. 46 of SARA). These objectives may be revised as new information related to WNS and bat populations across Canada become available.

6. Broad Strategies and General Approaches to Meet Objectives

6.1 Actions Already Completed or Currently Underway

The following list of actions is not exhaustive, but is meant to illustrate the main areas where work is already underway and to give context to the broad strategies to recovery outlined in section 6.2. Actions completed or underway include the following:

International:

- In April 2015, a 'Letter of Intent Related to Efforts to Promote Conservation of Bats in the United Mexican States, the United States of America and Canada' was signed by representatives of each of the three countries to increase collaboration and coordination of bat conservation across North America.
- The North American Bat Monitoring Program (NABat) is creating a continental-wide coordinated effort for monitoring bats at local to range-wide scales to provide reliable data that will promote effective conservation decision-making. A Plan for the North American Bat Monitoring Program was released in June 2015 (Loeb et al. 2015).
- North American Bat Conservation Alliance (NABCA) facilitates communication between bat organizations across North America, develops conservation priorities, and addresses conservation issues.
- The Northeast Bat Working Group and Western Bat Working Group enable information exchange between agencies, organizations, industry, and individuals interested in bat research, management, and conservation, and facilitates multi-state collaborations (Northeast Bat Working Group 2015, Western Bat Working Group 2015).
- The North American Society for Bat Research promotes and develops research of bats and coordinates an annual Northern American Symposium on Bat Research (NASBR 2015).
- The U.S. Fish and Wildlife Service provides funding for research and coordinates an annual WNS workshop or conference that brings together international researchers to present new results and develop management strategies.
- There is Canadian representation on the various United States technical working groups involved with WNS response to ensure approaches developed in Canada are consistent with international efforts and that the data collected is able to be shared and compared.

National:

- Canadian Wildlife Health Cooperative (CWHC) works in collaboration with federal, provincial and territorial, academic, and non-governmental organizations to organize surveillance for WNS and the fungus that causes it, ensure appropriate standardized diagnostic testing and reporting of surveillance results, develop national decontamination protocols and product assessment, coordinate national-level monitoring of bats, and identify data gaps and data management needs in Canada. CWHC leads Canada's Inter-agency White Nose Syndrome Committee which contains five technical working groups. This group updated *A National Plan to Manage White Nose Syndrome in Bats in Canada* in February 2015 and will likely continue to serve as one of the main avenues for national implementation efforts related to WNS (Canadian Wildlife Health Cooperative 2015a).
- Efforts are underway by CWHC, NABCA, and Environment and Climate Canada to expand the Edubat project into Canada to increase bat education and outreach (BatsLive 2015).
- The Ministère des Forêts, de la Faune et des Parcs of Québec in collaboration with the Centre de la science de la biodiversité du Québec (CSBQ) and the University of Winnipeg developed a website (English: www.batwatch.ca; French : chauve-souris.ca) to promote a citizen science project for maternity roost monitoring in central and eastern Canada (Quebec, Ontario and Manitoba) and may be expanded to other parts of the country. The website presents documentation about bats, their conservation, and BMPs for bats in buildings. The website also hosts a maternity roost database, where citizens can enter a roost and its annual counts.
- Federally, provincially and territorially, bats are considered for land-use development project screening and permitting and during environmental assessments across Canada. Mitigations measures and pre- and post-development monitoring programs are established as necessary to minimize and evaluate adverse effects.
- Environment and Climate Canada is developing beneficial management practices (BMPs) for the forestry, wind energy, mining, and nuisance wildlife control industries, as well as for bats in buildings.
- Researchers at University of Winnipeg and Trent University are investigating the genetic response of bats pre- and post-WNS across Canada.
- The Canadian Wildlife Federation has several outreach activities related to bats (Canadian Wildlife Federation 2015). For example, they have a national bat box program used to distribute bat boxes and encourage citizens to track occupancy.
- Several national parks across Canada are conducting bat monitoring using a national protocol developed by Parks Canada Agency and contributing to NABat.
- Parks Canada Agency has produced a video with support from CWHC to illustrate the use of decontamination protocols, along with information related to bats and WNS.
- Under the *National Park General Regulations*, caves within Canada's national park system are closed unless specifically opened by a park superintendent.
- Parks Canada Agency has drafted guidance for hibernacula and for roosting bats during the reproductive season.

Western and northern Canada:

- The Western Canada Bat Network (WCBN) facilitates information exchange between groups and individuals involved in bat research, management, and conservation in western Canada, Alaska, and some northwestern states, primarily through semi-annual newsletters.
- In British Columbia, the Community Bat Programs of British Columbia promotes conservation of bats on private lands, provides a resource to landowners dealing with bat issues, and engages citizen scientists to collect data on bat populations. They also conduct roost emergence counts at maternity colonies to establish baseline relative abundance data, against which future declines can be measured (Community Bat Programs of BC 2014).
- The Community Bat Programs of BC has developed BMPs for pest control techniques and has started outreach initiatives with provincial pest management companies (Community Bat Programs of BC 2014).
- The British Columbia Bat Action Team, in collaboration with the British Columbia Ministry of Environment is currently finalizing BMPs for caving activities and mining and wind energy industries.
- Winter bat activity is being monitored throughout southern British Columbia by Dr. Cori Lausen (Wildlife Conservation Society Canada), Environment and Climate Canada-Canadian Wildlife Service, the British Columbia Ministry of Environment (Dr. Purnima Govindarajulu) and others; winter activity across northern and central British Columbia is also being monitored by Dr. Cori Lausen.
- The British Columbia Ministry of Environment and Dr. Cori Lausen have developed appropriate hygiene protocols for bat researchers, cavers and others visiting/working in underground bat habitats.
- The British Columbia Ministry of Environment and the Royal British Columbia Museum are archiving carcasses from bat mortality incidents and bat DNA to establish baseline information for British Columbia. A complete health assessment including testing to detect WNS, rabies and other parasites is conducted by Dr. Chelsea Himsworth (British Columbia Ministry of Agriculture) on all the incidental mortality bat carcasses that are recovered.
- Dr. Cori Lausen is leading a liaison project (Bats and Cavers Project - BatCaver.org) with the caving community in British Columbia and Alberta to locate caves and mines used by bats.
- The British Columbia Ministry of Forests published the Karst Management Handbook for British Columbia (BC Ministry of Forests 2003) to assist forest planners in developing appropriate management practices when conducting forest operations in karst terrain.
- Thompson Rivers University, Dr. Ann Cheeptham, funded by US Fish and Wildlife Service is investigating potential sources of fungus-inhibiting microbes from caves, including the fungus that causes WNS.
- Alberta Environment and Parks has developed guidelines for minimizing the impacts of wind energy development on bats and protocols for pre- and post-construction surveys.
- The Alberta Bat Action Team develops protocols, identifies research and management priorities, and facilitates information exchange.

- Alberta Community Bat program is a new initiative in Alberta to provide resources to private landowners, and engage citizens in bat conservation efforts including locating and reporting roosts (www.albertabats.ca)
- Saskatchewan's Environmental Code includes a requirement for any industrial project in the province to ensure it is not impacting bats. The specific provisions pertaining to mines include the requirement of surveys for cave animals and habitat prior to mine reclamation activities.
- The Saskatchewan Ministry of Environment is finalizing guidelines for siting, monitoring and operation of wind energy projects in the province,
- The Government of Yukon surveys Little Brown Myotis and Northern Myotis to better document their occurrence, reproductive status, and range in Yukon.
- The Government of Yukon and Government of the Northwest Territories conduct public education through interpretative events and brochures.
- The Government of Yukon engages in various research projects including studying the effects of natural disturbances, the importance of old-growth riparian forest, and long-term monitoring at select maternity colonies.
- The Government of the Northwest Territories is gathering baseline information on bats throughout Northwest Territories, searching for undiscovered hibernacula, and conducting WNS surveillance, population monitoring, and management planning at known hibernacula.
- Various partners (including Government of the Northwest Territories, Sahtu Renewable Resources Board, industry, academic researchers and community members) have erected acoustic bat recorders at several locations in the Sahtu, Dehcho, South Slave and North Slave regions of the Northwest Territories to learn more about the distribution and activity patterns of bats in these regions.

Central Canada:

- Manitoba Conservation and Water Stewardship have taken a number of actions aimed at protecting Little Brown Myotis and Northern Myotis. For example, the locations of hibernacula are considered confidential and visitation to hibernacula is discouraged for any reason other than research. Researchers are required to follow decontamination procedures upon entering and leaving hibernaculum as a condition of their research permit. Some caves used by hibernating bats are protected in an ecological reserve and are gated to prevent human access.
- The Ontario Ministry of Natural Resources and Forestry has developed guidelines for minimizing the impacts of wind energy development on bats and is working with the Ministry of Northern Development and Mines and the mining industry to minimize industrial disturbance to bats and their habitats.
- Ontario's Forest Management Guide for Conserving Biodiversity at the Stand and Sites Scales includes direction designed to maintain suitable habitats and habitat features, including hibernacula (Ontario Ministry of Natural Resources 2010).
- The Ontario Ministry of Natural Resources and Forestry has developed Ontario's White-nose Syndrome Response Plan (Ontario Ministry of Natural Resources and Forestry 2015).
- The Ontario Ministry of Natural Resources and Forestry acoustically monitors bat populations during summer and winter throughout Ontario.

- Environment and Climate Canada has collected radar and acoustic data in southern Ontario to determine if bats exhibit broad-front migratory movements or concentrate along linear landscape features.
- Summer population monitoring is underway in Ontario by the University of Guelph and Myotistar.
- Myotistar and Gray Owl Environmental Inc. (with support from Environment and Climate Canada and the National Speleological Society) are conducting advanced roost use monitoring at a significant summer roost near Cambridge, Ontario where bats are surviving and reproducing despite being in a WNS endemic region of Canada.

Eastern Canada:

- The Ministère des Forêts, de la Faune et des Parcs of Québec continues to track the spread of WNS in various natural hibernacula during winter and spring. In summer, various initiatives have been put in place to monitor bat populations. The department is conducting acoustic surveys in various regions of Quebec through the acoustic surveillance network of bats (Réseau Chirops). This network, established in 2000 by the Ministère des Forêts, de la Faune et des Parcs du Québec in collaboration with the Montreal Biodôme and Envirotel, consists of 14 acoustic inventory routes in various Quebec regions. The department also conducts maternity roost counts in anthropogenic structures (www.batwatch.ca). More intensive monitoring is in place on the North Shore where WNS has not been detected.
- A bat recovery team for Québec was created in 2014. The team is developing a recovery plan for the province and coordinating provincial-level recovery actions.
- Bat populations are being monitored regularly by the Department of National Defence at Canadian Forces Base Valcartier.
- St. Mary's University and Environment and Climate Canada are investigating mercury levels in Little Brown Myotis in Atlantic Canada.
- The New Brunswick Museum has monitored the spread of WNS, and associated rate of mortality at known hibernacula throughout the province during pre- and post-WNS years, and continues to provide research in the pervasiveness of the pathogen, the cave microfauna, and environmental conditions.
- The New Brunswick Museum, in collaboration with New Brunswick Department of Natural Resources, have established a reporting program to collect observations of winter day-flying bats, leading to new information on the distribution of these species in the province.
- New Brunswick Department of Natural Resources has developed survey guidelines for bat and bird mortality during pre- and post-construction periods of wind farm developments in New Brunswick.
- Prince Edward Island's Forest, Fish and Wildlife Division promotes the reporting of bat sightings and works with the CWHC to implement bat monitoring programs.
- Nova Scotia Bat Conservation by the Nova Scotia Department of Natural Resources monitors bats during the spring, summer, and fall.
- St. Mary's University is monitoring winter counts at hibernacula in Nova Scotia.

- St. Mary's University is researching demographics and social behavior of Little Brown Myotis in collaboration with Newfoundland and Labrador Department of Environment and Conservation in Newfoundland and Labrador.
- The Government of Newfoundland and Labrador continues WNS surveillance and monitors known populations. In collaboration with Memorial University of Newfoundland and Parks Canada, acoustic monitoring takes place to determine species' presence and abundance. Surveys for Little Brown Myotis and Northern Myotis in Labrador are conducted to better document the occurrence, reproductive status and range.
- In the summer of 2015 CWHC was contracted by PEI National Park to acoustically monitor habitat with stationary and mobile detectors. Coastal dunes, forest edges, wetlands, and fresh water sites were monitored, as well as a selection of decommissioned buildings in the national park. Acoustic monitoring will continue for multiple years to analyze bat echolocation activity trends.
- Atlantic Coastal Action Plan (ACAP) Cape Breton has been monitoring bats on Cape Breton Island since 2013. Monitoring efforts primarily involve long-term deployment of acoustic detectors in summering habitat and at known and potential hibernacula, and conducting maternity colony counts. In 2015, the program expanded by including additional monitoring sites in New Brunswick, Quebec and Newfoundland though partnerships with La Société d'aménagement de la rivière Madawaska, the New Brunswick Museum, Attention FragÎles and ACAP Humber Arm.

6.2 Strategic Direction for Recovery

The Canadian Wildlife Health Cooperative (Canadian Inter-agency White Nose Syndrome Committee) released a revised version of *A National Plan to Manage White Nose Syndrome in Bats in Canada* in February 2015 (Canadian Wildlife Health Cooperative 2015b). Whenever possible, the approaches in Table 3 were developed to align with initiatives outlined in that plan. When appropriate, the approaches were categorized into those that are applicable to areas not known to be affected by WNS and those that are applicable to known WNS-affected areas (and the invasion front).

Table 3. Recovery Planning Table

Threat or Limitation	Broad Strategy to Recovery	Priority[1]	General Description of Research and Management Approaches
Knowledge gaps to recovery	Monitoring and surveys	High	Entire range: • Implement standardized protocols and survey / monitoring designs for the three species of bats and their habitats across Canada (e.g., using North American Bat Monitoring Program). • Maintain an effective and coordinated white-nose syndrome (WNS) surveillance program across Canada. • Where applicable, identify baseline population levels (see section 5: *Population and Distribution Objectives*)
		Medium	• Refine Canadian bat population estimates and trends once appropriate surveys are established and sufficient data are assessed.
		Low	• Monitor trends in bat prey across their Canadian ranges.
Knowledge gaps to recovery and all threats	Research	High	Known WNS-affected areas (and invasion front): • Investigate techniques to prevent or reduce the spread, mitigate the effects of, and/or treat WNS. • Identify risk factors that may exacerbate the spread of WNS. • Assess the current impact of WNS on bat populations throughout their distributions, and investigate the health and characteristics of populations remaining in WNS-affected areas and the ability and importance of these remnant populations to recovery. • Determine if natural, genetic resistance occurs within the remnant populations. • Further investigate the population structure of bats in Canada to better

Threat or Limitation	Broad Strategy to Recovery	Priority[1]	General Description of Research and Management Approaches
			understand the movement of WNS between populations and across the landscape. • Identify and implement a database system to serve as a central repository for data related to national bat populations and WNS. <u>Areas not yet known to be affected by WNS:</u> • Further investigate likely pathways of introduction and identify locations most at risk of WNS.
		Medium	<u>Entire range:</u> • Determine the relative importance of known and potential threats to the three species across their Canadian ranges (see Appendix B). • Continue to investigate habitat use across the Canadian ranges of the species. • Continue to identify migratory routes and important stopover locations. • Investigate factors affecting reproductive output, survival, and fidelity to breeding sites. • Continue to investigate best techniques to reduce disturbance (e.g., gate design) while alleviating landowner safety concerns. • Determine the importance of anthropogenic habitats to the survival or recovery of the species. • Determine the effectiveness of bat house designs across Canada and their value for conservation and recovery.
		Low	• Continue to investigate the diet composition using advanced techniques (e.g., DNA sequencing) throughout their annual cycles and their ranges. • Further investigate the potential for, and effects of, other species filling niches once occupied by declining bat populations.
Knowledge gaps to recovery and all threats	Education and awareness, partnerships and stewardship	High	• Deliver outreach products to key interest groups (e.g., landowners, cavers, industrial sectors, nuisance wildlife control organizations, and wildlife rehabilitators), Aboriginal peoples, and the general public on the importance of maintaining hibernacula and maternity roosts (including the approaches to do so) and the consequences of WNS.

Threat or Limitation	Broad Strategy to Recovery	Priority[1]	General Description of Research and Management Approaches
			• Develop targeted threat mitigation outreach products (e.g., decontamination protocols) and actively promote them to relevant stakeholders. • Foster cooperative relationships with key interest groups (e.g., government, landowners, cavers, wildlife rehabilitators, the forestry, mining, agriculture, nuisance wildlife control, and wind industries), Aboriginal peoples, and others to mitigate threats to the species' and their habitats. • Communicate the importance of bats to people, ecosystems, biodiversity, and economies. • Where appropriate, promote volunteer participation in surveys and monitoring, and publicize the need for public reporting of bat observations. • Promote national and international cooperation and collaboration to fill knowledge gaps and to mitigate threats. • Encourage landowners and industrial sector stakeholders, such as wind energy and mining, to develop, implement, and promote beneficial management practices to mitigate threats to the species' and their habitats where they are known to occur (e.g., related to nuisance wildlife control, wind energy, mining, forestry, agriculture, and gate design). • Provide information to landowners with bats on their properties to ensure unintentional harm to bats does not occur; use these opportunities to engage citizens in filling knowledge gaps and conducting specific actions to maintain/increase populations. • Continue to identify opportunities and approaches that can align and integrate with groups and initiatives working toward bat conservation (e.g., Canada Wildlife Health Cooperative, and North American Bat Conservation Alliance). • Ensure timely reporting of WNS testing results.
All threats	Habitat and species conservation and management	High	<u>Entire range:</u> • Implement all known precautionary measures to reduce the spread of WNS. • Mitigate sources of mortality that may have additional detrimental impacts on bat populations (beyond that caused by WNS). • Conserve and enhance habitat for the species and their prey throughout their

Threat or Limitation	Broad Strategy to Recovery	Priority[1]	General Description of Research and Management Approaches
			Canadian distributions (with particular attention to natural habitat). <u>Known WNS-affected areas (and invasion front):</u> • Should treatments, mitigative measures, or measures to prevent or reduce the spread of WNS become available, establish methods and implement techniques. <u>Areas not yet known to be affected by WNS:</u> • Should preventative measures for WNS become available, implement interventions.
		Medium	<u>Entire range:</u> • Participate in initiatives aimed at reducing climate change, mercury contamination, pesticide use, and other toxic substances. <u>Areas not yet known to be affected by WNS:</u> • If deemed appropriate, increase available habitat in strategic locations and promote activities that may increase population growth (e.g., reduce yearling mortality).
All threats	Law and policy	High	<u>Entire range:</u> • Develop, implement, and promote compliance with federal (e.g., SARA), provincial, and municipal acts and policies related to reducing threats and encouraging conservation of these species, their prey, and their habitat. • Consider the species' requirements in management plans and policies for public lands, environmental assessments, and land-use (energy, forestry, mining, agriculture, etc.) planning initiatives. • Where deemed necessary, increase compliance promotion and enforcement activities at sites particularly vulnerable to disturbance.

1 "Priority" reflects the degree to which the broad strategy contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species.

6.3 Narrative to Support the Recovery Planning Table

Recovery of Little Brown Myotis, Northern Myotis, and Tri-colored Bat will require commitment, resources, collaboration, and cooperation among federal, provincial, and territorial jurisdictions, wildlife management boards, Aboriginal people, species experts, researchers, local communities, landowners, industry, and other interested parties from Canada and the United States. Because of their widespread range across the country, it will be important to apply adaptive landscape-scale management both in the response to the threat of WNS and in the management of bat habitat. For the purposes of evaluating the effectiveness of recovery efforts, and adjusting them where necessary, it is also important to monitor the spread of WNS, hibernacula, maternity roosts, population trends, and the distributions of the three species of bats.

A comprehensive approach to research and monitoring (which includes all stages of the annual life cycles and the entire extent of occurrence) will be required to more completely understand the status, limiting factors, significant threats, and habitat use of each species. Currently, there are no reliable population estimates for any of the three bat species and, in the short-term, it is not realistic to expect that population estimates will be derived. To determine the success of conservation and management efforts, and determine if the population and distribution objectives have been met, an effective monitoring program is needed to measure relative changes in bat abundance over time. To maintain a uniform sampling method across Canada, the protocol of the North American Bat Monitoring Program (NABat) should be used, to the extent possible, as the Canadian national sampling framework (Loeb et al. 2015).

Because WNS is spreading quickly across Canada, research and monitoring pertinent to the fungus must be performed promptly and efficiently before opportunities are lost. This will likely require a large body of researchers, governments, industry, Aboriginal communities, and volunteers to coordinate efforts, communicate effectively, pool resources, and share findings efficiently (Langwig et al. 2015a). Whenever possible, research efforts and priorities should be coordinated through established groups (e.g., North American Bat Conservation Alliance, and CWHC) to avoid duplicated effort and resources. To succeed in preventing the spread of WNS (see section 5: *Population and Distribution Objectives*), research aimed at a treatment for individuals and/or hibernacula infected with WNS or methods to significantly reduce or prevent the spread of *P. destructans* will continue to be required.

As noted in the threats section (section 4: *Threats*), in areas where local bat populations have significantly declined as a result of WNS, the level of concern related to other potential threats increases (Langwig et al. 2015a). Identifying the importance and risk factors associated with these threats on each of the three species becomes increasingly important (see Appendix B), so that appropriate mitigation measures can be adopted in a timely manner.

While necessary monitoring and research occurs across North America, the current state of available science can provide a base of knowledge to conserve known habitats and mitigate threats to the species.

7. Critical Habitat

Critical habitat is the habitat that is necessary for the survival or recovery of the species. Section 41(1)(c) of SARA requires that the recovery strategy include an identification of the species' critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction.

7.1 Identification of the Species' Critical Habitat

The critical habitat identified in this document is considered a partial identification, insufficient to meet the population and distribution objectives. A schedule of studies has been developed to provide the information necessary to complete the identification of critical habitat (see section 7.2: *Schedule of Studies*). In this recovery strategy critical habitat is partially identified for hibernacula, based on the best available information for each species as of October 2015.

Hibernacula

Hibernacula are used by Little Brown Myotis, Northern Myotis, and Tri-colored Bat to survive when ambient temperatures decline and insects are unavailable, and as such are necessary for the survival and recovery of these species. The availability of suitable hibernacula may be limiting for these species (Ontario Ministry of Natural Resources 2010, COSEWIC 2013).

<u>Occupancy</u>

- Any site where evidence of hibernation by Little Brown Myotis, Northern Myotis, or Tri-colored Bat has been observed between October and April at least once between 1995 and 2016 is identified as critical habitat.

As a result of human safety concerns, efforts to minimize bat disturbance, and the difficulty in locating hibernating bats within complex structures, the number of bats using a hibernaculum often cannot be fully counted and other evidence of occupancy may be used (e.g., swarming behaviour, genetic material, acoustic data). The discovery of one hibernating individual often indicates the occurrence of more undetected individuals using the hibernaculum. At sites where there was appropriate habitat for hibernation but a hibernaculum could not be verified (e.g., chambers are inaccessible, or entry is avoided to minimize disturbance), swarming (an activity that typically occurs adjacent to or within a hibernaculum) was considered an indicator of a site's use for hibernation. As such, these sites (i.e., the subterranean features described in the biophysical attributes) were included in the identification of critical habitat.

The time period (≥ 1995) recognizes that Little Brown Myotis, Northern Myotis, and Tri-colored Bat exhibit strong site fidelity to hibernacula, individual sites may be used by hibernating bats for decades, and suitable hibernacula may be limiting. Winter in Canada is defined as the months of December, January and February. However, this period may extend longer in some locations within Canada; therefore, a bat observed hibernating during a time period of cold weather between October and April could be defined as being in hibernation, and thus the feature it is using, a hibernaculum.

Sites that were deemed to have unsuitable habitat (e.g., suitable habitat no longer exists, or hibernating bats did not survive winter) were not identified as critical habitat; this does not include sites affected by WNS (occupied or previously-occupied). The long-term persistence of the WNS pathogen, *P. destructans*, in hibernacula affects the suitability of caves and mines for maintaining self-sustaining and resilient bat populations. Nevertheless, WNS-affected hibernacula are considered critical habitat because they need to be preserved from loss or modification to aid population recovery in the scenario that a treatment or decontamination measures are discovered, or natural resistance is developed.

Knowledge regarding the importance of habitat associations, their configuration surrounding the hibernacula, and at what geographical scale they exert an influence, if any, on the predictability of bat occurrence at these sites, is limited. At present, knowledge related to the locations of hibernacula is also limited throughout the range of these species. In addition, difficulties in confirming the identity of Little Brown Myotis in areas of British Columbia where Yuma Myotis also exist, limits the ability to confirm hibernacula use by this species. Filling these knowledge gaps is necessary to complete the identification of critical habitat for hibernacula and will be addressed through completion of the schedule of studies (section 7.2).

<u>Biophysical attributes</u>

- Typically, hibernacula for these species are subterranean features, such as caves, abandoned mines, hand-dug wells, cellars, tunnels, rock crevices or tree root hollows where light and noise levels are low.
- Hibernacula typically contain sections that have relatively stable temperatures (2-10 ˚C) and stable, high humidity levels (>80 %).

A single hibernaculum may include multiple entry and exit points and vast underground networks of chambers. The full extent of these features are included in the definition of hibernacula as critical habitat (regardless of the location of hibernating bats within the structure) because (1) individuals may use multiple areas within these structures and it is not always possible to determine their usage, and (2) the entire, intact network is generally required to maintain microclimatic conditions (e.g., air flow, temperature, and humidity).

Sites used for hibernation in western Canada, particularly along the Pacific Coast, may differ substantially from those elsewhere in the species Canadian range, and our

knowledge of the location and biophysical attributes of these hibernacula is very limited (Jung et al. 2014). Bats in some parts of British Columbia may employ different strategies to survive the winter; information on winter activity patterns and how bats use overwintering sites in these areas is limited. These knowledge gaps have been addressed in the schedule of studies (section 7.2) and will allow for the complete identification of critical habitat for hibernacula in these areas.

Geographical Location

The areas known to containing critical habitat for Little Brown Myotis, Northern Myotis, and/or Tri-colored Bat are presented in Figures 4-20. Critical habitat occurs within the standardized UTM grids where the critical habitat criteria (occupancy and biophysical attributes) described in this section are met. Critical habitat is displayed as UTM grids that represent all species that occur within a particular province or territory and identified critical habitat may include one or more of the species of interest (e.g., areas outside of the Tri-colored Bat documented range represents critical habitat for Little Brown Myotis and/or Northern Myotis). The UTM grid squares shown on these figures are part of a standardized national grid system that highlights the general geographic area containing critical habitat. Critical habitat is presented within standardized UTM grids, in order to respect protocols for provincial and territorial species at risk data use (and related agreements) and to protect the species and their habitats from disturbance and the potential introduction of WNS. The grid size used to display the critical habitat (i.e., 10, 50, or 100 km^2) is relative to the ability and risks associated with the location of critical habitat being discovered (as perceived by the data owners). More detailed information on the location of critical habitat to support protection of the species and its habitat may be requested, on a need-to-know basis, by contacting Environment and Climate Canada's Recovery Planning section at: ec.planificationduretablissement-recoveryplanning.ec@canada.ca. Permission from the province/territory or other data custodian may be needed before sharing the information.

A total of 192 hibernacula were identified as critical habitat in Newfoundland and Labrador, Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Alberta, British Columbia, and Northwest Territories based on data as of October 2015. The locations of hibernacula are not known in Yukon, Saskatchewan, and Nunavut. Data on the locations of hibernacula in Prince Edward Island are unavailable because of landowner privacy concerns. Additional critical habitat may be added in the future as new information becomes available in an amended recovery strategy or in the species' action plan.

Maternity Roosts

Maternity roosts are used for giving birth and rearing young, and clearly contribute to the survival and recovery of these three species of bats. However, the locations of the vast majority of maternity roosts are currently either unknown or undocumented, or the data are unavailable to Environment and Climate Canada. Given this, it is not possible to determine which maternity roosts are necessary for the survival or recovery of these

species; therefore, maternity roosts are not identified as critical habitat in this recovery strategy.

Once additional information on the locations and attributes of maternity roosts is available, it will be possible to set criteria that would identify the roosts that are necessary for the survival or recovery of the species as critical habitat. Criteria for identifying which maternity roosts are critical habitat would likely consider species, number of individuals using the roost, whether the roost is within a WNS-affected area, and the number of other known maternity roosts in the vicinity.

The work required to obtain the necessary information and establish criteria for the identification of maternity roosts as critical habitat is included in the schedule of studies (section 7.2).

Similar to hibernacula, knowledge of the location and biophysical attributes of maternity roosts in western Canada is very limited and habitat characteristics may differ substantially from those elsewhere in the species' Canadian range (Jung et al. 2014). Filling these knowledge gaps is necessary to complete the identification of critical habitat for maternity roosts and will be addressed through completion of the schedule of studies (section 7.2).

Landscape-scale identification

The geographic range of the species, threats, and habitat specificity of Little Brown Myotis (and possibly Northern Myotis) suggest the critical habitat associated with summering habitat (i.e., roosting and foraging) should eventually be identified at a landscape scale. This would permit the long-term management of the habitat needed for survival and recovery of the species. This type of identification would reflect the dynamic mosaic of habitat conditions available and required on the landscape. Nevertheless, the available information is not adequate to currently identify critical habitat at a landscape scale for the following reasons:

- There is a lack of data related to bat presence and abundance in large portions of their ranges.
- Habitat requirements may vary across the ranges of the species. Management units (i.e., geographic units within which critical habitat would be managed) need to be identified in such a way to best reflect variation in habitat use and management patterns.
- There is a lack of understanding and data to indicate the appropriate configuration of important landscape biophysical attributes.
- It is unclear whether certain summering habitats with specific biophysical attributes may be functionally more important than others. For example, specific habitats may have greater densities of individuals and/or result in higher reproductive success.
- The relationships between anthropogenic disturbance and habitat quality are poorly known. A better understanding of these relationships is needed to ensure

sufficient suitable habitat is available for these species and to identify at what scale and intensity activities would be likely to destroy the critical habitat.

It will take many years to gather sufficient data to address the knowledge gaps above. Therefore, a long-term schedule of studies is presented in section 7.2 to address the landscape-scale identification of summering habitat.

Other Habitats

Currently, male roosting sites, migration routes, and swarming sites are not identified as critical habitat. It is unclear whether the habitats that support male roosts or migration routes would be required for the survival or recovery of each species. At present, the knowledge of habitat requirements for the selection of significant swarming sites is insufficient to identify the biophysical attributes. Determining if male roosting sites and migration routes warrant identification as critical habitat and studies on the importance and biophysical attributes of swarming sites is included in the schedule of studies (section 7.2).

In summary, the critical habitat of Little Brown Myotis, Northern Myotis, and Tri-colored Bat can be partially identified at this time. A schedule of studies has been developed to provide the information necessary to complete the identification of critical habitat that will be sufficient to meet the population and distribution objectives. Although the short-term schedule of studies spans 10 years, the critical habitat can be updated as new information becomes available, either in a revised recovery strategy or action plan(s).

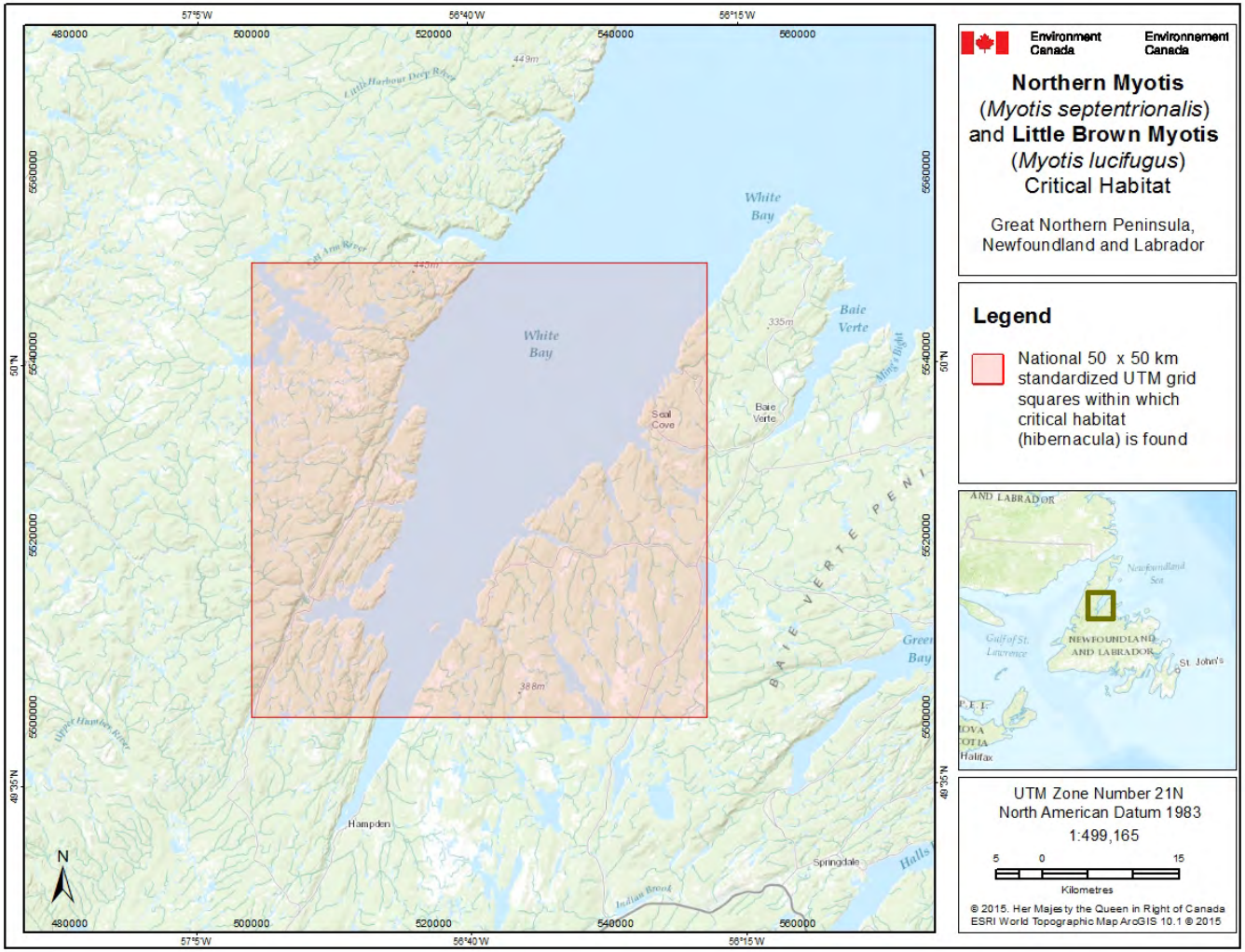

Figure 4. Grid square that contains critical habitat for Little Brown Myotis (*Myotis lucifugus*) and/or Northern Myotis (*Myotis septentrionalis*) in Newfoundland and Labrador. Critical habitat for these species occurs within the 50 x 50 km standardized UTM grid square where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

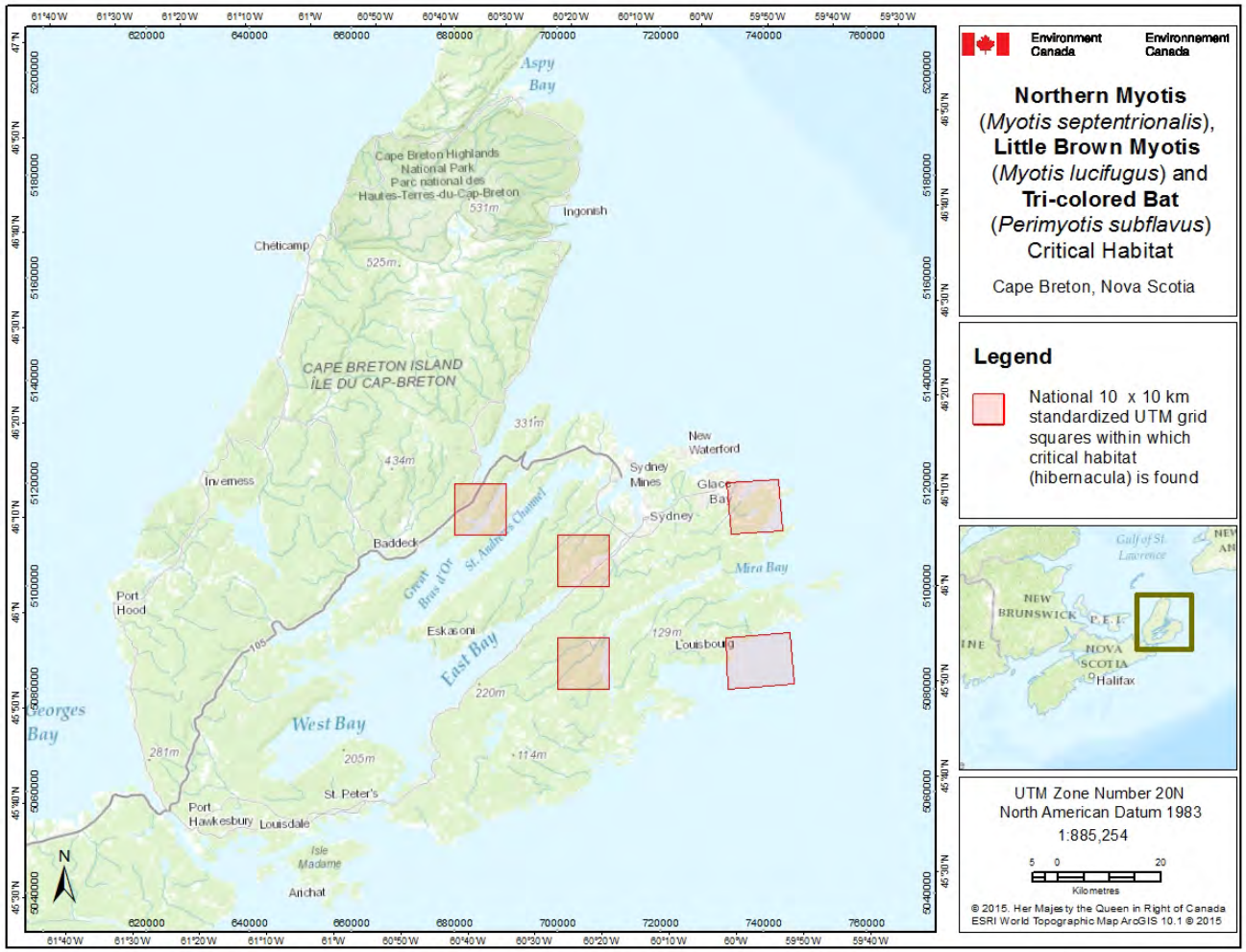

Figure 5. Grid squares that contain critical habitat for Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and/or Tri-colored Bat (*Perimyotis subflavus*) in Nova Scotia (Cape Breton). Critical habitat for these species occurs within these 10 x 10 km standardized UTM grid squares where the description of critical habitat is met (i.e., hibernacula have been identified). Standardized UTM grid squares at the intersection of UTM zones are merged with their adjacent grid squares. This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

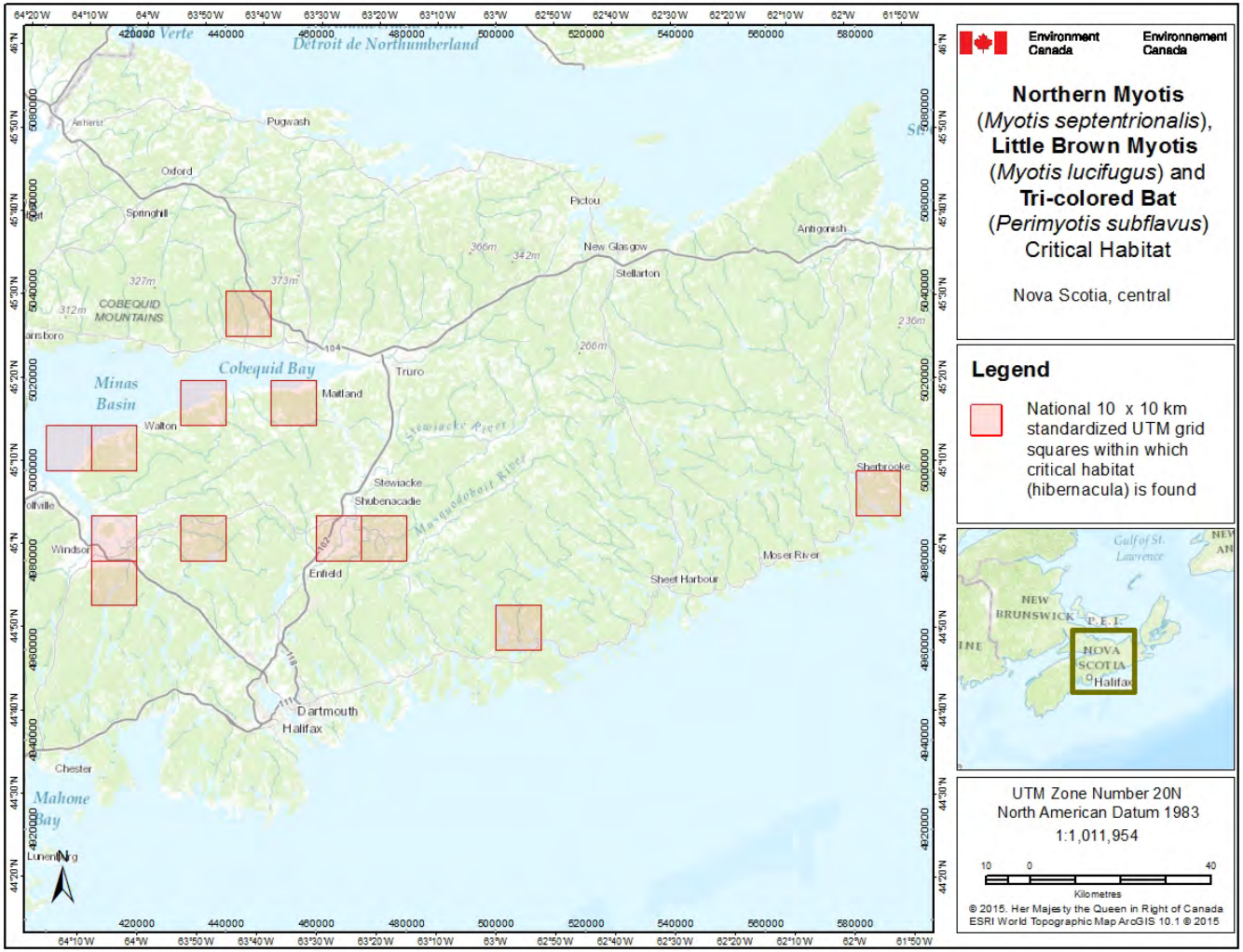

Figure 6. Grid squares that contain critical habitat for Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and/or Tri-colored Bat (*Perimyotis subflavus*) in central Nova Scotia. Critical habitat for these species occurs within these 10 x 10 km standardized UTM grid squares where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

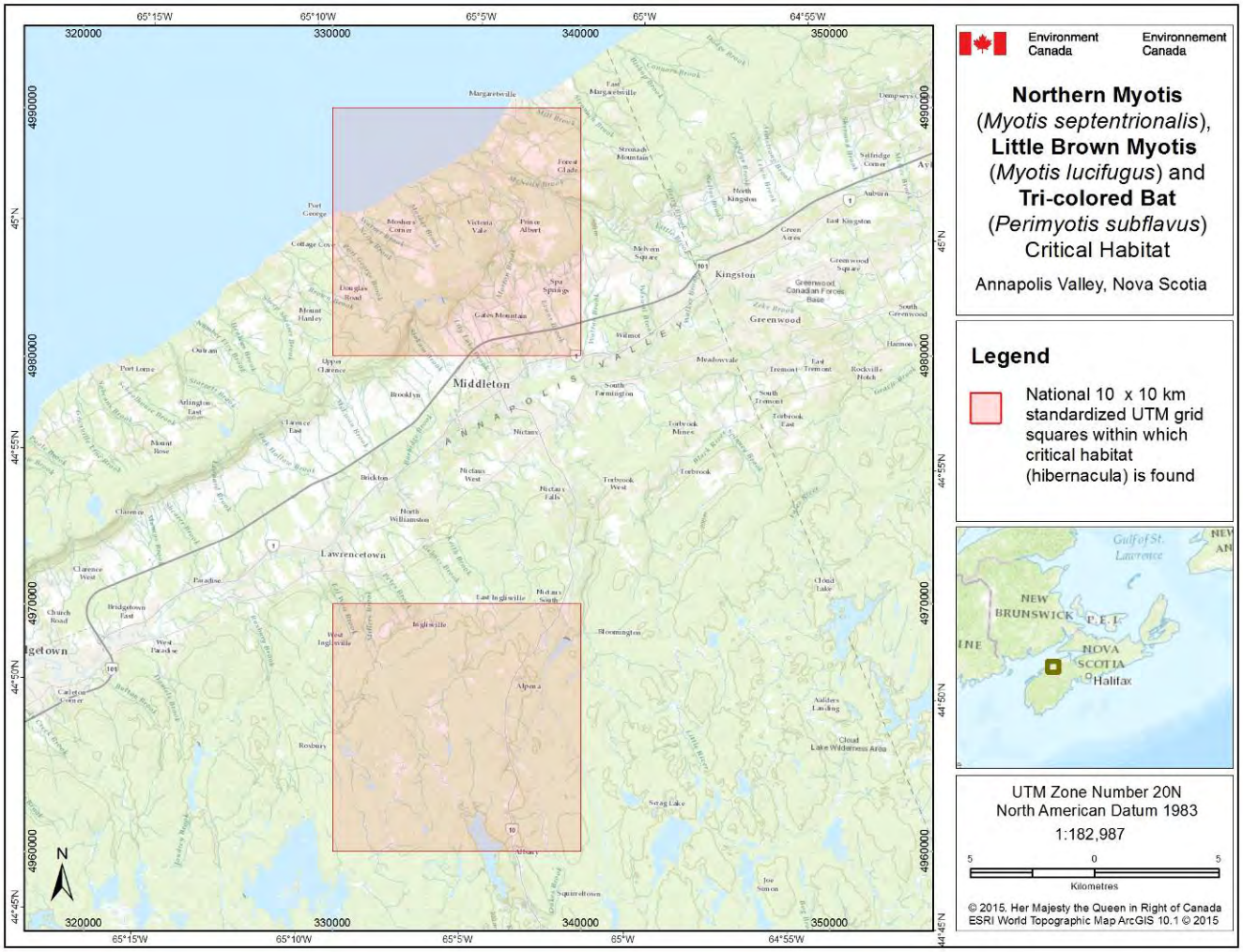

Figure 7. Grid square that contains critical habitat for Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and/or Tri-colored Bat (*Perimyotis subflavus*) in Annapolis Valley, Nova Scotia. Critical habitat for these species occurs within the 10 x 10 km standardized UTM grid square where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

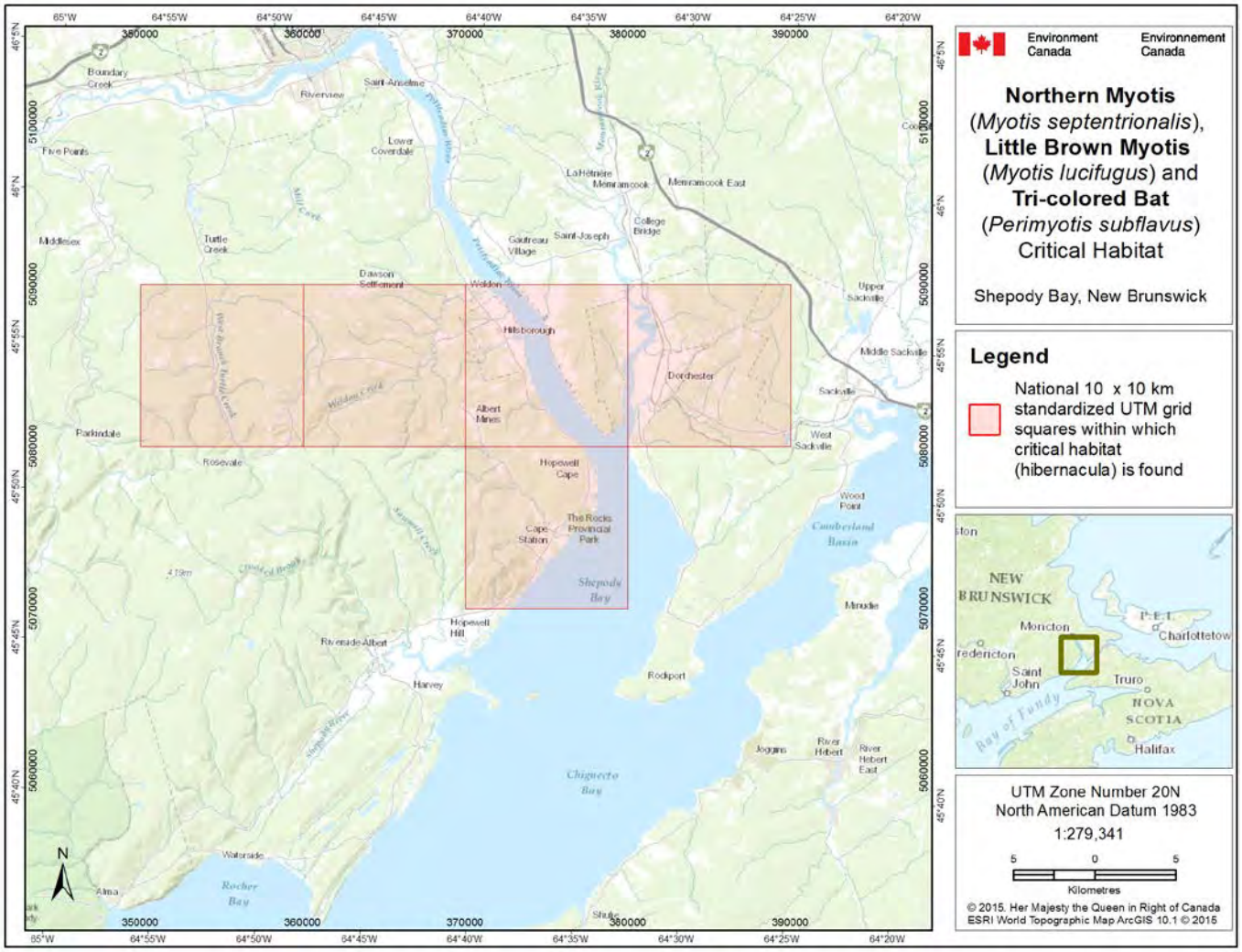

Figure 8. Grid squares that contain critical habitat for Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and/or Tri-colored Bat (*Perimyotis subflavus*) in New Brunswick (Shepody Bay area). Critical habitat for these species occurs within these 10 x 10 km standardized UTM grid squares where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

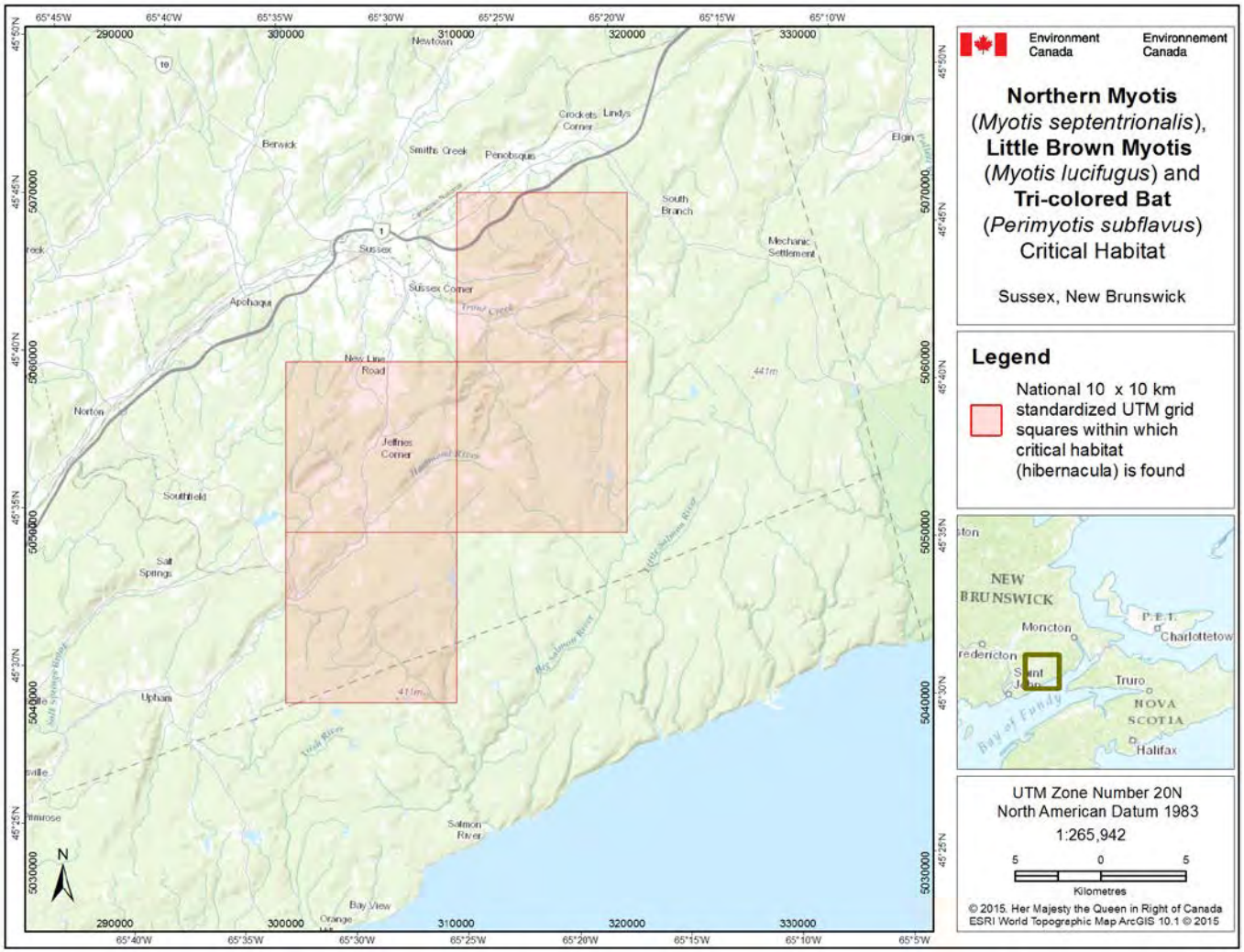

Figure 9. Grid squares that contain critical habitat for Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and/or Tri-colored Bat (*Perimyotis subflavus*) in New Brunswick (Sussex area). Critical habitat for these species occurs within these 10 x 10 km standardized UTM grid squares where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

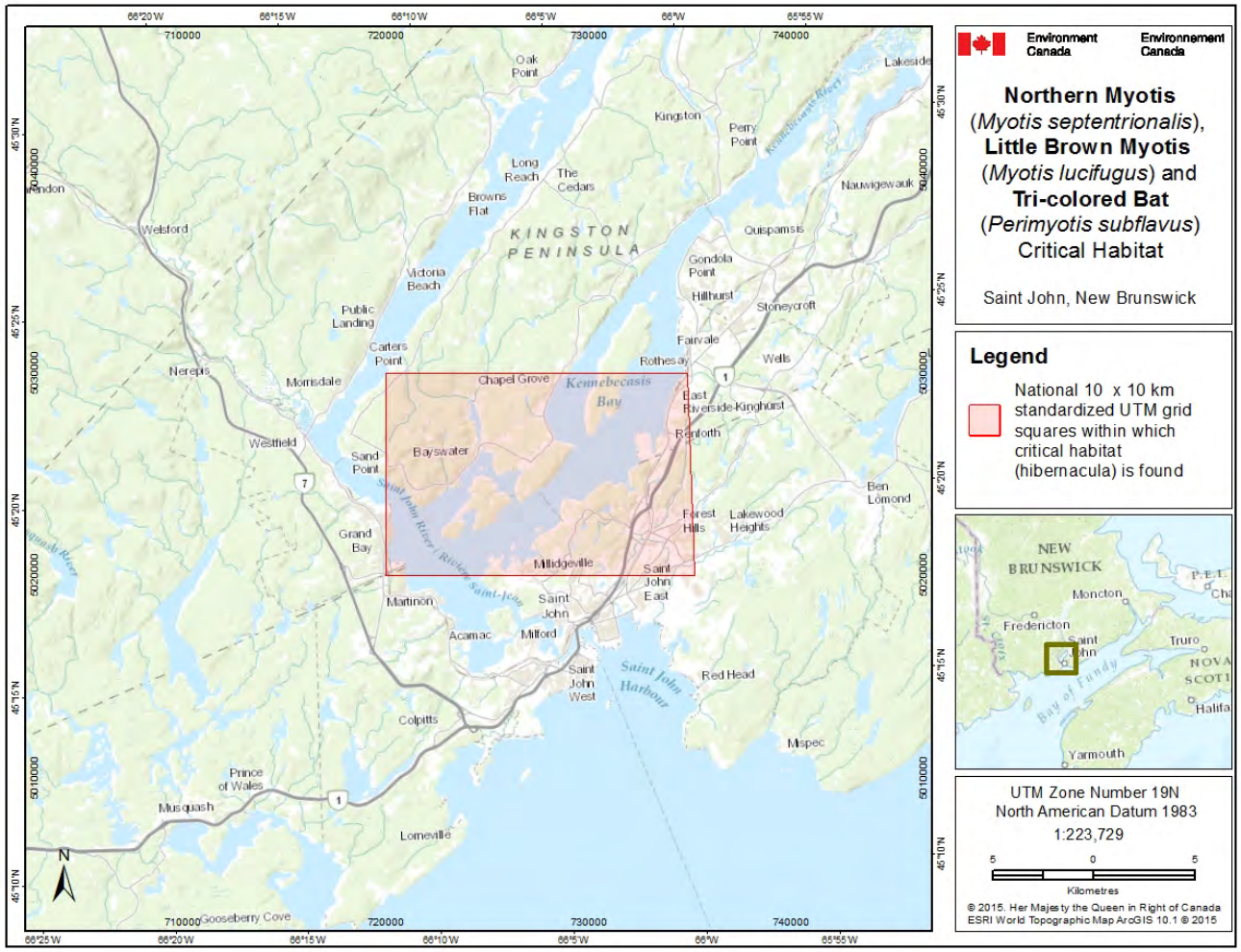

Figure 10. Grid square that contains critical habitat for Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and/or Tri-colored Bat (*Perimyotis subflavus*) in New Brunswick (St. John area). Critical habitat for these species occurs within this 10 x 10 km standardized UTM grid square where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown. Standardized UTM grid squares at the intersection of UTM zones are merged with their adjacent grid squares.

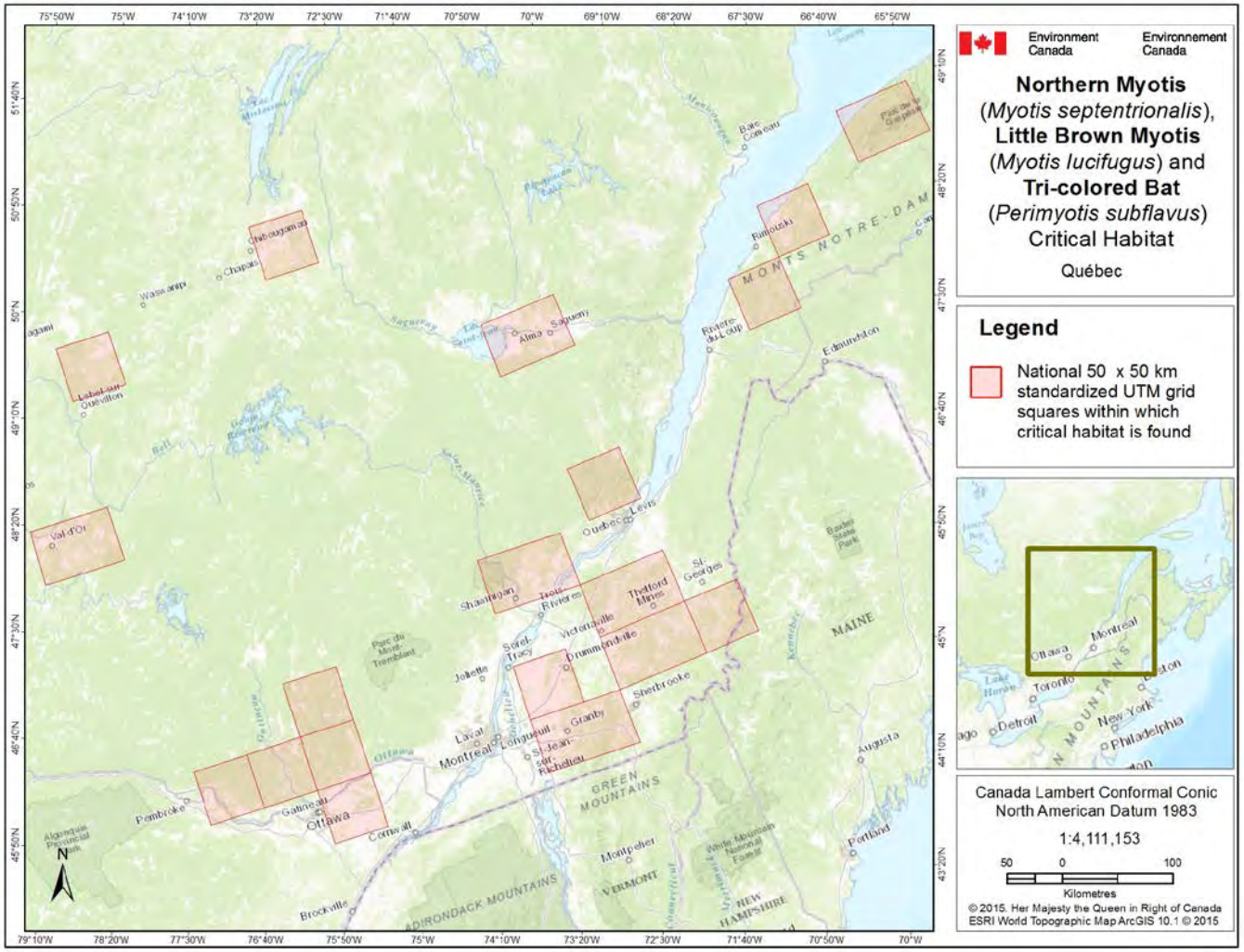

Figure 11. Grid squares that contain critical habitat for Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and/or Tri-colored Bat (*Perimyotis subflavus*) in Quebec. Critical habitat for these species occurs within these 50 x 50 km standardized UTM grid squares where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

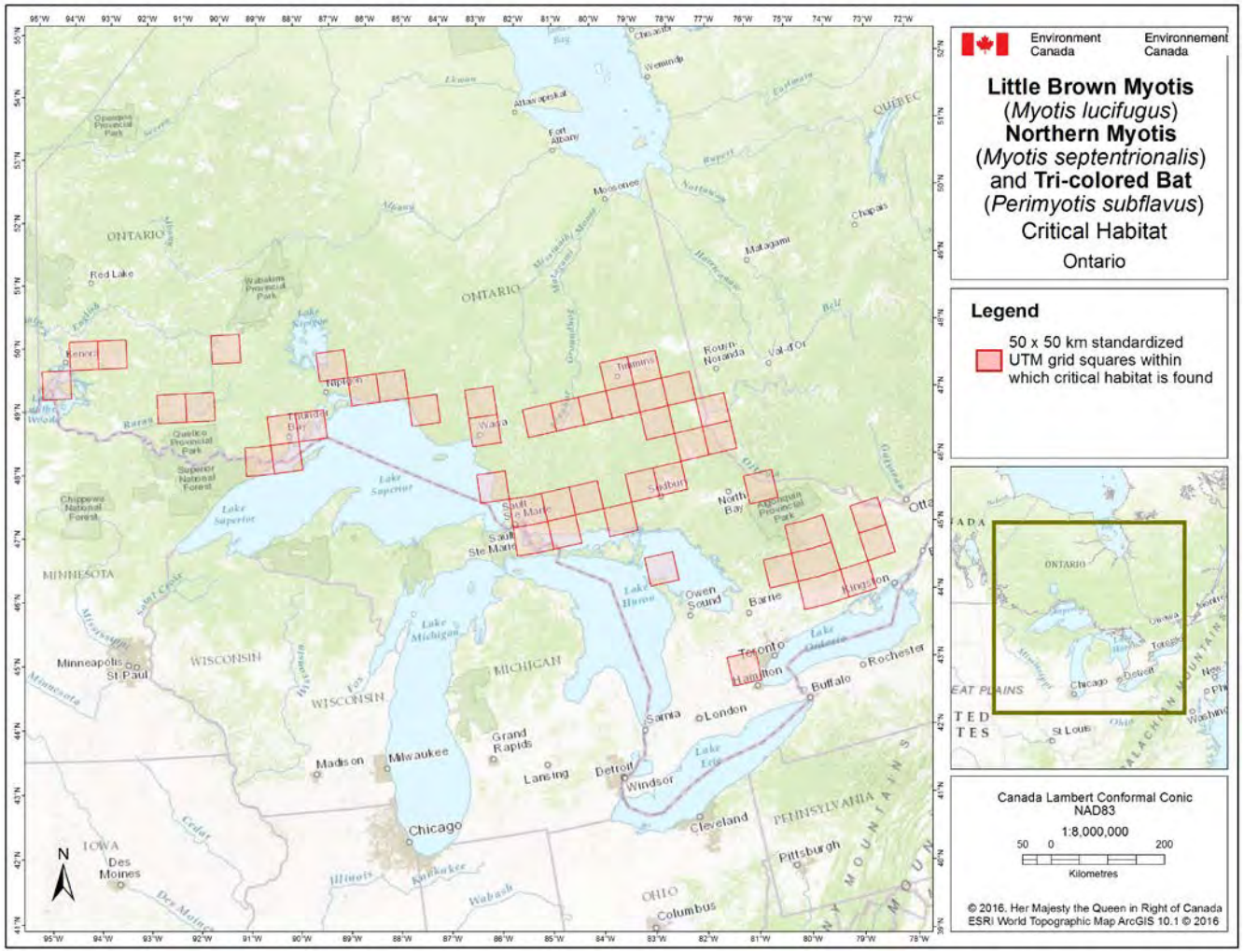

Figure 12. Grid square that contains critical habitat for Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and/or Tri-colored Bat (*Perimyotis subflavus*) in Ontario. Critical habitat for these species occurs within these 50 x 50 km standardized UTM grid squares where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown. Standardized UTM grid squares at the intersection of UTM zones are merged with their adjacent grid squares.

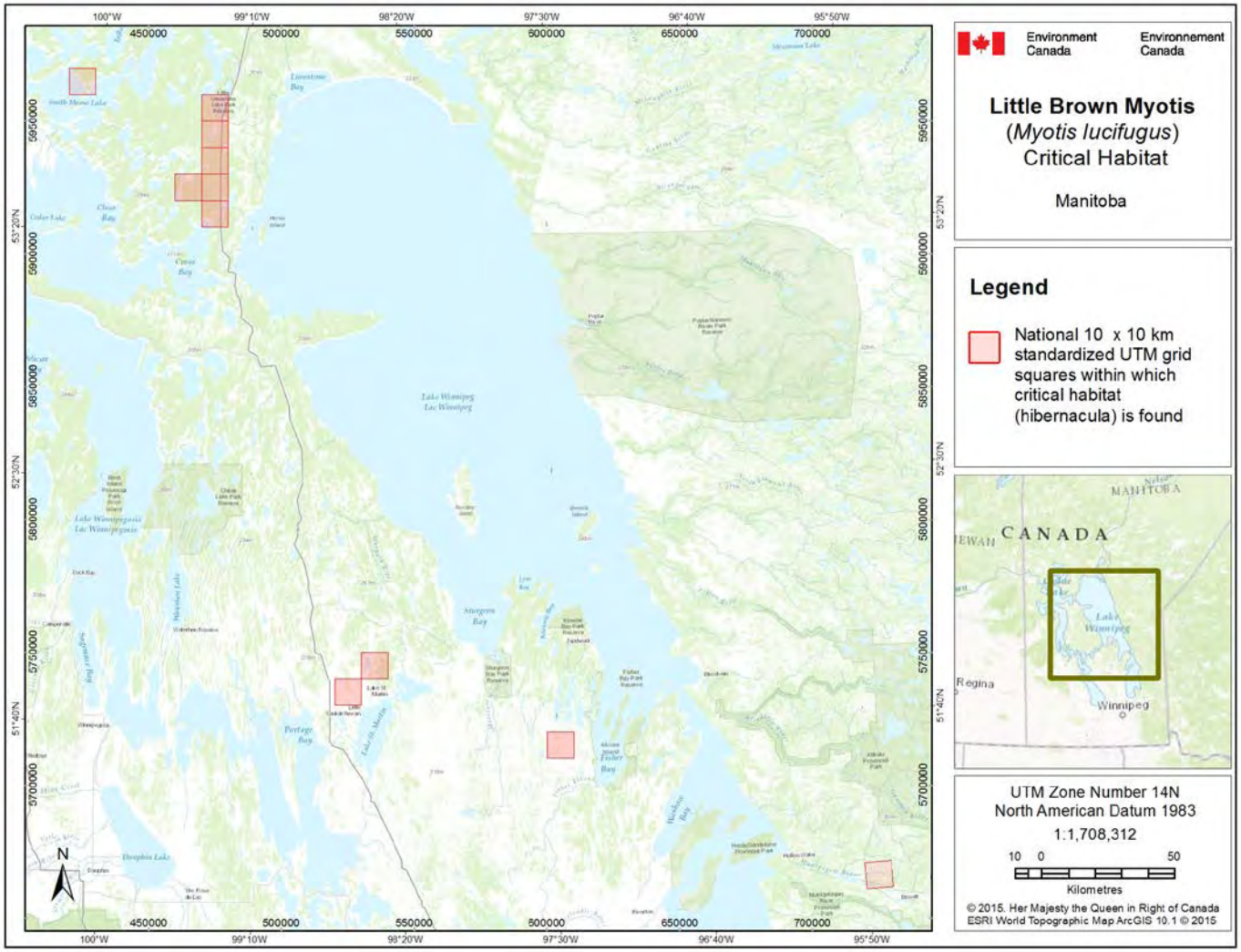

Figure 13. Grid squares that contain critical habitat for Little Brown Myotis (*Myotis lucifugus*) in Manitoba. Critical habitat for this species occurs within these 10 x 10 km standardized UTM grid squares where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

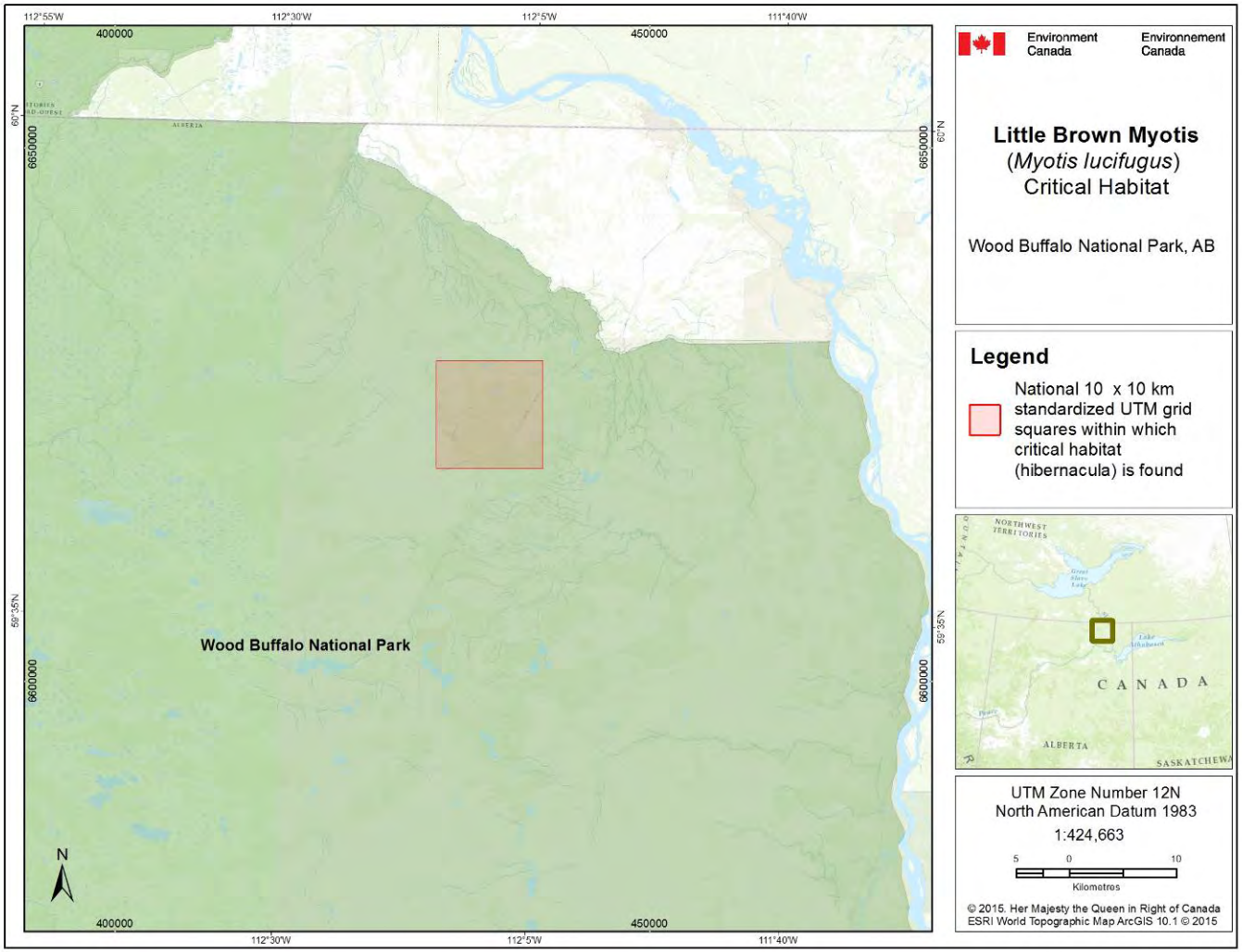

Figure 14. Grid square that contains critical habitat for Little Brown Myotis (*Myotis lucifugus*) in Alberta (Wood Buffalo National Park area). Critical habitat for this species occurs within this 10 x 10 km standardized UTM grid squares where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

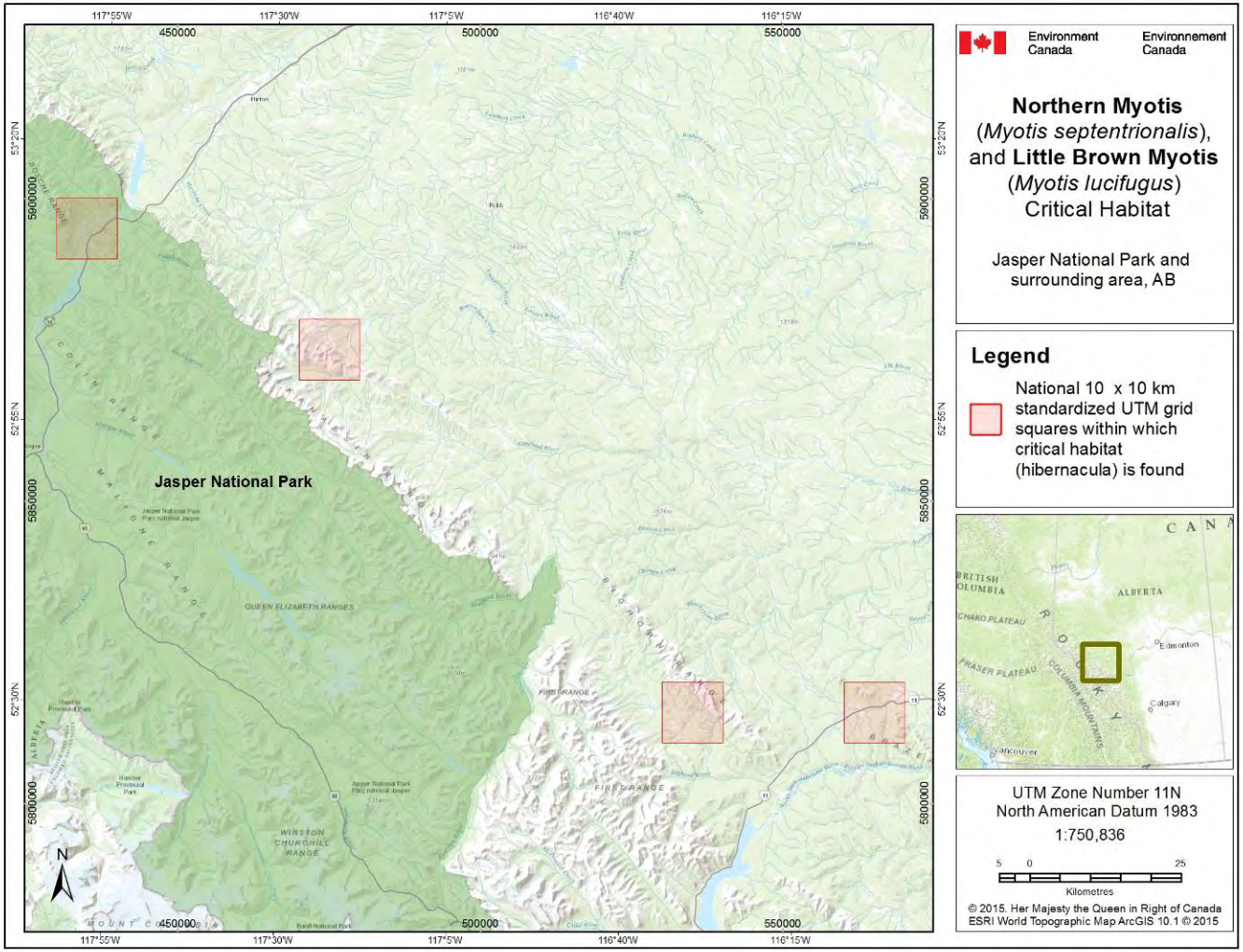

Figure 15. Grid square that contains critical habitat for Northern Myotis (*Myotis septentrionalis*) and/or Little Brown Myotis (*Myotis lucifugus*) in Alberta (Jasper National Park and surrounding area). Critical habitat for these species occurs within these 10 x 10 km standardized UTM grid squares where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

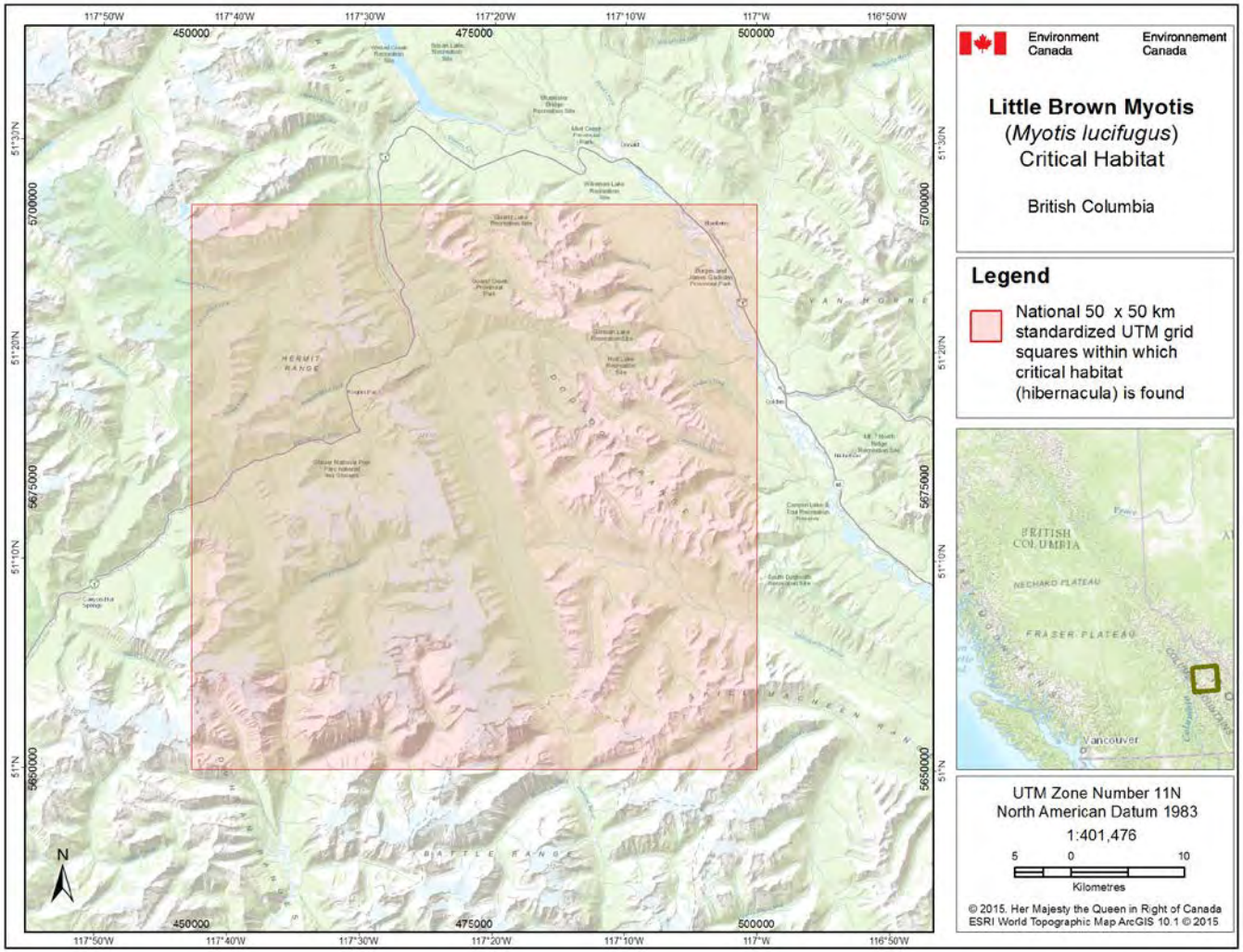

Figure 16. Grid square that contains critical habitat for Northern Myotis (*Myotis septentrionalis*) in British Columbia. Critical habitat for this species occurs within this 50 x 50 km standardized UTM grid squares where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

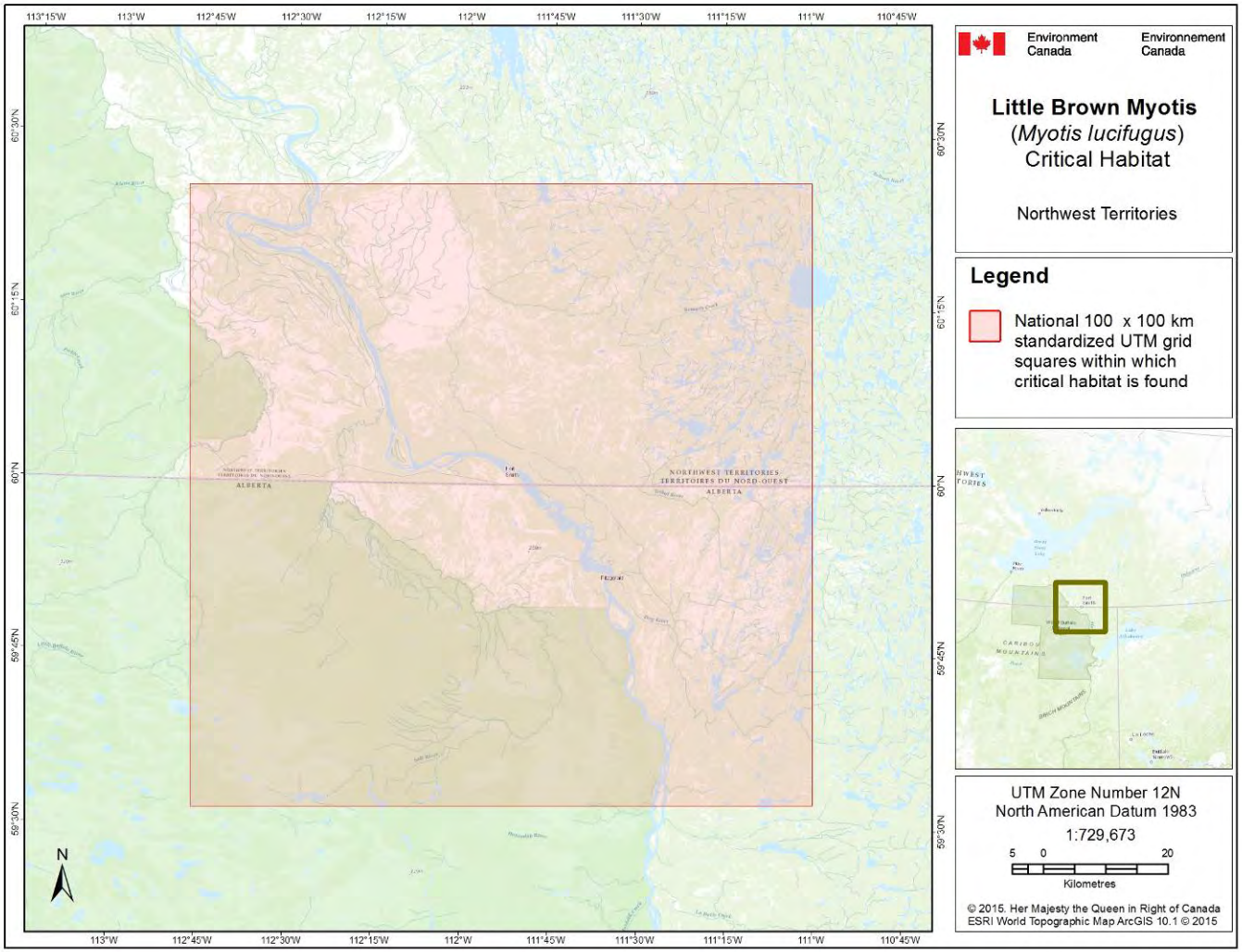

Figure 17. Grid square that contains critical habitat for Little Brown Myotis (*Myotis lucifugus*) in Northwest Territories. Critical habitat for this species occurs within these 100 x 100 km standardized UTM grid square where the description of critical habitat is met (i.e., hibernacula have been identified). This standardized national grid system indicates the general geographic area containing critical habitat; detailed critical habitat mapping is not shown.

7.2 Schedule of Studies to Identify Critical Habitat

A schedule of studies has been developed to provide the information necessary to complete the identification of critical habitat (Table 4 & 5).

Table 4. Short-term Schedule of Studies to Identify Critical Habitat

Description of Activity	Rationale	Timeline
Work with researchers, provinces / territories, Aboriginal communities, and non-government organizations to determine how sensitive data can be made available and used for critical habitat identification.	Lack of data availability (particularly related to anthropogenic structures) is a major impediment to critical habitat identification.	2016-2017
Conduct surveys in areas where hibernacula and maternity roosts are suspected but unconfirmed.	Known locations of hibernacula and maternity roosts are limited. In addition, confirmation of use is lacking for some locations. This information is needed to fully identify critical habitat.	2016-2025
Conduct surveys to determine the extent of the species' ranges where it is currently unknown (e.g., in the north).	The spatial extent of the species' ranges is required to fully identify critical habitat.	2016-2025
Refine biophysical attributes and criteria for hibernacula and determine biophysical attributes for maternity roosts (particularly in western and northern parts of the species' ranges).	Although general biophysical attributes are understood, further refining these is deemed essential for full identification of critical habitat. Understanding overwintering behaviour and how bats use hibernaculum is also required. Knowledge limitations are especially evident in western and northern parts of the species' ranges.	2016-2025
Identify the location, characteristics, and biophysical attributes of swarming sites.	The importance of individual swarming sites to survival and recovery and the important biophysical attributes of these sites are unknown.	2016-2025
Determine criteria for identifying maternity roosts as critical habitat.	There is a lack of appropriate data to develop science-based criteria.	As appropriate

Table 5. Long-term Schedule of Studies to Identify Critical Habitat at a Landscape Scale

Description of Activity	Rationale	Timeline
Increase surveys and monitoring of summering habitat at strategic locations.	Information on abundance and other measures of summering habitat quality is poor in many regions of the country. Increased surveys and monitoring in pre-determined locations is necessary.	2016-2031
Determine male roosting sites and migration routes and whether they are considered necessary for recovery and survival, and thus would warrant critical habitat identification.	It is currently unclear if these habitats (or even a subset of these) should be considered critical habitat.	2019-2025
Determine the appropriate configuration of landscape biophysical attributes.	To identify critical habitat at a landscape scale it is necessary to understand the biophysical attributes required by the species' at this scale and to determine how these should be configured to meet the species' needs.	2016-2031
Determine habitat quality across the species' ranges.	Information on abundance, productivity and other measures of habitat quality may lead to the identification of areas that contribute disproportionately to the survival or recovery of these species.	2016-2031
Determine the scale and intensity at which suitable habitat would likely be destroyed by anthropogenic activities.	A better understanding of the relationship between anthropogenic disturbance and habitat quality is needed to ensure sufficient suitable habitat is available for these species and to identify at what scale and intensity activities would be likely to destroy critical habitat.	2016-2031
Determine how much suitable summering habitat is required to meet the population and distribution objectives.	It is uncertain whether summering habitat is limiting in Canada. An assessment of whether there is sufficient	2032

Description of Activity	Rationale	Timeline
	habitat in Canada to meet the population and distribution objectives is required.	
Develop and validate summering habitat models to determine where biophysical attributes are present in required quantity, quality and configuration across the species' ranges to meet population and distribution objectives.	Results from studies listed above, will allow models to be built to identify the location, quantity, and quality of habitat that should be identified as summering critical habitat.	2032-2036

7.3 Activities Likely to Result in the Destruction of Critical Habitat

This subsection of a recovery strategy describes the kinds of activities that are likely to cause the destruction of critical habitat and provides examples of such activities. Information is provided on potential impacts to critical habitat and species populations that may result from these example activities.

Destruction of critical habitat is determined on a case-by-case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. Activities described below include those likely to cause destruction of critical habitat for the species; however, destructive activities are not limited to those listed.

Hibernacula

Activities likely to result in the destruction of hibernacula identified as critical habitat include, but are not limited to, the following: activities resulting in the introduction of WNS into hibernacula previously free of WNS, activities that result in collapsed walls or ceilings or flooding, or activities that result in the hibernaculum being inaccessible or unavailable to bats or alters the hibernaculum's temperature, humidity, airflow, or other microclimatic characteristics outside of the range acceptable to the bat species for which critical habitat is identified.

Examples of activities, in no particular order of priority, that may cause such results include, but are not limited to, the following:

Description of activity	Description of effect
Visitors (e.g., researchers, cavers, tourists) that do not follow proper decontamination protocols	May result in permanent or temporary direct destruction of habitat by introducing WNS.
Modifications to accommodate visitors (e.g., observation platform, altering entrance)	May result in permanent or temporary direct destruction of habitat or indirect effects (e.g., changes to microclimatic

Description of activity	Description of effect
	conditions, limit bat access to site).
Erection of physical barriers (e.g., doors, or gates) leading to reduced bat access and/or use[21]	May result in permanent or temporary direct destruction of habitat and/or indirect effects (e.g., restricting bat access to site, changes to airflow, temperature, or other microclimatic characteristics).
Filling wells or sealing mine entrances	May result in permanent direct destruction of habitat by eliminating the hibernaculum features or limiting access by bats to such features.
Intentional vandalism	May result in permanent or temporary direct destruction of habitat and/or indirect effects (e.g., restricting bat access to site, removing/damaging barriers that were intended to limit human access, changes to airflow, temperature, or other microclimatic characteristics).
Activities that cause excessive disturbance (e.g., light, noise, vibrations or visitation) could result in arousal from torpor which in turn could cause a cascade of arousals in nearby bats and/or could cause the abandonment of a site. Repeated visits over several consecutive days can have the most severe impacts.	May result in temporary destruction of habitat by reducing the functionality of the hibernacula to provide for the survival of bats during overwintering periods. Arousals from excessive disturbance causes increased fat consumption (and premature energy depletion), starvation, reduced energy reserves for reproduction, and ultimately, death. Although these activities may occur outside the hibernaculum, they can still cause destruction of the hibernaculum.
Quarrying, mining exploration and development, agriculture, forestry, dam construction, and other industrial practices that alter the microclimate characteristics of the hibernaculum, including changes to airflow or flooding of hibernacula.	May result in permanent or temporary direct destruction of habitat and/or indirect effects (e.g., ceiling or wall collapse, limit access to site). Although these industrial practices may occur outside the hibernaculum, they can still cause destruction of the hibernaculum.

[21] Bat-friendly gating is often necessary to prohibit human access to hibernacula. Any bat-friendly gates erected to restrict human access should be associated with a well-designed pre- and post-monitoring program that includes measures for adaptable management to ensure no negative impacts to the bats and ensure no reduction in bat access or use of the site (U.S. Fish and Wildlife Service 2007).

8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

Little Brown Myotis and Northern Myotis

- Little Brown Myotis' and Northern Myotis' extent of occurrence is maintained (or where applicable restored to) the pre-WNS extent (to be verified every five years).
- In the short-term (12-18 years), the population of each species is maintained and increased (where feasible) at its current level.
- In the long-term (many generations) within WNS-affected areas, the population of each species is self-sustaining, resilient, and redundant.

Tri-colored Bat

- Tri-colored Bat's extent of occurrence is restored (then maintained) to the pre-WNS extent of occurrence (to be verified every 5 years).
- In the short-term (next 10 years), the population is maintained and increased (where feasible) at its current level.
- In the long-term (many generations), the population is self-sustaining, resilient, and redundant.

9. Statement on Action Plans

One or more action plans for Little Brown Myotis, Northern Myotis, and Tri-colored Bat will be posted on the Species at Risk Public Registry within 3 years of the final posting of the recovery strategy.

10. References

Abbott, I. M., A. Berthinussen, E. Stone, M. Boonman, M. Melber, and J. Altringham. 2015. Bats and Roads. Pages 290-299 *In* R. van der Ree, D. J. Smith, and C. Grilo (eds.). Handbook of Road Ecology. John Wiley & Sons, Ltd. Chichester, UK.

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Appendix A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[22]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[23] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

WNS affects other bat species not considered in this recovery strategy (e.g., Eastern Small-footed Myotis – *Myotis leibii*) (U.S. Fish and Wildlife Service 2016). Therefore, any approaches that mitigate the impact or spread of WNS will most likely also benefit these species. In contrast, it is possible that other species of bats with populations not heavily impacted by WNS (e.g., Big Brown Bat – *Eptesicus fuscus*) may be benefiting from the declining populations of Little Brown Myotis, Northern Myotis, and Tri-colored Bat by filling the niche recently vacated (Francl et al. 2012). It is unknown how recovery of the three at-risk species will affect these other bat species that have recently increased.

Many potential threats identified in this recovery strategy have also been identified as threats for other species at risk. Approaches that help to minimize these threats may also benefit other species. For example, Rusty Blackbird (*Euphagus carolinus*) is thought to be susceptible to mercury contamination in Eastern Canada (Edmonds et al. 2010), and feral and free-roaming cats have been identified as a potential threat to numerous bird species (Calvert et al. 2013), including other species at risk, such as Common Nighthawk (*Chordeiles minor*) (Environment Canada 2016b). Conservation of forests surrounding hibernacula and roosts may positively affect other species (at local scales) that are also threatened by forest removal (e.g., Canada Warbler – *Cardellina canadensis* and Woodland Caribou – *Rangifer tarandus caribou*) (Environment Canada 2012, 2016a).

[22] http://www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[23] http://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=CD30F295-1

Bat populations consume substantial quantities of insects each night and therefore control the local populations of insects. Initiatives that result in the recovery of bat populations may cause local declines in insect populations (some of which may have already exhibited drastic declines) (Dirzo et al. 2014). In contrast, strategies that investigate the declining insect prey, or research, mitigate, or educate the public about mutual potential threats may aid in the recovery of possible depleted insect populations.

The possibility that the present recovery strategy inadvertently generates negative effects on the environment and on other species was considered. The majority of recommended actions are non-intrusive in nature, including surveys, research, and outreach. It is unlikely that the present recovery strategy will produce significant negative effects.

Appendix B: Additional Research Needs Related to Known and Suspected Threats

The following list is not exhaustive, but illustrates some of the research required to understand the threats (other than WNS) to Little Brown Myotis, Northern Myotis, and Tri-colored Bat and their habitats.

Disturbance or harm

- Determine the effects of different levels and types of noise on behavior and biology of bats throughout their life-cycles.
- Determine the effects of research activities on bat stress and survival.
- Further investigate the location and characteristics of wind turbines in Canada that may significantly affect bat populations.
- Further investigate the timing and population-level effects of wind turbines.
- Continue to monitor frequency of wind turbine collisions in Canada, and develop a consistent range-wide monitoring program for wind energy facilities.
- Investigate the effects and characteristics of vehicle-bat collisions in Canada.
- Investigate the effects of bat collisions related to non-traditional / recreational vehicles and devices (e.g., boats, unmanned aerial vehicles, and fishing lines).

Habitat loss or degradation

- Determine the effects of common forestry operations (e.g., silviculture, and selective cutting) on roost tree availability, behavior, biology, and movement patterns across the range of the species.
- Determine the amount (and characteristics) of forest removal, harvesting, and silviculture that can be completed while maintaining enough suitable habitat for bat populations across the range of the species.
- Continue to investigate the effects of forest fragmentation from various sources (e.g., agriculture and road development).
- Investigate the significance of habitat loss due to insect outbreaks (e.g., Mountain Pine Beetle).
- Further investigate the effects of exclusion of maternity colonies from anthropogenic structures.
- Further investigate the use of bat boxes to mitigate loss of anthropogenic or natural roosting structures.

Pollution

- Further investigate the bats' exposure to mercury and other pollutants across their ranges.
- Determine the potential effects of mercury on biology, survival, and behavior.
- Determine the effects of neonicotinoids and other widely-used pesticides on bats.
- Determine the effects of techniques to reduce the spread of spruce budworm on bats.
- Determine the effects of light pollution on bat behavior, foraging efficiency, and their prey.

Problematic non-native species

- Determine human-related predation risk in urban and rural areas (e.g., by cats).

Climate and natural disasters

- Determine the impacts of climate change on these species, their prey, and their habitat.
- Investigate the potential impact of insect outbreaks and forest fires on these species, their prey, and their habitat.