Ontario Species at Risk Evaluation Report

for

Tri-colored Bat (*Perimyotis subflavus*)

Committee on the Status of Species at Risk in Ontario (COSSARO)

Assessed by COSSARO as Endangered

June, 2015

Final

Pipistrelle de l’Est (*Perimyotis subflavus*)

La pipistrelle de l’Est (*Perimyotis subflavus*) est l’une des plus petites chauves-souris en Amérique du Nord. Environ 10 p. 100 de son aire de répartition mondiale se situe au Canada (en Ontario, au Québec, au Nouveau-Brunswick et en Nouvelle-Écosse) et elle est considérée rare dans la majeure partie de son aire de répartition canadienne. En Ontario, elle est considérée peu courante, bien que la taille des populations ne soit pas bien connue. La pipistrelle de l’Est se nourrit d’insectes. Elle s’alimente au-dessus de l’eau, le long des cours d’eau ainsi qu’à la lisière des forêts; elle évite généralement les grands champs ouverts ou les zones de coupe à blanc. À l’automne, les chauves-souris reviennent aux gîtes d’hibernation, qui peuvent être à des centaines de kilomètres de distance de leurs sites d’été. Elles s’agglutinent près de l’entrée, elles s’accouplent, puis elles pénètrent dans ce gîte d’hibernation ou elles se déplacent vers un gîte différent pour y passer l’hiver. La femelle produit un ou deux petits par année après l’âge d’un an et la longévité maximale consignée est de 15 ans. La principale menace qui pèse sur la pipistrelle de l’Est est une maladie appelée le syndrome du museau blanc (SMB), qui est causé par l’introduction du champignon *Pseudogymnoascus destructans.* Le SMU, qui infecte les chauves-souris qui se trouvent dans leur gîte d’hibernation, provoque des taux de mortalité élevés. Pendant une période qui couvre trois générations de cette espèce (entre 15 et 21 ans) depuis l’arrivée du SMU en Ontario, des diminutions ont été présumées à l’aide d’une surveillance dans d’autres administrations du nord-est de l’Amérique du Nord où le taux de prévalence du SMU est supérieur à 50 p. 100. Compte tenu de la présence confirmée et grandissante du SMU dans l’ensemble de l’Ontario et des taux élevés de diminution de la pipistrelle de l’Est dans d’autres administrations où le SMU est présent, la pipistrelle de l’Est est classifiée comme une espèce en voie de disparition en Ontario.

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Executive summary

The Tri-colored Bat (*Perimyotis subflavus*) is one of the smallest bats in eastern North America. Approximately 10% of its global range is in Canada (Ontario, Quebec, New Brunswick, Nova Scotia), and it is considered rare in much of its Canadian range. In Ontario it is considered uncommon, although population sizes are not well known. Tri-colored Bats feed on insects, and foraging occurs over water and along waterways and forest edges; large open fields or clear cuts are generally avoided. In autumn, bats return to hibernacula, which may be hundreds of kilometres from their summer sites, swarm near the entrance, mate, and then enter that hibernaculum, or travel to different hibernacula to overwinter. Females produce one-two pups a year after one year of age, and the maximum recorded longevity is 15 years. The main threat to Tri-colored Bats is a disease known as White-nose Syndrome (WNS), which is caused by the introduced fungus *Pseudogymnoascus destructans.* WNS infects bats as they overwinter in hibernacula, and causes high mortality rates. For the three-generation period for this species (15-21 years) since the arrival of WNS in Ontario, declines are inferred from monitoring in other northeastern North American jurisdictions where WNS also occurs to exceed 50%. Due to the confirmed and increasing presence of WNS across Ontario and the high rates of decline of Tri-colored Bat in other jurisdictions where WNS occurs, Tri-colored Bat is classified as Endangered in Ontario.

1. Background information

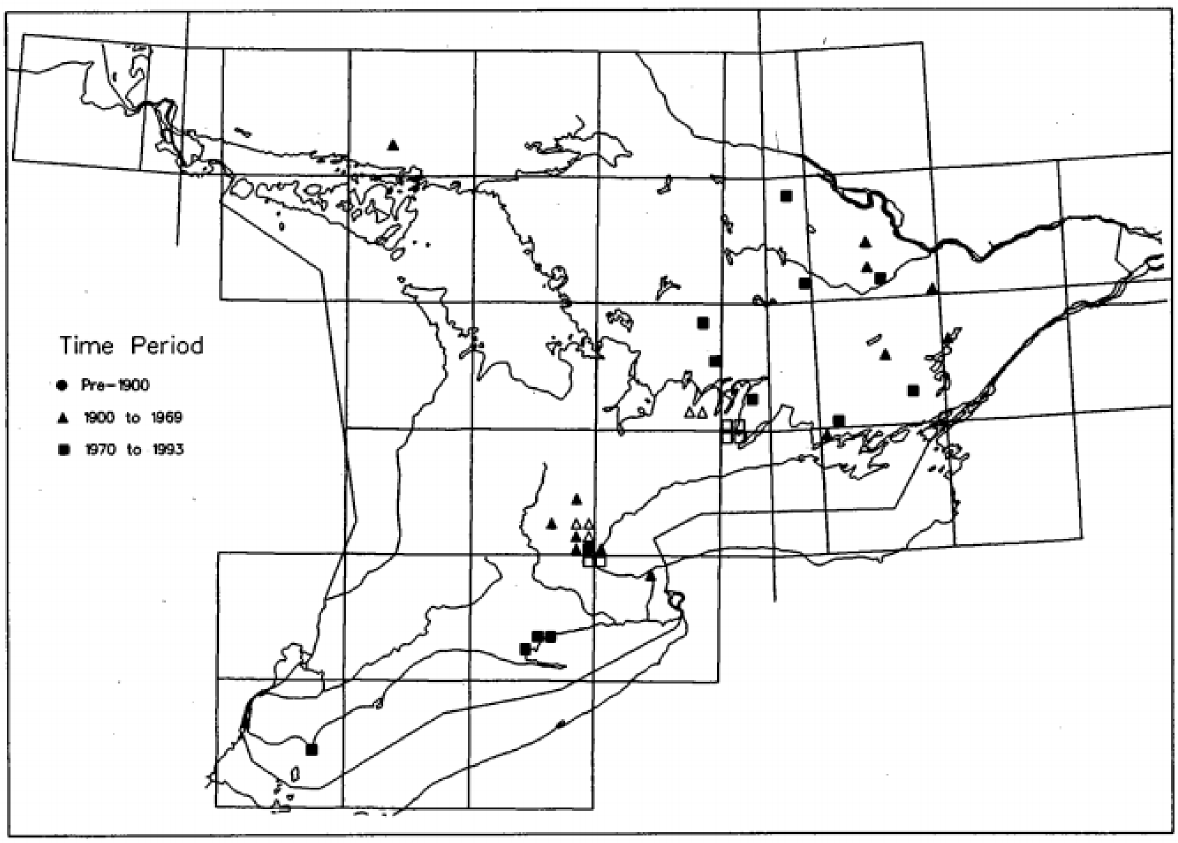
1.1. Current designations

- G-RANK: G3G4 (NatureServe 2015)
- N-RANK Canada: N2N3
- COSEWIC: Endangered (November, 2013)
- SARA: Endangered (Schedule 1)
- ESA 2007: Not assessed
- S-RANK: S3?

1.2. Distribution in Ontario

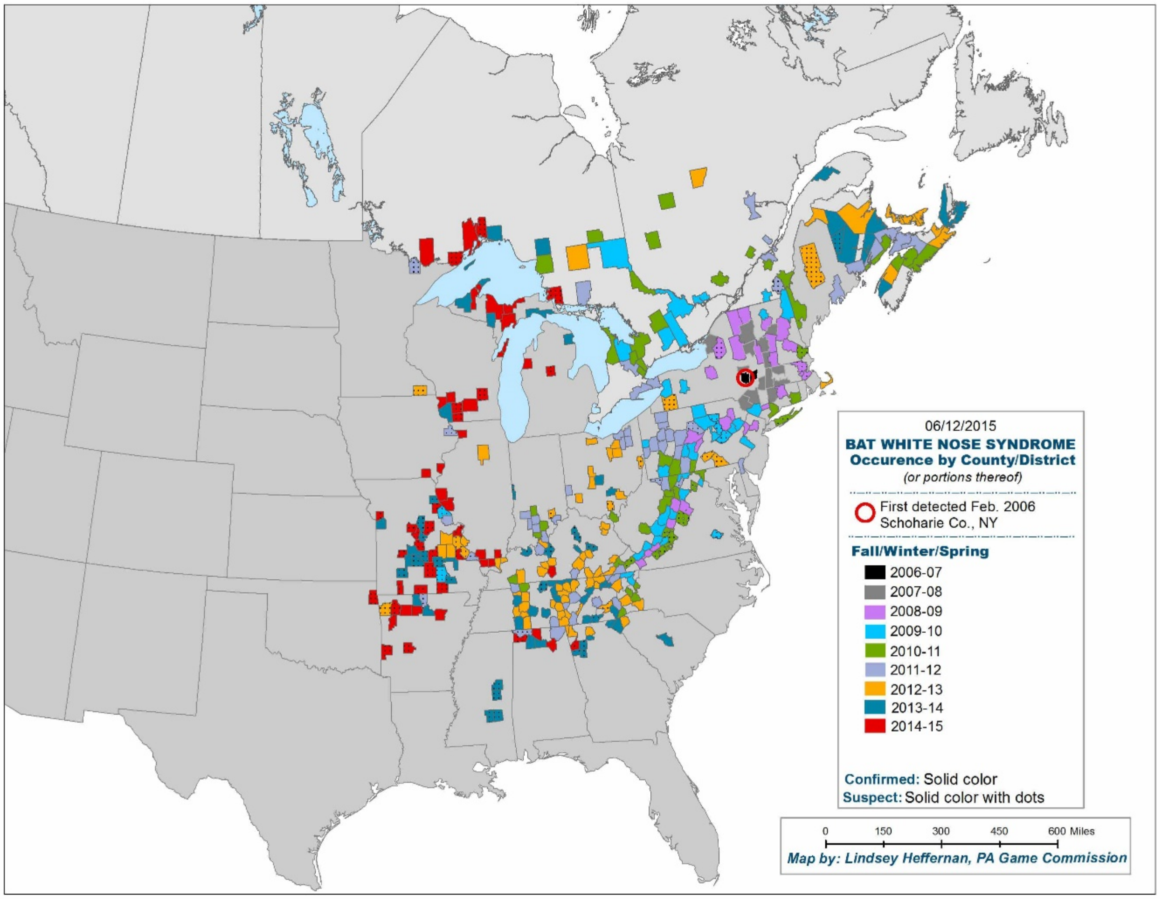
Tri-colored Bat was first recorded in Ontario in 1890 (Hitchcock 1940). Tri-colored Bat have since been recorded in several widespread locations in the south of the province (Figure 1): along the north shores of Lake Erie and Lake Ontario, from Kingston to Renfrew and as far north as Espanola and Alona Bay (Dobbyn 1994). Recent analysis of fur isotopes suggest that Tri-colored Bat may also exist in north-central Ontario (Fraser et al. 2012).

Figure 1. Distribution of Tri-colored Bat records in Ontario (Dobbyn 1994).



The greatest threat to the species in Ontario is a fungal pathogen (*Pseudogymnoascus destructans)* that causes a disease called White-Nose Syndrome (see Section 1.5), and with which Tri-colored Bats now share a distribution in Ontario (Figure 2). Because the range of Tri-colored Bats and that of *Pseudogymnoascus destructans* now completely overlap in Ontario, the entire distribution of the species in the province is considered to be a single "location". Ontario's Natural Heritage Information Centre (NHIC) tracks reports of Tri-colored Bat in the province. The NHIC database contains 17 Element Occurrence (EO) records for the species from before the 1980s, 4 EOs in the 1980s and 5 EOs in the 1990s. No new EOs since the year 2000 have been entered into the NHIC database.

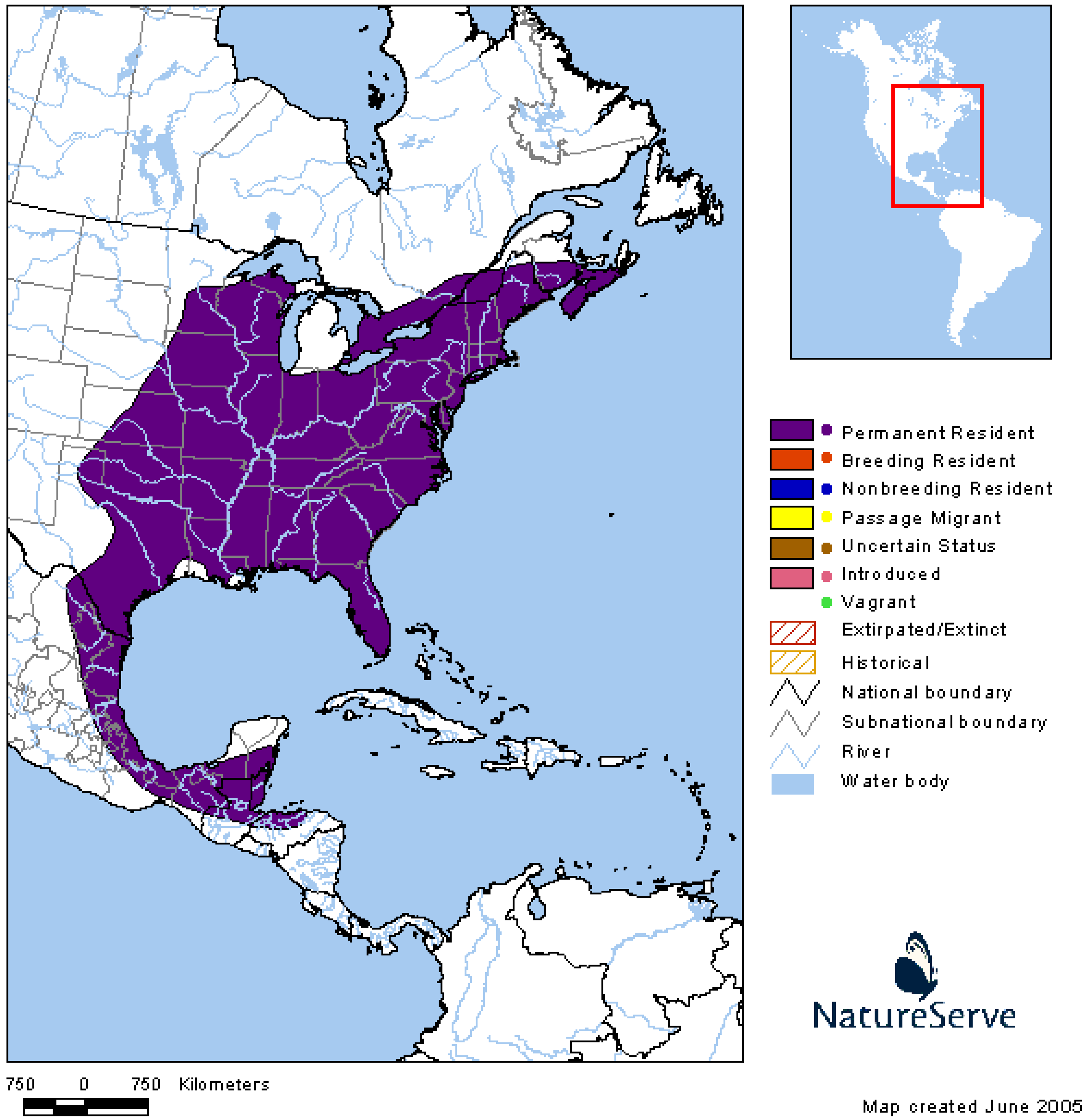
Figure 2. Current range of White-nose Syndrome in North America (Source: www.whitenosesyndrome.org/resources/map, 2015).



1.3. Distribution and status outside Ontario

The global range of Tri-colored Bats is greater than 2 500 000 km^2, covering 4 Canadian provinces from Nova Scotia to Ontario and 37 states from the east coast to Minnesota, south through Nebraska, Kansas, Oklahoma, New Mexico and Texas to Mexico, Guatemala and Honduras (Figure 3) (NatureServe 2015). Since the 1980s, the range of this species has expanded westwards in the United States with new records in the central Great Lakes region including northwestern Ohio, northern Indiana, and southern Michigan (Kurta *et al*. 2007) and beyond the western edge of its known range in Minnesota, South Dakota, Nebraska, Kansas, Colorado, New Mexico, and western Texas (Geluso *et al.* 2005).

Figure 3. Global range of Tri-colored Bat (NatureServe 2005).



1.4. Ontario conservation responsibility

Less than 10% of the global range of Tri-colored Bat exists in Ontario. Population estimates are not available for the province so a determination of the proportion of the global population within Ontario cannot be made.

1.5. Direct threats

White Nose Syndrome (WNS) is caused by a dermatophyte fungus *Pseudogymnaoscus destructans*, formerly known as *Geomyces destructans* (Minnis and Lidner 2013) that infects the bat's epidermis and causes high mortality rates among infected bats due to abnormal overwintering behaviour. WNS was first detected in North America in 2006

(Lorch *et al*. 2011) and has since spread at a rate of 200-250 km/year in Canada, and up to 600 km/year in the US. WNS was first confirmed in Ontario in 2010 and as of 2015 has been confirmed in 21 areas that coincide with the range of the Tri-colored Bat in the province (www.whitenosesyndrome.org/resources/map 2015).

Mass mortality of several bat species, including Tri-colored Bats with WNS (Table 1) is associated with altered patterns of torpor during hibernation with increased periods of activity that prematurely deplete their fat reserves and increase the need for food and water during the winter when insect prey are generally unavailable (Reeder *et al.* 2012). The resulting high mortality rates are believed to be caused by starvation, dehydration and exposure of individuals leaving hibernacula in winter (Cryan *et al.* 2010).

Table 1. Summary of the findings of Tri-colored Bat declines in WNS-affected areas across varying time frames.

Location	Rate and Timeframe of Decline (P when available)	Season of Survey	Type of Survey	Source
Ontario	>75% 8 -18 passes per sampling night pre-WNS (2009–2011) < 2 passes per sampling effort post WNS (2012–2013)	summer	acoustical	D. Morningstar pers. comm. Dec 2014
New Brunswick	75% N=20 in 5 sites to N=5 at one site in 1 year	Winter	Visual, in hibernacula	D. McAlpine and K. Vanderwolf in COSEWIC 2012, Vanderwolf *et al.* 2012.
Quebec	94% N=17 to N=1 in one site in 3 years	Winter	Visual, in hibernacula	Mainguy *et al.,* 2011 in COSEWIC 2012
Maryland	77% N=437 to N=100	Winter	Not specified	D. Feller, pers. Comm. In COSEWIC 2012
New York, Pennsylvania, West Virginia & Tennessee	5 year rate of decline: 34% ±0.14 (P=0.016) 1999 - 2011 576 surveys, 145 routes, N=68148 for all years	Winter	Visual, in hibernacula	Ingersoll, Sewall, and Amelon, 2013

Location	Rate and Timeframe of Decline (P when available)	Season of Survey	Type of Survey	Source
New York, Vermont, Connecticut & Massachusetts	5 years post-WNS: Year 1 -39%, Year 2 -46.4%, Year 3 -10.7%, Year 4 +24%, Year 5 -9.7%. 5-year rate of decline: 77%.	Winter	Visual, in hibernacula	Langwig *et al.* 2012 K. Langwig, pers. comm. Dec, 2014.
New York	n.s.	Summer	Acoustic, by water sources	Ford *et al.* 2011
New York	95% N = 1014 pre-WNS (1999-2006) N = 47 post-WNS (2010– 2011) at 18 sites	Winter	Visual, in hibernacula	Turner, Reeder and Coleman 2011
New York	95% N = 38/ 737 net nights (2003-2007) to N =3/ 1856 net nights (2008-2011)	Summer	Net, location not specified	C. Herzog, pers. comm in COSEWIC 2012
Pennsylvania	90% N = 284 pre-WNS (2004-2010) N = 28 post-WNS (2010-2011) at 6 sites	Winter	Visual, in hibernacula	Turner, Reeder and Coleman 2011
Vermont	47% N = 15 pre-WNS (2004–2009) N = 8 post-WNS (2010) at 6 sites	Winter	Visual, in hibernacula	Turner, Reeder and Coleman 2011
Virginia	16% N = 746 pre-WNS (2001-2009) N = 627 post-WNS (2011) at 2 sites	Winter	Visual, in hibernacula	Turner, Reeder and Coleman 2011
Virginia	87% N=920 to N=100 in one site; avg 15 to 2 per site	Autumn	Swarm trapping	R. Reynolds, pers. comm.in COSEWIC 2012
West Virginia	93% N = 1020 pre-WNS (2007)	Winter	Visual, in hibernacula	Turner, Reeder and Coleman 2011

Location	Rate and Timeframe of Decline (P when available)	Season of Survey	Type of Survey	Source
	N = 73 post-WNS (2011) at 3 sites			
West Virginia	77.1% (P<0.001) Capture rate: 0.215 (±0.009) pre-WNS (1997-2008) Capture rate: 0.049 (±0.010) post-WNS (2010)	Summer	Net, by cave sites	Francl *et al.* 2012
West Virginia	n.s.	Summer	Acoustic, by water sources	Johnson, Rodrigue & Ford 2013
West Virginia	74% N = 386 to N = 101 in 2 years	Summer	Net, locations not specified	C. Stihler, pers. comm, in COSEWIC 2012
West Virginia	30% Avg 2.3 captures (2005-2008) to 1.6 in 2011	Summer	Net, locations not specified	C. Johnson, pers. comm. in COSEWIC 2012

Mortality due to collisions with wind turbines also pose a direct threat to Tri-colored Bats. In Ontario, wind turbine-related mortality of all bat species is estimated to be 25,397 (95% confidence interval of 22,225 to 28,569) with Tri-colored Bat comprising 0.35% of the species composition of dead bats found at wind power installations (Environment Canada, the Canadian Wind Energy Association, Bird Studies Canada and the Ontario Ministry of Natural Resources 2014).

1.6. Specialized life history or habitat use characteristics

The populations that have been infected by WNS are not expected to recover quickly because bats, including Tri-colored, typically have slow population growth rates. Mortality is high in Tri-colored Bat yearlings while adults are long-lived (>15 years) and only produce 1-2 young every year or two (Walley and Jarvis 1971). Such a life-history strategy heightens the vulnerability of these bat species to high adult mortality rates.

Tri-colored Bats are known to overwinter with other bat species in caves and mine sites. *Pseudogymnaoscus destructans* can be contracted through direct contact with other bats (Lorch *et al.* 2010). The fungus can persist on substrates (soil, cave walls) in the absence of bats, possibly serving as a vector for infecting bats recolonizing contaminated hibernacula (Hoyt *et al.* 2014; Langwig *et al.* 2015). While observations of Tri-colored Bat numbers in caves consistently demonstrate population decline in areas affected by WNS (Table 1), it is uncertain whether such hibernacula are the only sites used by Tri-colored Bats to overwinter. Reduced likelihood of exposure to WNS may occur if the bats are able to migrate far enough to overwinter in areas outside of the WNS affected zone or if some individuals don't associate in communal hibernacula at all, instead using more solitary overwintering sites as was suggested by Griffin (1945) such as small deep rock crevices or burrows made by other animals. However, despite some uncertainties regarding migration (Fraser et al. 2012) and above-ground roosting (Sandel *et al*. 2001) *Perimyotis subflavus* do occupy communal hibernacula in Canada and in the northeastern US within the range of WNS. Data from the summer months are limited and confined to relatively small areas, but similarly reveal significant levels of decline as in winter months, suggesting that low numbers in winter are more likely to be reflecting mortality than migration (reviewed in COSEWIC 2012; see also Table 1).

2. Eligibility for Ontario status assessment

2.1. Eligibility conditions

2.1.1. Taxonomic distinctness

Yes. Morphological and genetic evidence suggests that the Tri-colored Bat, formerly called Eastern Pipistrelle *Pipistrellus subflavus*, is taxonomically distinct from all other bats (Hoofer *et al.* 2006).

2.1.2. Designatable units

No. There is currently no evidence of any significant genetic or other differentiation to justify consideration of additional designatable units for this species in Ontario.

2.1.3. Native Status

Yes. The earliest records for the Tri-colored Bat in Ontario are from Ottawa in 1890 and Niagara-on-the-Lake in 1920 (Hitchcock 1940). With only two specimens identified in 47 years, the Tri-colored Bat was initially suspected to be of accidental occurrence in Ontario (Downing 1938). However, records of Tri-colored Bat have since been recorded with more regularity in several widespread locations in the province: along the north shores of Lake Erie and Lake Ontario, from Kingston to Renfrew and as far north as Espanola and Alona Bay (Dobbyn 1994), thus it is considered to be native to Ontario.

2.2. Eligibility results

2.2.1. Extant

Yes. Ontario's Natural Heritage Information Centre (NHIC) tracks reports of Tri-colored Bat in Ontario; however, no reports of this species are documented in the NHIC database since the 1990s. In 2009- 2011, 8 hibernacula were identified and monitored in eastern Ontario (COSEWIC 2012). Monitoring from wind energy projects confirms the presence of Tri-colored Bats in Ontario in 2014 (Environment Canada *et al.* 2014).

3. Ontario status assessment

3.1. Application of endangered/threatened status in Ontario

3.1.1. Criterion A – Decline in total number of mature individuals

A4ce - Endangered
Because WNS is not reversible at this time, is not completely understood, and has not ceased, Criterion A1 does not apply.

Population trend data for Tri-colored Bat in Ontario are unavailable. In eastern Ontario, 8 hibernacula were monitored for changes in bat abundance upon confirmation of *Pseudogymnaoscus destructans*; all had significant declines in the total number of bats using the sites, comprised mainly of Little Brown Myotis but also including Tri-colored Bat. After 1 year of exposure to WNS, the average decline of all bats in these hibernacula was 30% (COSEWIC 2012). After 2 years' exposure, the average decline of all bat species was 92% (COSEWIC 2012); however, rates of decline specifically for Tri-colored Bat were not reported. Summer acoustical monitoring at Dunnville, Ontario between 2009 and 2013 showed a significant decline of over 75% in detection rates of Tri-colored Bats since the arrival of WNS (D. Morningstar pers. comm. Dec 2014).

In other Canadian jurisdictions, monitored locations affected by WNS show declines of Tri-colored Bat by 94% (from 17 individuals to 1) in one year at a site in Quebec and 75% (from 20 to 5 individuals) over three years at a site in New Brunswick (COSEWIC 2013). In US locations affected by WNS for over 2 years, average population decline of Tri-colored Bat from winter hibernacula was 76% with extirpation of the species at 35% of the 40 investigated sites (COSEWIC 2013). Data on summer abundance of Tri-colored Bat in the US reveal rates of decline ranging from 43% to 95% with >2 years since infection of WNS with 5/8 studies reporting declines of 74% or higher (COSEWIC 2013). Whether year to year sampling effort was consistent in these studies is unknown.

Nearly all the studies in the United States reveal rates of decline greater than 50% for Tri-colored Bat since the arrival of WNS within the past 9 years. One exception is the analysis by Ingersoll *et al.* (2013) of population trend data for four bat species, including Tri-colored Bat in the eastern United States within areas where WNS has been confirmed. Accounting for bias due to varying sampling effort from 576 surveys along 145 routes in four different states (New York, Pennsylvania, West Virginia and Tennessee), they determined from 68148 records of the species that relative abundance of Tri-colored Bats had declined by 34% in the region between 1999 and 2011; however, this study ended in 2011, and over the 12 years of study, each year demonstrated further decline. There are no robust data after 2011, although it is notable that the decline had not stabilized after 12 years. Langwig *et al.* (personal communications, December 2014) also analysed the same data as Ingersoll et al (2013) and calculated a five year rate of decline of 77% since the arrival of WNS in New York, Vermont, Massachusetts, and Connecticut, with data collection ending in 2010. Langwig et al. (2012) also reported density-dependent effects of WNS, and suggested that Tri-colored Bats were less susceptible than some other species because they rarely form large clusters (Barbour & Davis 1969). In a more recent investigation, Langwig *et al.* (2015) studied contamination rates of WNS among bats in two caves in Virginia. They found that contamination rates of Tri-colored Bats were much lower than other species with greater clustering behaviour in the first year that WNS was detected. But in the second year, when the cave substrate had a higher degree of contamination, Tri-colored Bats showed declines of 47% and 73% at each site. Contaminated substrate seemed to be the greatest means of transmission. Therefore the Tri-colored Bat's propensity to roost singly helps to slow infection rates from bat-to-bat transmission in the first year of exposure to WNS, but it does not prevent infection once the substrate of the hibernacula is heavily contaminated.

The data on the Ontario population size are insufficient to address Criteria A2a or A2b. Although presence of WNS in Tri-colored Bat hibernacula is confirmed throughout its Ontario range, there is insufficient information on the bat's distribution in the province to quantify changes in the extent of occurrence, and area of occupancy for Tri-colored Bat at this time. Habitat quality is confirmed to be compromised due to the arrival of WNS in Ontario in 2010. Too little information is available on the short-term rates (<5 years) of decline for Tri-colored Bat since the arrival of WNS to infer with confidence that declines have occurred in the past 10 years or three generations (15-21 years); therefore, there is insufficient information to assess the species for criteria A2c and A2e in Ontario at this time. Similarly, it is difficult to know if the majority of the decline has already occurred in the 5 years since WNS arrived in Canada, nor what the long term trends for this species would be in order to address the next three-generation period for Criterion A3. Criteria A2d, A3d and A4d do not apply as the species is not exploited.

Criterion A4, which addresses any 10 year or 3-generation period spanning the past, present, and future is most relevant for an assessment of this species in Ontario at this time. Nearly every investigation of post-WNS rates of decline in Canada and the eastern United States reveal rates of decline greater than 50% since the arrival of WNS in 2006. Even the most conservative estimate of rates of decline by Ingersoll et al. (2013) are considered, a steady rate of annual decline between 1999-2011 could be extrapolated to the longer period of 15-21 years, we infer a decline of 46-65%. Thus, for the 15-21 year period since the arrival of WNS in Ontario in 2010, Tri-colored Bats meet the threshold of endangered (reduction of ≥50%) according to criterion A4ce.

3.1.2. Criterion B – Small distribution range and decline or fluctuation

Insufficient information. Insufficient data for Ontario are available to meet this criterion, though extent of occurrence likely exceeds 20,000 km^2. Insufficient data are available on number of mature individuals in Ontario.

3.1.3. Criterion D – Very small or restricted total population

Insufficient information. Population size information is not available for Ontario.

3.1.4. Criterion E – Quantitative analysis

Insufficient information. No population viability analyses for Tri-colored Bat have been conducted in Ontario.

3.2. Application of Special Concern in Ontario

Does not apply.

3.3. Status category modifiers

3.3.1. Ontario's conservation responsibility

Does not apply. While Global Rank for this species is G3, less than 25% of the global range is found in Ontario.

3.3.2. Rescue effect

Does not apply. Although immigration is possible from outside of Ontario, WNS has been confirmed in all adjacent jurisdictions resulting in depleted population sizes from possible source areas. Populations in the Northeast US have declined by 34% in recent years (Ingersoll et al. 2013) and evidence from one site in Quebec indicates declines of greater magnitude (COSEWIC 2012).

3.4. Other status categories

3.4.1. Data deficient

Does not apply. Although few recent data on Tri-colored Bat numbers in Ontario are available, the presence of WNS is confirmed in several counties throughout the species' range in the province. The effects of WNS causing decline in Tri-colored Bat populations are reported in other Canadian and US jurisdictions, with a robust analyses of extensive datasets for eastern US populations exposed to WNS enabling inferences to be made about the effects of the fungus on Ontario populations.

3.4.2. Extinct or extirpated

Does not apply.

3.4.3. Not at risk

Does not apply.

4. Summary of Ontario status

Tri-colored Bat (*Perimyotis subflavus*) is classified as Endangered in Ontario based on meeting criterion A4ce.

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Appendix 1: Technical summary for Ontario

Species: Tri-colored Bat (*Perimyotis subflavus*)

Demographic information

Demographic attribute	Value
Generation time. Based on average age of breeding adult: age at first breeding = X year; average life span = Y years.	5-7 years
Is there an observed, inferred, or projected continuing decline in number of mature individuals?	Yes
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations.	Unknown
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over the last 10 years or 3 generations.	Unknown: declines inferred since the arrival of WNS in Ontario in 2010 but rate of decline from this period to 2015 is unknown.
Projected or suspected percent reduction or increase in total number of mature individuals over the next 10 years or 3 generations.	Unknown
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over any 10 years, or 3 generations, over a time period including both the past and the future.	>50% reduction (inferred)
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No b. Yes c. No
Are there extreme fluctuations in number of mature individuals?	No

Extent and occupancy information in Ontario

Extent and occupancy attributes	Value
Estimated extent of occurrence. *(Request value from MNRF or use http://geocat.kew.org/)*	>20 000 km^2
Index of area of occupancy (IAO). *(Request value from MNRF or use http://geocat.kew.org/)*	Unknown

Is the total population severely fragmented? (i.e. is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?)	a. Unknown b. No
Number of locations (*as defined by COSEWIC*).	1
Number of NHIC Element Occurrences (*Request data from MNRF)*	0 for the year 2000 onwards. 5 in the 1990s, 4 in the 1980s, and 17 pre-1980.
Is there an observed, inferred, or projected continuing decline in extent of occurrence?	Unknown
Is there an observed, inferred, or projected continuing decline in index of area of occupancy?	Unknown
Is there an observed, inferred, or projected continuing decline in number of populations?	Unknown
Is there an observed, inferred, or projected continuing decline in number of locations?	No
Is there an observed, inferred, or projected continuing decline in [area, extent and/or quality] of habitat?	Yes, quality of known hibernacula is confirmed to have declined due to WNS. (observed)
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of mature individuals in each sub-population or total population (if known)

Unknown.

Quantitative analysis (population viability analysis conducted)

Does not apply.

Rescue effect

Rescue effect attribute	Likelihood
Is immigration of individuals and/or propagules between Ontario and outside populations known or possible?	Yes

Would immigrants be adapted to survive in Ontario?	Yes
Is there sufficient suitable habitat for immigrants in Ontario?	Unlikely due to the prevalence of WNS at hibernacula
Is the species of conservation concern in bordering jurisdictions?	Yes
Is rescue from outside populations reliant upon continued intensive recovery efforts?	Probably, if a means to control impact and spread of WNS is determined.

Appendix 2: Adjoining jurisdiction status rank and decline

Information regarding status rank and decline for Tri-colored Bat

Jurisdiction	Subnational rank	Sources	Population trend	Sources
Ontario	S3?	NatureServe 2015	unknown	COSEWIC 2012
Manitoba	Not present	NatureServe 2015	n/a	n/a
Michigan	S2	NatureServe 2015	n/a	n/a
Minnesota	S3	NatureServe 2015	unknown	Minnesota Department of Natural Resources n.d.
Nunavut	Not present	NatureServe 2015	n/a	n/a
New York	S3	NatureServe 2015	Negative for region 30-34%, possibly as much as 95% decline	Ingersoll *et al.* 2012, Turner *et al.* 2011, Langwig *et al.* 2012
Ohio	SNR	NatureServe 2015	n/a	n/a
Pennsylvania	S1	NatureServe 2015	Negative for region 30-34%, possibly as much as 90% decline	Ingersoll *et al.* 2012, Turner *et al.* 2011
Quebec	S1	NatureServe 2015	Negative (unquantified)	COSEWIC 2012
Wisconsin	S1S3	NatureServe 2015	n/a	n/a

Acronyms:

COSEWIC: Committee on the Status of Endangered Wildlife in Canada
COSSARO: Committee on the Status of Species at Risk in Ontario
ESA: Endangered Species Act
GRANK: global conservation status assessments
IAO: index of area of occupancy
MNRF: Ministry of Natural Resources and Forestry
NHIC: Natural Heritage Information Centre
NNR: Unranked
NRANK: National conservation status assessment
NS: no significance between populations pre and post WNS detected
PVA: Population viability analysis
SARA: Species at Risk Act
SNR: unranked
SRANK: subnational conservation status assessment
S1: Critically imperiled
S2: Imperiled
S3: Vulnerable