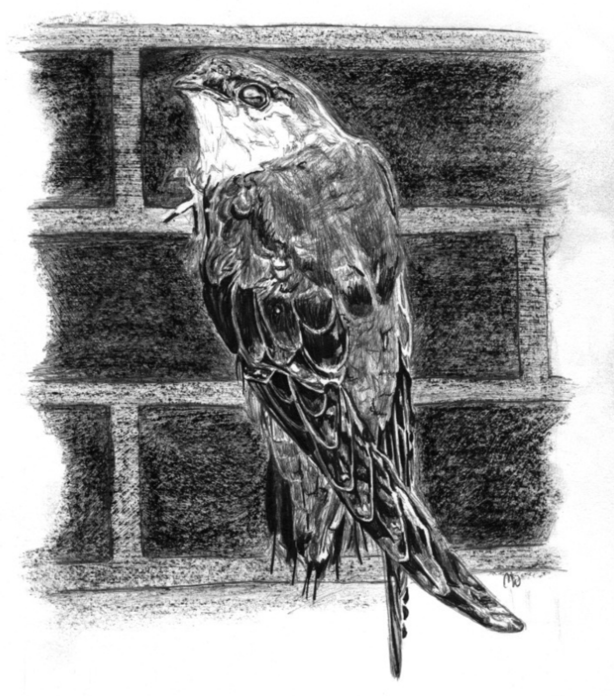
COSEWIC
Assessment and Status Report

on the

Chimney Swift
Chaetura pelagica

in Canada



THREATENED
2018

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Previous report(s):

COSEWIC 2007. COSEWIC assessment and status report on the Chimney Swift *Chaetura pelagica* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 49 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Production note:
COSEWIC would like to acknowledge Kristyn Richardson, Myles Falconer and Liz Purves for writing the status report on Chimney Swift, *Chaetura pelagica*, prepared under contract with Environment and Climate Change Canada. This report was overseen and edited by Richard Elliot, Co-chair of the COSEWIC Birds Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment and Climate Change Canada
Ottawa, ON
K1A 0H3

Tel.: 819-938-4125
Fax: 819-938-3984
E-mail: ec.cosepac-cosewic.ec@canada.ca
http://www.cosewic.gc.ca

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COSEWIC
Assessment Summary

Assessment Summary – April 2018

Common name
Chimney Swift

Scientific name
Chaetura pelagica

Status
Threatened

Reason for designation
This aerial insectivore is a long-distance migrant, breeding in central and eastern Canada and wintering in South America. It has experienced a long-term population decline of close to 90% since 1970 in areas outside towns and cities, including a reduction of 49% over the past three generations (14 years). However, most roost counts in towns and urban areas show relatively stable numbers. A significant cause of decline is the reduced availability of aerial insects, likely due to the effects of agricultural and other pesticides, changing agricultural practices, and broad-scale ecosystem modifications in much of its breeding, migratory and wintering range. Reduced availability of roosting and nesting sites in chimneys and similar human-made structures, and in large hollow trees, is also likely contributing to declines. Greater frequency and severity of weather extremes may be reducing productivity, and increasing mortality during migration.

Occurrence
Saskatchewan, Manitoba, Ontario, Québec, New Brunswick, Nova Scotia

Status history
Designated Threatened in April 2007. Status re-examined and confirmed in April 2018.

COSEWIC
Executive Summary

Chimney Swift
Chaetura pelagica

Wildlife Species Description and Significance

This aerial insectivore is a long-distance migrant, breeding in central and eastern Canada and the eastern United States, and wintering in South America. It is sometimes mistaken for a swallow, as both soar through the air feeding on small insects. Chimney Swift is distinguished by its cigar-shaped body, long and narrow pointed wings, short and spiny tail, and rapid wing beats and jerky flight.

Chimney Swift is the only swift regularly found in central and eastern North America. Swifts have aroused considerable interest among the public – their spectacular pirouetting entrances into communal roosts at dusk fascinate people.

Distribution

The breeding range of Chimney Swift is limited to central and eastern North America, with about one quarter of its range in Canada. It breeds in east-central Saskatchewan, southern Manitoba, Ontario, Québec, New Brunswick, and Nova Scotia. In the United States, Chimney Swift is found westward to Montana, eastward to New England, and southward to Texas and Florida; it is also a regular, but rare localized breeder in southern California. This long-distance migrant winters primarily in the upper Amazon River drainage basin in South America, mainly in Peru, as well as in southern and northeastern Ecuador, northwestern Brazil, and northern Chile.

Habitat

It is assumed that Chimney Swift mainly used large hollow trees for nesting and roosting, before the arrival of Europeans in North America. These trees became increasingly rare with the logging of forests, and Chimney Swift adopted chimneys for both nesting and roosting. It is now mainly associated with urban and rural areas where chimneys and similar structures are available, and where aerial insects are abundant for foraging. Winter habitat extends from riparian forest and tropical lowland evergreen forest edge to farmland and suburban and central city zones.

Biology

Chimney Swift is monogamous and usually first breeds at two years of age, with a generation time of about 4.5 years. Pairs usually stay together as long as both individuals return to the same nesting site. The nest is a half-saucer made of small twigs attached together and to the vertical surface with the swifts' glutinous saliva. Mean clutch size is four eggs, and only one clutch is produced annually.

Population Sizes and Trends

The Chimney Swift population in Canada is estimated at between 20,000-70,000 mature individuals. In those areas of Canada sampled by the Breeding Bird Survey, primarily outside towns and urban areas, numbers of Chimney Swift declined by 4.9% per year between 1970 and 2016 – a long-term reduction of about 90%. BBS data from the most recent 14-year period (3 generations; 2002-2016) show a significant, continuing short-term decline of 49%. However, targeted species-specific surveys that monitor numbers of Chimney Swift using roosts in towns and urban areas, where it is most abundant, indicate that many local populations are stable or increasing.

Threats and Limiting Factors

Significant threats facing Chimney Swift are residential and commercial development; biological resource use; human intrusions and disturbance; natural system modifications; pollution; and climate change and severe weather.

Chimney Swift productivity is reduced due to the ongoing loss of roosting and nesting sites as a result of demolition or modification of chimneys and other structures, as well as human use of chimneys during the nesting period. Additionally, development is likely causing a loss and degradation of foraging habitat, with possible subsequent decline in aerial insect prey. Removal of nests from chimneys, both intentional and incidental, occurs due to concerns of fire risk. Current forestry practices that harvest mature and old growth forest likely remove natural nest sites for swifts. Chimney sweeping or using chimneys for heating disturbs nesting swifts throughout the breeding season. Broad-scale ecosystem modifications occurring for a variety of reasons in many parts of the breeding, migratory and wintering areas, are likely leading to changes in insect abundance and community composition. Exposure to pollutants, including chemical or heavy metal contaminants, may be causing deleterious effects to Chimney Swift populations, both directly and indirectly. Inclement weather during the breeding or migratory season can negatively affect Chimney Swift, and the frequency and severity of weather extremes is likely to increase as a result of climate change.

Protection, Status and Ranks

Chimney Swift is currently listed as Threatened in Canada under the *Species at Risk Act (2002)* and is protected under the *Migratory Birds Convention Act (1994)*. Together these Acts provide protection for individuals, residences and nests regardless of where they are located in Canada. A national SARA Recovery Strategy for Chimney Swift in Canada is in preparation.

Chimney Swift is listed as Threatened under Manitoba's *Endangered Species and Ecosystems Act*, Threatened under Ontario's *Endangered Species Act*, Threatened under New Brunswick's *Species at Risk Act*, and Endangered under Nova Scotia's *Endangered Species Act*. In Québec, this species is protected under the *Act Respecting the Conservation and Development of Wildlife* (RSQ, c C-61.1) and is included on the *Liste des espèces susceptibles d'être désignées menacées ou vulnérables*. Chimney Swift is also protected in Saskatchewan under the *Wildlife Act* (1998) and in New Brunswick under the *New Brunswick Fish and Wildlife Act* (S.N.B. 1980, c. F-14.1).

TECHNICAL SUMMARY

Chaetura pelagica

Chimney Swift

Martinet ramoneur

Range of occurrence in Canada: Saskatchewan, Manitoba, Ontario, Québec, New Brunswick, Nova Scotia (formerly Prince Edward Island).

Demographic Information

Generation time	4.5 years.
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, observed (see **Fluctuations and Trends** section).
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Estimated decline of 32% over the last 9 years (2 generations) in areas covered by Breeding Bird Survey; some local populations in towns and urban areas stable or increasing (see **Fluctuations and Trends** section).
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Estimated decline of 49% over the last 14 years (3 generations) in areas covered by Breeding Bird Survey; some local populations in towns and urban areas stable or increasing (see **Fluctuations and Trends** section).
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Not estimated, but decline is expected to continue at a similar rate, based on recent long- and short-term population trends.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Not estimated, but decline is expected to continue at a similar rate, based on recent long- and short-term population trends.
Are the causes of the decline (a) clearly reversible and (b) understood and (c) ceased?	a. No. b. Partly c. No.
Are there extreme fluctuations in number of mature individuals?	No.

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	2.0 million km².
Index of area of occupancy (IAO) (Reported as 2x2 grid value).	12,424 km².
Is the population “severely fragmented” i.e., is >50% of its total area of occupancy 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. No. b. No.

Number of "locations"[1] (use plausible range to reflect uncertainty if appropriate)	Unknown, but far greater than the threshold of 10 locations.
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, inferred decline (see **Distribution** section).
Is there an [observed, inferred, or projected] decline in number of subpopulations?	N/A.
Is there an [observed, inferred, or projected] decline in number of "locations"[1]?	Unknown.
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, observed decline in extent and quality of habitat (see **Habitat Trends** section).
Are there extreme fluctuations in number of subpopulations?	N/A.
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 subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Total	20,000 - 70,000

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Unknown, quantitative analysis not performed.

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species?

Yes: A threat assessment calculator was completed for this species on 24 July 2017, by: Kristyn Richardson, Liz Purves and Myles Falconer (report writers); Richard Elliot (COSEWIC Birds SSC Co-chair); Mary Sabine (New Brunswick); François Shaffer and Celine Maurice (CWS - Québec Region), Mike Cadman and Ken Tuininga (CWS - Ontario Region), Karen Potter (CWS-Atlantic Region), Amy-Lee Kouwenberg (Bird Studies Canada), Winnifred Wake, Dwayne Lepitzki (Facilitator) and Joanna James (COSEWIC Secretariat). (Appendix 1).

The assigned overall threat impact is High, and the following contributing threats were identified, listed in decreasing order of severity:

i. Natural system modifications (High-Medium)
ii. Residential and commercial development (Medium)
iii. Biological resource use (Low)

iv. Human intrusions and disturbance (Low)
v. Pollution (Unknown)
vi. Climate change and severe weather (Unknown)

Limiting factors: This specialized species is highly adapted to feeding on aerial insects while on the wing, with little flexibility to use other foraging modes. It is sensitive to weather fluctuations which affect both the birds and their food supply. Chimney Swift has limited capacity for quick recovery following population reduction, given its rather low reproductive potential, high adult nest-site fidelity, and reliance on human structures for nesting and roosting.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Populations in most U.S. states bordering Canada, which would be most likely to serve as source populations for rescue, are experiencing similar although less severe population declines (see **Rescue Effect** section).
Is immigration known or possible?	Yes, possible but requires further study.
Would immigrants be adapted to survive in Canada?	Yes.
Is there sufficient habitat for immigrants in Canada?	Unknown (see **Habitat Trends** section).
Are conditions deteriorating in Canada?[1+]	Yes.
Are conditions for the source population deteriorating?[2+]	Yes.
Is the Canadian population considered to be a sink?[3+]	Unknown.
Is rescue from outside populations likely?	No, unless long-term declines in adjacent U.S. states are reversed.

Data Sensitive Species

Is this a data sensitive species? No.

Status History

COSEWIC: Designated Threatened in April 2007. Status re-examined and confirmed in April 2018.

[1] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Status and Reasons for Designation:

Status: Threatened	**Alpha-numeric codes:** A2bce+4bce
Reasons for designation: This aerial insectivore is a long-distance migrant, breeding in central and eastern Canada and wintering in South America. It has experienced a long-term population decline of close to 90% since 1970 in areas outside towns and cities, including a reduction of 49% over the past three generations (14 years). However, most roost counts in towns and urban areas show relatively stable numbers. A significant cause of decline is the reduced availability of aerial insects, likely due to the effects of agricultural and other pesticides, changing agricultural practices, and broad-scale ecosystem modifications in much of its breeding, migratory and wintering range. Reduced availability of roosting and nesting sites in chimneys and similar human-made structures, and in large hollow trees, is also likely contributing to declines. Greater frequency and severity of weather extremes may be reducing productivity, and increasing mortality during migration.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets criteria for Threatened, A2bce and 4bce. Breeding Bird Survey analysis indicates an estimated population reduction of 49% over the past three generations, largely outside towns and cities and due to habitat loss and reduced insect abundance linked to pesticide use, which is expected to continue, although roost surveys indicate that some local populations largely in urban areas are stable or increasing.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO and IAO exceed thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Total number of mature individuals exceeds thresholds.
Criterion D (Very Small or Restricted Population): Not applicable. Total number of mature individuals and IAO exceed thresholds.
Criterion E (Quantitative Analysis): Analysis not conducted.

PREFACE

Since Chimney Swift was first assessed as Threatened by COSEWIC in 2007 (COSEWIC 2007), new information on its distribution and abundance has become available as a result of targeted roost surveys in Manitoba, Ontario, Québec, and the Maritimes, as well as the completion of the second Maritimes Breeding Bird Atlas (Stewart *et al.* 2015), the second Québec Breeding Bird Atlas (QBBA 2016), and the first Manitoba Breeding Bird Atlas (MBBA 2016).

New information is also available regarding the threats affecting Chimney Swift on its Canadian breeding grounds. Analysis of an accumulation of Chimney Swift guano in Kingston, Ontario showed that steep increases in applications of DDT during the 1950s were correlated with a dramatic reduction in the remains of beetles, indicating a significant change in the prey taken by swifts (Nocera *et al.* 2012). Furthermore, work by Smith *et al.* (2015) demonstrated that many aerial insectivore species, including Chimney Swift, share a common population trend change point during the 1980s. Another recent study demonstrated that there are limited spatially concordant common trends among most aerial insectivore species in North America, including Chimney Swift (Michel *et al.* 2016). Thus, the degree to which Chimney Swift population declines are a result of species-specific or region-specific factors, a common population driver affecting many species of aerial insectivores, or a combination of both, remains uncertain.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2018)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service

Environnement et Changement climatique Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

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Chaetura pelagica

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2018

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific Name: *Chaetura pelagica* (Linnaeus 1758)

English Name: Chimney Swift

French Name: Martinet ramoneur

Spanish Name: Vencejo de chimenea

Classification: Class: Aves, Order: Apodiformes, Family: Apodidae

Chimney Swift belongs to the genus *Chaetura*, which includes 12 other swift species in the Americas (Steeves *et al*. 2014). There are three other species of swifts regularly found in Canada: Vaux's Swift (*Chaetura vauxi*), Black Swift (*Cypseloides niger*), and White-throated Swift (*Aeronautes saxatalis*), which are all restricted to the western cordillera (Godfrey 1986).

Morphological Description

Chimney Swift is 12-14 cm long, with a wingspan of 29-31 cm, and weighs about 21 g (Snow and Perrins 1998; Chantler 1999). The shafts of the tail feathers extend 5-7 mm beyond the feather tips, giving the tail its spiny appearance, a diagnostic feature of the genus *Chaetura*. Upperparts are dark sooty brown, palest on the rump, and blackish on the wings. Underparts are dark, paling to brownish grey and sometimes white on the throat (Godfrey 1986). This species does not exhibit sexual dimorphism (Fischer 1958). Chimney Swift is distinguished from swallows by its cigar-shaped body, long and narrow pointed wings, short spiny tail, rapid wing beats and jerky flight.

Within the genus *Chaetura*, Chimney Swift is generally considered to form a super species with Vaux's Swift of western North America and Central America, and Chapman's Swift *(C. chapmani*) of northern South America (Lack 1956; Steeves *et al*. 2014). It is morphologically similar to Vaux's Swift, but is larger, darker, and has a lower-pitched call. Chimney Swift's smaller size and spiny tail distinguish it from Black Swift and White-throated Swift.

Population Spatial Structure and Variability

There is no evidence for variation in plumage or size across the breeding range of this species in Canada, and no subspecies have been identified (Steeves *et al*. 2014).

Designatable Units

Chimney Swift is considered a monotypic species (Chantler 1999). This report considers the species in Canada as a single designatable unit.

Special Significance

Chimney Swift is the only swift regularly occurring in central and eastern North America. This species has aroused considerable public interest, as the spectacular pirouetting entrances of flocks of swifts descending into their roosts in old chimneys fascinate observers. Some roost sites (e.g*.,* in Wolfville, NS; St-Georges de Beauce, QC; Sault Ste. Marie, ON) attract many visitors to observe hundreds of swifts entering chimneys at sunset, where information is provided to raise the awareness of the Canadian public of declines and threats to this species.

Chimney Swift is one of several species of aerial insectivores (along with many swallows, nightjars and flycatchers) experiencing significant population declines in Canada and North America, and research on causes of swift population declines may help understand threats to other species in the guild.

The Mi'kmaq word for Chimney Swift is *Kaktukopunjej*. This name refers to Chimney Swift as being a "Thunder Bird" and it means that thunder will soon arrive when an individual sees this bird (Young pers. comm. 2017). There is no other relevant Aboriginal Traditional Knowledge available for this species.

DISTRIBUTION

Global Range

The breeding range of Chimney Swift is largely limited to eastern North America, from eastern Saskatchewan across southern Canada to Nova Scotia, and southward spanning Texas to Florida (Steeves *et al*. 2014; Figure 1). It is also a rare and localized breeder in southern California (Hamilton *et al*. 2007). Chimney Swift is a long distance migrant which winters in the upper Amazon basin of South America, mainly in Peru, Ecuador, northern Chile, and northwestern Brazil (Steeves *et al*. 2014), although accurately delimiting its wintering range is difficult due to the presence of similar *Chaetura* spp. in South America (Marin 1993).

Large flocks of Chimney Swift migrate over a broad front in fall south to Texas and Louisiana, where they cross the Gulf of Mexico or fly along the Central American coast to the South American wintering grounds. Small numbers have been recorded in the Darién of Panamá and Colombia during the southbound migration (Bayly *et al*. 2014; Pulgarín-R *et al*. 2015), and Chimney Swift is considered an uncommon or rare migrant throughout the Caribbean (Steeves *et al*. 2014).

A westward expansion of Chimney Swift's breeding distribution occurred during the 20th century in settled regions of the Great Plains, and also into southern California (Hamilton *et al*. 2007). It is unknown to what extent the loss of old growth forests and the changing availability of chimneys with industrialization may have altered its historical distribution and abundance (see **Habitat Trends** section).

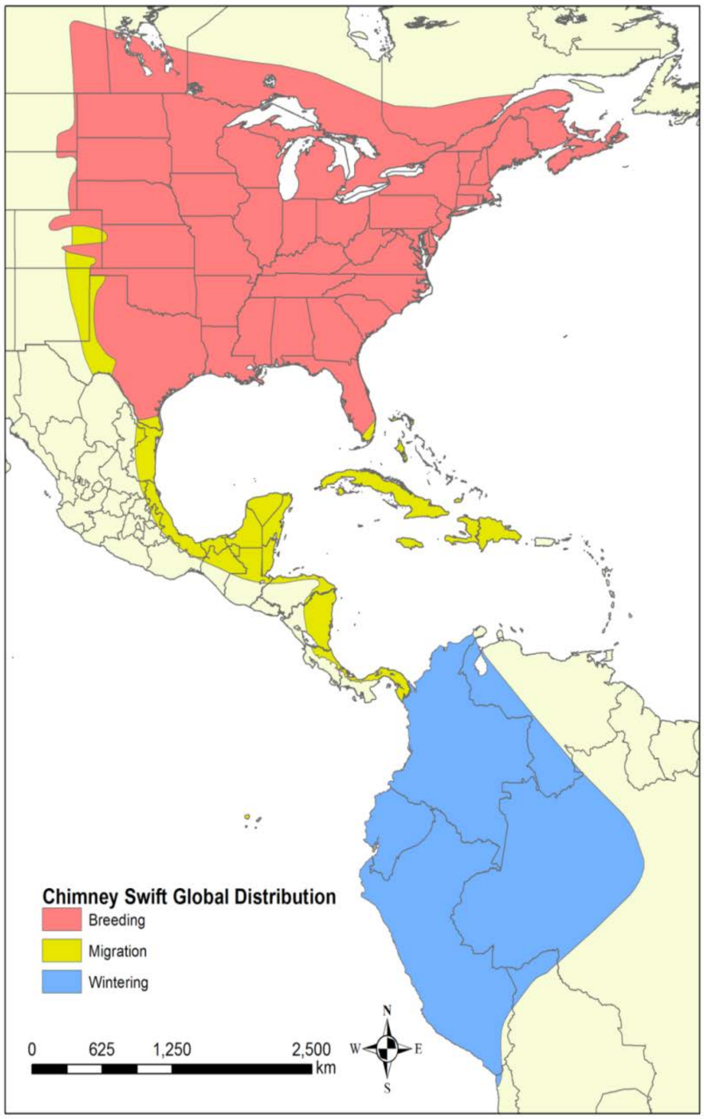

Figure 1. The breeding, migration and wintering distribution of Chimney Swift. Note that the small breeding population in southern California is not mapped here. Map created by Bird Studies Canada, based on BirdLife International and NatureServe (2015).

Canadian Range

Chimney Swift occurs throughout south-central and south-eastern Canada (Figure 2). Its western breeding range extends across settled regions of southern Manitoba into extreme eastern Saskatchewan, with most records for Manitoba coming from the Winnipeg area (MBBA 2016). It is sparsely distributed across central Ontario and Québec, but widespread and quite common in southern parts of those provinces (Cadman *et al*. 2007; Atlas of the Breeding Birds of Québec (QBBA) 2016). Chimney Swift breeds throughout New Brunswick and Nova Scotia, but is now absent as a breeder in Prince Edward Island (Stewart *et al*. 2015). It occurs uncommonly in summer in Newfoundland and Labrador as a non-breeding vagrant, with most records near Port aux Basques and on the Avalon Peninsula (Durocher pers. comm. 2017).

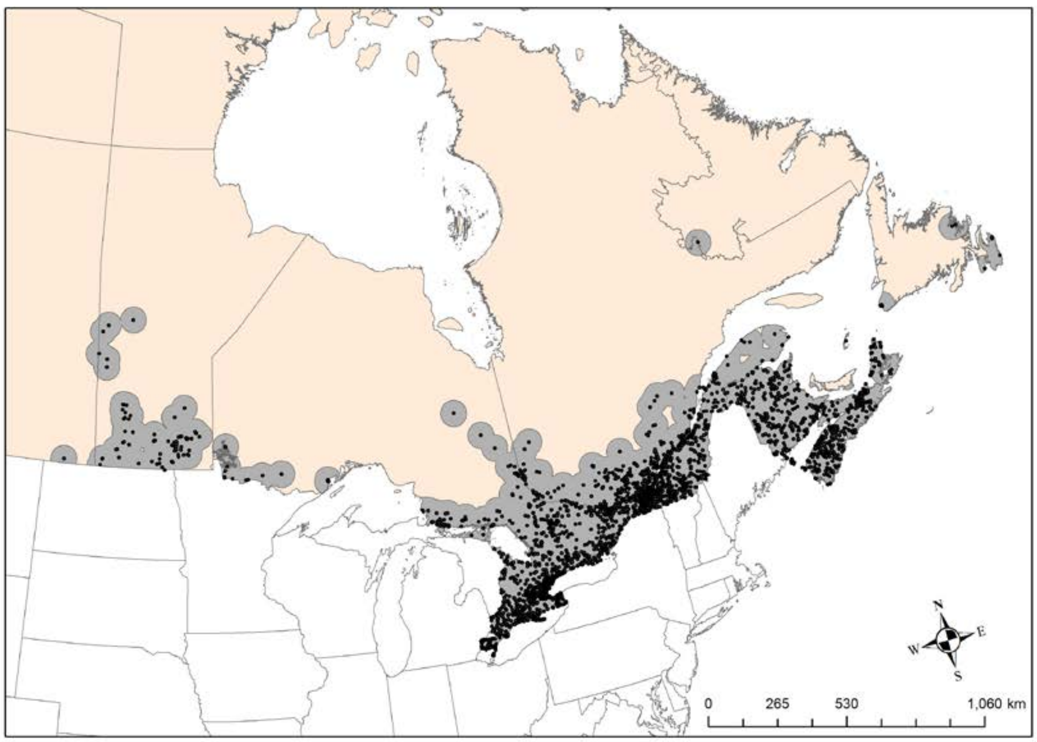

Figure 2. The breeding distribution of Chimney Swift in Canada, based on Breeding Bird Survey data (2005-2015; ECCC), Breeding Bird Atlas data from Manitoba (MBBA 2016), Ontario (Cadman *et al*. 2007), Québec (QBBA 2016), and the Maritime Provinces (Stewart *et al*. 2015), targeted surveys from MCSI, BSC, and ECCC-Québec Region (2005-2016), and eBird breeding season records (1 Jun - 31 Aug; 2005 - 2016). Black dots represent observation records from these data sources and may include nesting, roosting or other observation records (including vagrants) during the breeding season. Grey (50 km) buffered areas around point data represent a more general distribution, assuming moderate population connectivity between areas with sparse data points.

Individuals still breed in natural tree cavities to some extent in central and southern Ontario (e.g., Algonquin Park and Long Point; Tozer 2012; Zanchetta *et al.* 2014; Conboy pers. comm. 2017), southern Québec (e.g., Parc national du Mont-Mégantic and possibly Réserve écologique Judith-De Brésoles; Shaffer pers. comm. 2017) and the Maritimes Provinces (e.g., north-central and northwestern New Brunswick; western Nova Scotia; Zanchetta *et al.* 2014; Manthorne in Stewart *et al.* 2015).

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) of Chimney Swift in Canada is 2.0 million km^2 (Figure 3), calculated as the minimum convex polygon within Canada's extent of jurisdiction, and based on point data mapped in Figure 2 (excluding occurrences from Newfoundland and Labrador). EOO was given in the original status report as 1.3 million km^2 (COSEWIC 2007); about 35% less than reported here. This difference is attributable to changes in methodology rather than an actual increase in EOO.

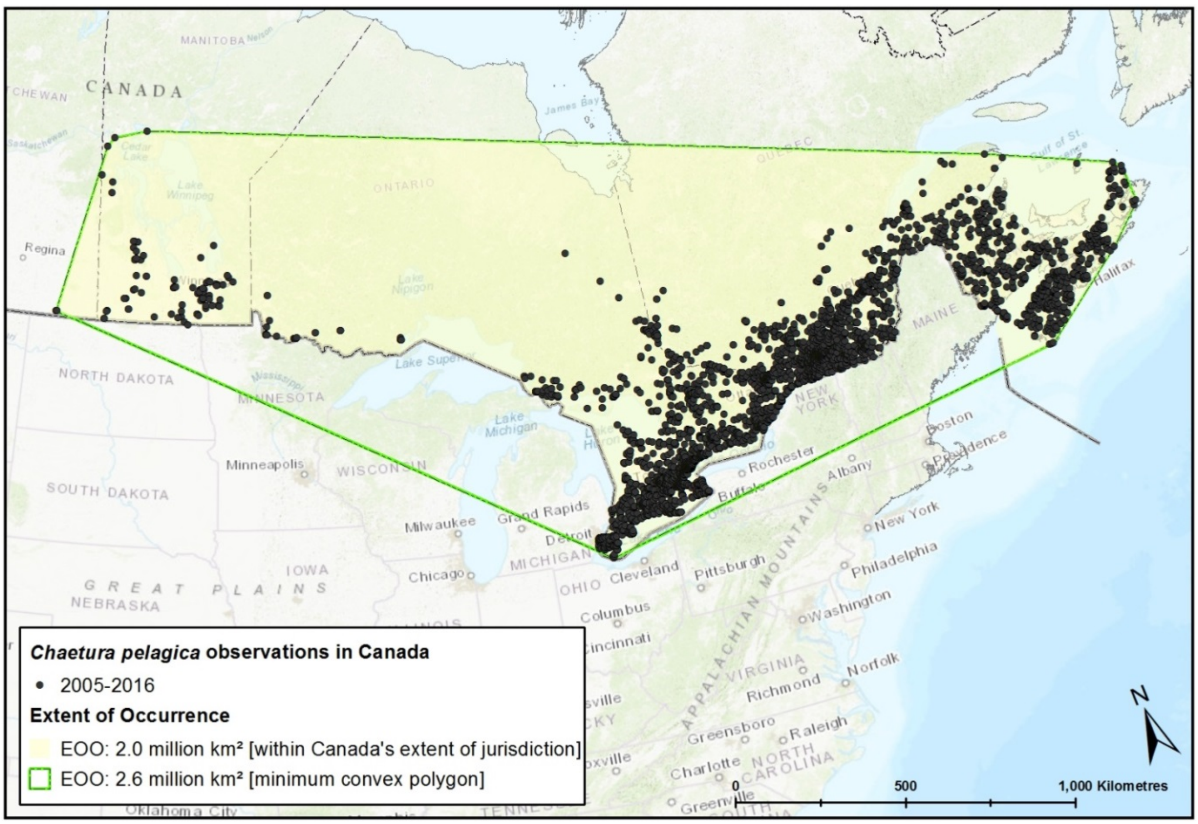

Figure 3. The extent of occurrence (EOO) of Chimney Swift in Canada, mapped as the minimum convex polygon within Canada's extent of jurisdiction (in pale yellow). Distribution is based on the point data from 2005-2016 mapped in Figure 2, but excluding non-breeding records from Newfoundland and Labrador. Map prepared by J. Wu, COSEWIC Secretariat (2018).

The index of area of occupancy (IAO) is 12,424 km^2, calculated assuming that the point data in Figure 2 represent nesting occurrences. Although these data may include several observations of vagrancy, this is unlikely to have a significant effect on the calculation of IAO. IAO was given in the original status report as 200,000 km^2 (COSEWIC 2007); about 95% greater than reported here. This difference is attributable to differences in grid scale, rather than an actual decline. The original status report used a 100 km^2 grid (COSEWIC 2007), whereas a 2 km x 2 km grid was used here. The latter is likely a more biologically relevant scale for breeding swifts (see **Diet and Foraging Behaviour**).

Search Effort

Chimney Swift has been adequately surveyed to determine the extent of its Canadian breeding range, especially where it is most widespread and abundant (i.e., southern Ontario and Québec. In eastern Saskatchewan, where its breeding density is low, few standardized surveys have been conducted. Distributional information for Chimney Swift in Canada was compiled using recent data from breeding bird atlas projects in Manitoba (2010-2014; MBBA 2016), Ontario (2001-2005; Cadman *et al*. 2007), Québec (2010-2014; QBBA 2016), and the Maritime Provinces (2006-2010; Stewart *et al*. 2015), the Breeding Bird Survey (2005-2015), and targeted Chimney Swift roost and nest monitoring surveys in Manitoba, Ontario, Québec, and the Maritimes (2005-2016). More information about these data sets is provided in the **Sampling Effort and Methods** section.

In addition, eBird observation records of Chimney Swift (from June-August, 2005-2016) have been included as supplementary data to fill in spatial gaps in occurrence data.

HABITAT

Habitat Requirements

As Chimney Swift spends most of the day ranging widely while foraging on the wing for insects, it is difficult to associate this species with a single type of habitat. It forages over a variety of habitats, including cities, towns, and villages, as well as various natural landscapes. However, it is more common over urban and suburban areas (Chantler 1999; Graves 2004; Steeves *et al*. 2014), possibly as a result of the greater availability of nesting and roosting sites, combined with an abundance of insects meeting the energetic requirements of brood-rearing (DeGraaf and Rappole 1995; Kaufman 1996). According to a survey of chimneys in an Ontario study area, only 25% of suitable substrates were used by swifts, suggesting that chimneys are not a limiting factor for the species in this area of the breeding range (Fitzgerald *et al*. 2014).

Chimney Swift requires a vertical cavity for nesting and roosting, with an interior surface that is porous but stable, and to which swifts can cling and attach their nests (Fischer 1958; Fitzgerald *et al*. 2014). Prior to European settlement in the late 17th and 18th centuries, Chimney Swift mainly nested and roosted inside large hollow trees (living or dead) and occasionally on cave walls and in rocky crevices (Tyler 1940; Coffey 1944; Lack

1956; Fischer 1958; Godfrey 1986; Tufts 1986; Erskine 1992; Graves 2004). A review of recent and historical records of trees used by Chimney Swift for nesting or roosting revealed that all trees had a DBH (diameter at breast height) greater than 50 cm (Zanchetta *et al*. 2014). Chimney Swifts were equally likely to enter the tree through an opening in the top or side of the trunk or branch. Some used openings as small as 5 cm in width, which required the swift to land on the surface rather than flying in directly (Zanchetta *et al*. 2014). In some instances, individuals used entrances excavated by Pileated Woodpeckers (*Dryocopus pileatus*), but it is unclear whether the swifts used these cavities for nesting or roosting (Zanchetta *et al*. 2014).

Extensive forest clearing took place following the arrival of Europeans in North America, and large trees became increasingly scarce (Leverett 1996; Drushka 2000). At the same time, artificial structures (i.e., chimneys, barns, wells) were being built, and Chimney Swift rapidly adopted such structures for nesting and roosting (MacNamara 1918; Coffey 1936; Lack 1956; Fischer 1958; Johnsgard 1979; Bull 1985; Norse and Kibbe 1985; Sibley 1988; Peterjohn and Rice 1991; Sutcliffe 1994; Fleckenstein 1996; Snow and Perrins 1998; Steeves *et al*. 2014). In addition to chimneys, Chimney Swift uses air shafts, silos, wells, barns, tobacco-curing sheds, abandoned buildings, and large concrete sewer pipes (Fischer 1958; Bull 1985; Dexter 1991; Manthorne pers. comm. 2015). Inside buildings, the birds generally build their nests above the floor in the darkest corners (Fischer 1958).

While Chimney Swift is now mostly associated with urban and rural habitat where chimneys are available, some still use hollow trees and tree cavities (Blodgett and Zammuto 1979). It has recently been observed using deciduous and coniferous old forest habitat in Ontario, Québec, and the Maritimes (Broeckaert and Julien 2013; Zanchetta *et al.* 2014; Conboy pers. comm. 2017), and the few historical swift observations in Saskatchewan were detected in remote areas and probably used hollow trees for nesting and roosting (COSEWIC 2007). Chimney Swift likely uses old-growth or mature forest habitat on protected lands across their Canadian range (e.g., Algonquin Provincial Park, Ontario). Chimney Swift flocks have also been observed roosting on tree trunks, perhaps when there are no other appropriate sites available (Spendelow 1985), or when their usual sites suddenly become inaccessible – e.g., when a fire is lit in a fireplace (Campbell and Campbell 1944) or sudden poor weather conditions force them to seek shelter (Arvin 1982). Nesting sites can sometimes be difficult to locate due to the secretive behaviour of swifts as they approach the nest. Although roosts are easier to identify because of the larger number of birds entering them, few roosts have been reported in hollow trees in recent years.

Internal temperature of chimneys may be a factor when swifts select nesting and roosting sites, as internal temperature of chimneys occupied by swifts in Québec fluctuated very little compared to the outside ambient temperature (COSEWIC 2007). In Ontario, chimneys used by swifts had higher internal temperatures in May than unused chimneys, and furthermore, unused chimneys experienced periods when internal temperature went below 13°C, which is considered the temperature threshold below which Chimney Swift abandons its nest (Gauthier *et al.* 2007; Richardson and Zanchetta 2015). Tyler (1940) reported that the chimneys most frequently occupied by swifts were not in use (i.e., without fires), connected to the basement of buildings, and provided a flow of warm air. Bowman

(1952) reported similar features of a chimney used in Kingston, Ontario, and concluded that the flow of warm air likely attracted roosting swifts on cool spring nights. Chimney Swift can successfully rear young in ambient temperatures reaching as high as 42.2ºC (Bull 2003), but temperatures above the maximum threshold of 43ºC are likely fatal to the embryos and young of most individuals (Drent 1973, 1975).

Suitable chimneys appear to be those with an opening diameter greater than 28.5 cm and a rough interior surface. In a recent study in southern Ontario by Fitzgerald *et al*. (2014), swifts preferred chimneys that extended 2.86 m above the roofline, had an internal area of about 1 m^2, and were attached to non-residential buildings (only 14% of surveyed residential chimneys were occupied versus 73% of non-residential).

Artificial nesting structures (hereafter "towers") are successful at attracting breeding Chimney Swifts in parts of the U.S. (Kyle and Kyle 2005), but have had limited success in Canada. A study has shown that these towers were avoided in Ontario, even when conspecific vocal and visual attraction cues were provided (Finity and Nocera 2012). Although the length of time that swifts spent within 25 m of the towers doubled when playback and decoys were deployed, nesting was never observed (Finity and Nocera 2012). However, a tower constructed in southern Ontario in 2017 was occupied by a Chimney Swift pair from June to August 2017 (Bird Studies Canada unpubl. data). Seven towers erected in Manitoba have never been utilized by Chimney Swift to date (Bazin pers. comm. 2017). Two towers, out of a total of 32, have been occupied by nesting Chimney Swifts in Québec, one with a heating system (heated lamp) in Lévis from 1998-2005 (except in 2004) and one (not heated) at Lac Edouard from 2015-2017 (Shaffer pers. comm. 2017). In 2015, the nest in the latter tower fledged four young (Parent 2016). Nine nesting towers and one roosting tower installed throughout New Brunswick have never been used (Richardson pers. comm. 2017).

Chimney Swift wintering habitat in South America consists of riparian forest, margins of tropical lowland evergreen forest, and second-growth scrub (Rappole *et al*. 1983; Stotz *et al*. 1996). Swifts also frequent irrigated farmland, suburban areas, and city centres (Hughes 1988). On the Peruvian coast, they regularly occur up to 2,500 m and sometimes 3,000 m above sea level (Hughes 1988). In the winter, swifts roost in chimneys, crevices, and caves (Fjeldså and Krabbe 1990), and in hollow trees that are plentiful in the Amazon forest (Whittemore 1981). However, winter habitat requirements are still not very well known (Stotz *et al*. 1996; Steeves *et al.* 2014).

Habitat Trends

As mature forests in North America were cleared following European settlement, and as many permanent buildings were constructed, Chimney Swift became closely associated with stone chimneys (Graves 2004). It appears to have adopted chimneys only a few decades after European colonization; the first record of Chimney Swifts using a human-made chimney for nesting and roosting was in Maine in 1672 (Palmer 1949; Graves 2004). Coffey (1944) noted that swifts began using chimneys in the southeastern U.S. by 1808. At the beginning of the 19th century, Audubon (1840) had already observed the widespread use of chimneys by Chimney Swift for nesting. In the same period, Wilson (1812) observed that nesting by swifts was already limited to chimneys in western Pennsylvania. Fischer (1958) reported that the number of observations of Chimney Swift nesting in hollow trees had fallen considerably since the 1920s. Blodgett and Zammuto (1979) similarly noted that there were fewer than 10 records of Chimney Swift nests in hollow trees in the previous 100 years in Illinois.

Many authors have suggested that Chimney Swift populations increased with the arrival of European settlers and the increased number of hollow structures provided by chimneys (Tyler 1940; Norse and Kibbe 1985; Dexter 1991; Kaufman 1996; Zucker 1996; Chantler and Driessens 2000; Steeves *et al.* 2014). Graber and Graber (1963) observed an increase in Chimney Swift density in Illinois between 1906-09 and 1956-59. They attributed this to increasing human population and development, and the urbanization process (10 of the 14 million acres of forest in Illinois had been cut during the 19th century and by 1900, 33 of the 36 million acres of land in Illinois had been modified; Graber and Graber 1963).

Alternatively, European colonization may have reduced Chimney Swift population in North America (if nest-site availability was population-limiting), because surveys of remnant old growth forests suggest that the number of hollow trees removed was greater than the number of chimneys built. McGee *et al*. (1999) found an average of 18 snags/ha (at least 50 cm DBH) in old-growth deciduous forests of New York State. Goodburn and Lorimer (1998) found similar results for deciduous old growth forests in Wisconsin and Michigan (20 snags/ha of at least 45 cm DBH). According to data from the U.S. Census Bureau, there were 0.15 chimneys/ha in the eastern U.S. in 1900, assuming four persons and two chimneys per house (COSEWIC 2007). Although an approximation, this figure is two orders of magnitude less than similar estimates of snag density before colonization, and demonstrates that chimneys were not constructed at the same rate that large hollow trees were felled, although not all snags present nesting opportunities for swifts. Similarly in Canada, the number of households, and therefore chimneys, was less than in the U.S. following colonization, but logging activities and land clearing were of the same order (Kerr and Holdsworth 1990).

Large areas of forest were removed for urbanization and agriculture in the Maritimes (Loo and Ives 2003) and southern Ontario (Suffling *et al*. 2003). In the Maritimes, only 1-5% of forest cover could be characterized as old growth by the early 2000s (Mosseler *et al*. 2003). As of 1986, only 0.07% of the forest in southern Ontario was classified as greater than 120 years old (Larson *et al*. 1999). In Québec, 7 of 49 old growth forests identified are protected as ecological reserves, representing 20.9% of the total area of old growth forest (Gouvernement du Québec 1996). It is unknown how much old growth forest is actually in the range of Chimney Swift. However, forest cover is increasing in some areas within Chimney Swift’s breeding range (e.g., due to the reversion of abandoned farmland to forest in parts of southern Ontario; Larson *et al.* 1999; Blancher *et al.* 2007), which might help offset the loss of chimneys over time.

Habitat may not currently be limiting Chimney Swift populations in parts of its breeding range. However, the number of available and suitable chimneys continues to decline in

Canada, largely due to the growing use of electrical heating, beginning in the 1950s, and more recent conversion to natural gas heating (Fitzgerald *et al.* 2014). Today, most new buildings either have no chimneys or have chimneys that are unsuitable for swifts. Canadian insurance companies require that wood-burning appliances are certified by a Wood Energy Technology Transfer (WETT) professional; most appliances must have metal liners and spark arresting caps, both of which prevent the use of chimneys by swifts (Manthorne 2013). Construction requirements for open fireplaces, oil furnaces, and unused flues vary among insurance companies, leading to uncertainty in regards to the potential use of chimneys by swifts (Manthorne 2013). In Québec, about 75% of residential chimneys have a metal liner or a cap (COSEWIC 2007), and almost 60% of the remaining chimneys have a diameter of 28.5 cm or less (COSEWIC 2007), and are therefore unsuitable for use by swifts.

Efforts have been made in several provinces to quantify the proportion of once-suitable chimneys that have been demolished, capped, or otherwise made unavailable to swifts.

A study in Manitoba found that 29 of 200 suitable chimneys (14.5%) were lost over a 10-year period (Stewart *et al.* 2017). During the same period, 19 of 134 chimneys (14.2%) known to be used by swifts were lost, mainly due to capping, demolition, or covering with a screen (Stewart *et al.* 2017). During the period 2004-2013, Nature London amassed an inventory of 162 chimneys known to be used by swifts in London, Ontario, and determined that in 2015, 47 (29%) were no longer available for use by swifts, mainly due to demolition or capping (Wake 2016). In Québec, 177 of 813 (22%) nesting and roosting sites known to have been used at least once by swifts between 1998 and 2015 were rendered unavailable (Shaffer pers. comm. 2016). In New Brunswick and Nova Scotia, 16 of 111 (14%) nesting and roosting sites known to have been used at least once by swifts between 2006 and 2017 were made unavailable (Manthorne pers. comm. 2017).

In Québec, church and rectory chimneys likely represent a large proportion of breeding sites available to Chimney Swift. Based on estimates of the number of available church and rectory chimneys, and the assumption that the maximum lifespan of these chimneys is about 60 years, Gauthier *et al*. (2007) concluded that by 2030, few traditional chimneys would be left for use by swifts. The rate of chimney conversion, destruction, and closure probably increases with latitude, as northern areas experience freeze and thaw periods that can result in quicker deterioration of chimneys when water infiltrates cement and brick and freezes (Gauthier *et al*. 2007).

BIOLOGY

Steeves *et al*. (2014) provide the most comprehensive account of Chimney Swift biology and life history, though little of the information presented there is from Canada.

Life Cycle and Reproduction

Chimney Swift forms breeding pairs shortly after arriving on its breeding grounds, typically between April and May in Canada (Steeves *et al*. 2014). Median arrival date of nesting pairs for Manitoba is May 18 (Stewart and Stewart 2013). Most adults first breed at two years of age (Dexter 1969). Non-breeding individuals and failed breeders roost communally during the summer, sometimes in chimneys that are also occupied by a breeding pair (Zammuto and Franks 1978).

Chimney Swift is considered monogamous and tends to retain the same mate across years, as long as both members of the pair return to the same nesting site (Dexter 1971, 1992; Kyle and Kyle 2005). Dexter (1992) found that 84% (of 294 pairs) of nesting Chimney Swift kept the same mate between years when both birds returned to the nesting site. One or two extra adults, generally offspring of the pair from the previous season, may help to incubate, brood, and/or feed the young of a breeding pair (Fischer 1958; Dexter 1969).

Chimney Swift is a solitary breeder (Fischer 1958; Dexter 1969, 1974, 1991). While several pairs may nest in separate chimneys on the same building roof (Dexter 1969), Chimney Swift is not a true colonial species (Fischer 1958).

Chimney Swift pairs build half-saucer shaped nests by cementing small twigs against a vertical surface using their sticky saliva (MacNamara 1918; Shelley 1929; Fischer 1958; Zammuto and Franks 1981). The average depth of nests below chimney tops was 6.7 m (range 1.7-16.2 m, n = 400) in Ohio (Dexter 1969), and 3 m (range 1.1-5.1, n = 40) in Kansas (Steeves *et al*. 2014). Swifts do not usually reuse nests built in previous years, as most fall down during the fall or winter (Dexter 1969). However, nests built in well-sheltered sites may be renovated and reused (Amadon 1936; Fischer 1958; Dexter 1978, 1981; Steeves *et al.* 2014).

Females begin egg-laying when the nest is half-built, with nest construction continuing during the incubation period (Fischer 1958). Nest construction is complete within 18 days, on average (Fischer 1958). First eggs are laid between 14 May and 9 June in Ohio (Dexter 1969). In Ontario, first and last known egg dates are 24 May and 4 August, respectively (Peck and James 1983). In Manitoba, the incubation period starts between 3 June and 16 July (average date = 26 June; Stewart and Stewart 2013). Females lay 2-5 eggs in Ontario (Peck and James 1983) and 3-7 eggs in Manitoba (Stewart and Stewart 2013). The incubation period averages 19 days, with both parents incubating (Sherman 1952; Fischer 1958; Wetherbee 1961); however, inclement weather can extend the incubation period (Steeves *et al*. 2014). Hatching success was 56% in Manitoba (22 of 39 eggs hatched; Stewart and Stewart 2013), 90.7% in New York (77 of 86 eggs hatched; Fischer 1958), and 69.7% in Kansas (53 of 76 eggs hatched; Steeves *et al*. 2014).

Both parents brood and feed nestlings (Steeves *et al*. 2014). Young take first flight 28-30 days after hatching (Fischer 1958). Fledging success of hatched eggs varies, from 50% in Manitoba (11 young fledged from 22 hatched eggs, 1-3 fledglings per nest; Stewart and Stewart 2013), 86% in New York (74 young fledged from 86 hatched eggs, three to seven fledglings per nest; Fisher 1958), and 69.7% in Kansas (53 young fledged from 76 eggs; Steeves *et al.* 2014). In Manitoba, fledging dates were between 27July and 16 August (Stewart and Stewart 2013). In New York, fledging occurred between 11 July and 7 August, with young leaving the chimney between 2 and 17 August (Fischer 1958); young often return to roost with parents and siblings at the nest site for 1-2 weeks after their initial flight (Fischer 1958; Dexter 1969; Steeves *et al*. 2014). Fledged young either stay with parents to roost at the nest site or join adults at communal roosts, later departing with adults on fall migration (Dexter 1969; Steeves *et al*. 2014).

In Manitoba, 63% of nesting attempts between 2007 and 2013 failed (19 of 30 nests; Stewart and Stewart 2013). Instances of re-nesting following early nest failure have been recorded (Dexter 1969). Chimney Swift is usually single-brooded in northern latitudes (Baicich and Harrison 1997; Stewart and Stewart 2010, 2013), but there are reports of double-brooding in Texas (Kyle and Kyle 1997).

Chimney Swift has a longevity record of 14 years, with an average of 4.6 years for banded birds in the wild (n = 129; Dexter 1969, 1979). Generation length is calculated by IUCN as 5.35 years, although a generation period of 5 years IUCN was used when assessing rates of decline of this species (IUCN 2017). Generation time is considered here to be the average age of parents in the population, or about 4.5 years (Dexter 1979; COSEWIC 2007). Annual mortality rates average 37%, based on banding data collected in the U.S. and Canada between 1920 and 1956 (Henny 1972). This is similar to survival rates of 73% ± 7% calculated using banding data from Kyle and Kyle's (2005) Chimney Swift project in Texas, between 1989 and 2002 (COSEWIC 2007). Mortality is assumed to be highest in the first year after hatching, as it is for most swift species (Chantler and Driessens 2000).

Physiology and Adaptability

Chimney Swift quickly adapted to using chimneys and other human-made structures for nesting and roosting, following European settlement of North America (Steeves *et al*. 2014). However, swifts are susceptible to disturbance at these sites when chimney sweeping or chimney use by humans overlaps with their nesting and roosting periods (Harrison 1921; Tyler 1940; Plenge 1974; Kyle and Kyle 2005). Chimney Swift has also adapted to using towers specifically designed for them in parts of the U.S. (Kyle and Kyle 2005), although similar structures have been largely unused by Chimney Swift in Canada, possibly because of inadequate thermal properties (Finity and Nocera 2012; see **Habitat Requirements**).

Physiological requirements are poorly understood, although thermoregulation ability is known to be an important constraint. Adult Chimney Swifts congregate in large masses within roosting chimneys during cold or rainy weather, likely to minimize heat loss, with birds huddling closer together under colder ambient temperatures (Musselman 1926; Zammuto and Franks 1981; Steeves *et al*. 2014). Chimney Swift can also enter a torpid state when exposed to cold temperatures (Dawson and Hudson 1970; Ramsey 1970). Swifts are susceptible to starvation if prolonged cold and rainy periods severely reduce insect availability (Spendelow 1985).

Dispersal and Migration

There is little information on Chimney Swift dispersal from natal sites. In Ohio, 16% of juveniles banded at nests at Kent State University between 1944 and 1968 returned to nest in subsequent years (33 out of 207 juveniles banded; Dexter 1969). Adults have high annual fidelity to nest sites in New York (Fischer 1958) and Ohio (Dexter 1992). In Kent, Ohio, 248 of 258 pairs that returned and retained the same mate from the previous year nested in the same air shaft as the previous year. In cases where single individuals of a former nesting pair returned, 42% of females and 26% of males used their previous nest site with a new mate (Dexter 1992). In New York, 19 of 27 returning adults reused their previous nest site (Fischer 1958).

Chimney Swift is a long-distance migrant. Mean dates of first spring arrival in the northeastern U.S. have shifted earlier over the 20th century, possibly due to warming spring temperatures (Butler 2003). Chimney Swift arrives in Manitoba between 10 May and 25 June and departs between 31 July and 2 September (Stewart and Stewart 2010, 2013). It arrives between late April and early May in southern Ontario and mid-May in northern Ontario (Speirs 1985), and departs by mid-October (Bird Studies Canada unpubl. data). Chimney Swift arrives in Québec between late April and early May (eBird 2012). In Nova Scotia, it arrives in early May and departs by early October (Tufts 1986).

Chimney Swift migrates diurnally in flocks (Coffey 1936; Tyler 1940; Whittemore 1981; Chantler 1999), sometimes congregating in the thousands at roost sites along the migration route (Groskin 1945; Michael and Chao 1973). Three flyways have been suggested for their migratory flight; along the Atlantic Coastal Plain, the east side of the Appalachian Mountains (Piedmont Flyway), and the Mississippi River (Coffey 1938; Calhoun and Dickenson 1942). Ontario breeders use the Mississippi and Piedmont flyways about equally during fall migration, although individuals might not use the same flyway each year; there are insufficient data to suggest the same for spring migration (Bowman 1952). Chimney Swifts from the northern U.S. and Canada converge in the lower Mississippi Valley during fall migration (Lowery 1943; Ganier 1944; Bowman 1952). Most individuals then cross over the Gulf of Mexico (Lowery 1943), passing over the Yucatan Peninsula and following the Atlantic coast of Central America into northwestern South America (Howell and Webb 1995; Steeves *et al.* 2014). They then reportedly follow the Pacific coast, reaching Peru in early November (Plenge *et al*. 1989) and migrating as far south as northern Chile (Sick 1993). In contrast, during spring migration, most individuals reportedly do not cross the Gulf of Mexico, instead moving overland through South America, Central America, and Mexico (Howell and Webb 1995).

Chimney Swift is susceptible to effects of stochastic weather events during migration; hurricanes can disrupt their migratory trajectory and may cause mass mortality (Dionne *et al*. 2008).

Diet and Foraging Behaviour

Chimney Swift is an aerial insectivore that preys mostly on flying insects, including beetles, true bugs, caddisflies, mayflies, crane flies, wasps, ants, and bees (Martin *et al*. 1951; Fischer 1958; Nocera *et al*. 2012). Swifts feed in flight; larger insects are snatched with their bills and smaller ones are caught in their large gape (Steeves *et al*. 2014). They carry food as a bolus to regurgitate to young (Steeves *et al.* 2014). Chimney Swift in Manitoba returned to feed non-brooded young 6-8 times per hour between mid-July and fledging (Stewart and Stewart 2013). Swifts fly low over the water and touch the surface with their bill to drink, often making several passes (Sutton 1928; Whittemore 1981; Godfrey 1986).

Chimney Swift spends the majority of its life airborne. It generally forages at heights that range from 20-150 m in the air (Steeves *et al.* 2014). A study conducted in Guelph, Ontario during the nesting season found that swifts tended to select airspace above industrial areas for foraging and did not select airspace above water features, low-density housing, early successional habitat, or open space (Wheeler 2013). Little information exists regarding the distance that swifts forage from the nest, but in New York State some individuals foraged 3-6 km away (Fischer 1958).

Heavy dichlorodiphenyltrichloroethane (DDT) applications in the 1950s likely altered insect communities and resulted in Chimney Swifts in Ontario shifting their main prey from beetles to true bugs (Nocera *et al*. 2012). Although the proportion of beetles in the diet did increase again after DDT use declined, the nutritional consequences of the shift, coupled with other stressors, might have contributed to widespread Chimney Swift population declines (Nocera *et al.* 2012).

Interspecific Interactions

Chimney Swift has been observed attempting to steal prey from Purple Martin (*Progne subis*; Brown 1980) and chasing bats while converging on the same prey item (Mumford and Keller 1984). Potential competition for roost and nest sites with European Starling (*Sturnus vulgaris*) may lead to site abandonment (Maurice pers. comm. 2017). However, competition with other species is not known to affect survival (Steeves *et al*. 2014).

Chimney Swift has different predators depending on its life stage. In the U.S., the Eastern Ratsnake (*Pantherophis alleghaniensis*) is a known nest predator (Laskey 1946; Cink 1990). Adults are preyed on by Sharp-shinned Hawk (*Accipiter striatus*) (Musselman 1931), Peregrine Falcon (*Falco peregrinus*; Errington 1933), Merlin (*F. columbarius;* Wake 2013), Eastern Screech-Owl (*Megascops asio*; Kyle and Kyle 1995), Herring Gull (*Larus argentatus*; Evans *et al.* 2017), and Raccoon (*Procyon lotor*; Manthorne pers. comm. 2017), often when the swifts are entering or exiting a chimney.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Breeding Bird Survey

The Breeding Bird Survey (BBS) is an annual standardized, road-side survey designed to monitor changes in breeding bird populations across North America since 1970. Surveyors conduct the survey on a single morning (usually in June) along a 39.2 km route, stopping every 0.8 km to count birds at 50 stations. At each station, surveyors conduct a three-minute point count, tallying all species and individuals seen and heard within 0.4 km.

The BBS has good overlapping coverage with Chimney Swift breeding range, although BBS routes do not intersect urban areas where the species is most abundant. BBS routes are sampled during early morning periods, potentially resulting in fewer detections of Chimney Swift, but this probably does not affect trend estimates (Smith pers. comm. 2017). Only about 20 BBS routes record Chimney Swift across Canada in an average year. BBS trend analyses use information to interpret the reliability of bird trends, including trend precision, the influence of spatial coverage and population density on the trend, and model fit. These measures are summarized into high, medium, and low reliabilities (see Table 1). The Canadian trend analysis undertaken by ECCC is reported here (ECCC 2017). Overall, the BBS trend is considered the most reliable source for population trends in this assessment, especially for areas outside towns and urban areas, due to its extensive temporal and spatial coverage, survey standardization, and strong data analysis procedures.

Table 1. Long- and short-term annual population trends for Chimney Swift, based on BBS data (ECCC 2017), with 95% lower (LCI) and upper (UCI) credible intervals and trend reliability classification. Results in bold are statistically significant declines. See Sampling Effort and Methods section for details.

	Long-term (1970-2016)				Short-term (2002-2016)			
Geographic area	**Trend (%/yr)**	**LCI**	**UCI**	**Reliability**	**Trend (%/yr)**	**LCI**	**UCI**	**Reliability**
Canada	**-4.89**	**-5.71**	**-4.05**	**High**	**-4.71**	**-6.87**	**-2.30**	**Medium**
Manitoba	0.82	-3.80	13.4	Low	3.19	-7.40	52.9	Low
New Brunswick	**-3.98**	**-5.25**	**-2.46**	**High**	**-4.79**	**-8.83**	**-1.02**	**Low**
Nova Scotia and PEI	**-6.93**	**-8.39**	**-5.59**	**High**	**-7.2**	**-10.8**	**-5.08**	**Medium**

	Long-term (1970-2016)				Short-term (2002-2016)			
Geographic area	**Trend (%/yr)**	**LCI**	**UCI**	**Reliability**	**Trend (%/yr)**	**LCI**	**UCI**	**Reliability**
Ontario	**-6.22**	**-7.31**	**-5.07**	**High**	**-5.47**	**-8.08**	**-2.23**	**Medium**
Québec	**-3.98**	**-5.45**	**-2.60**	**High**	**-4.35**	**-7.80**	**-0.83**	**Low**

Continental and national population estimates have been derived using BBS data (Blancher *et al*. 2013). More up-to-date population estimates for Canada are provided in this report, derived using area-based extrapolation methods and detectability adjustments (e.g., for time of day; Stanton unpubl. data 2016). Their accuracy and precision for estimating Chimney Swift numbers are unknown, and considering the clustered nature of the species' distribution, caution is advised when interpreting population estimates (see methods in Blancher *et al*. 2013 for details).

Breeding Bird Atlases

Breeding Bird Atlases are typically five-year survey efforts aimed at documenting the distribution and relative abundance of breeding birds across geopolitical regions (e.g., provinces). Observers record breeding evidence of all bird species detected in 10 km x 10 km squares. Observers generally aim to survey for a minimum of 20 person-hours per square. Atlas data are valuable for comparing temporal changes in breeding bird distribution, rather than annual population trends, as many atlas surveys are replicated at about 20-year periods. Most of the period over which population changes may be detected by atlases conducted within the range of Chimney Swift in Canada precedes the last three-generation period (since about 2002).

Targeted Chimney Swift monitoring

In order to better understand Chimney Swift population trends in towns and urban areas not well-covered by the BBS, many surveys have recently been implemented to document the number of swifts using traditional roost and nest-sites. Three organizations have led targeted Chimney Swift monitoring programs in Canada: Environment and Climate Change Canada-Canadian Wildlife Service in Québec, starting in 1998; the Manitoba Chimney Swift Initiative (MCSI), starting in 2007; and Bird Studies Canada (BSC) in Ontario and the Maritimes, starting in 2009 and 2011, respectively. Prior to BSC's involvement in Ontario, Nature London initiated intensive roost and nest monitoring surveys in London during 2005-2008 (Wake 2013). Each organization also participates in the annual National Roost Monitoring Survey (NRMP), a four-day synchronized survey of roost counts in over 100 chimneys across Canada.

Because protocols and data from NRMP and standard chimney surveys (e.g., SwiftWatch) are the same, these data sets are amalgamated, collectively representing 12,940 chimney surveys at breeding and roosting sites. Hereafter, these data are referred to as “chimney survey data”. Chimneys are monitored throughout the pre-breeding to post-breeding period, many of them annually. Although protocols are not completely standardized among provinces, these evening surveys generally count the number of swifts returning to the site from 30 minutes before sunset to 30 minutes after sunset.

Currently, no trend analyses exist for chimney survey data. Trend periods differ by province (i.e., 10-year trends for Ontario and Québec, nine-year trends for Manitoba, and four-year trends for the Maritimes). Trend estimates from periods of less than 10 years are of lower reliability, but are included here in order to provide the most up-to-date population monitoring information for Chimney Swift. They should be interpreted with caution. National trends based on these data are not presented, as differing trend periods apply in each region. Chimney survey data with six or more years of existing surveys within the trend period were used, except for the Maritimes, where those with two or more years of surveys were used (due to a smaller sample). Survey dates were separated into two seasons (spring = on or before 14 July, fall = on or after 15 July). These dates roughly correspond to the breeding and post-fledging periods for Chimney Swift. This separation was necessary to account for the increased number of (juvenile) birds in the population in fall. The maximum number of swifts (log-transformed) that used a chimney site in a given season was used as the response variable in a linear mixed model framework, with year and province (plus interaction) as fixed effects, and the chimney site as a random intercept. This approach controlled for variance in effort (number of chimneys sampled per year) and the fact that not all chimneys are sampled every year. Spring and fall models were analyzed separately. Model fit was assessed by examining plots of fitted and residuals values which suggested overall adequate model fit. Although the number of chimneys used in the trend analysis is not substantial (Table 2), it is numerically comparable to data from the BBS (above). The number of chimney surveys used in the trend analysis was 841 and 348 for the spring and fall, respectively.

Table 2. Chimney Swift population trends based on targeted chimney surveys during spring and fall. Results in bold are statistically significant trends. See Sampling Effort and Methods section for details.

	Spring				Fall			
Region	**Start year (total trend years)**	**Trend**	**SE**	**n (sites)**	**Start year (total trend years)**	**Trend**	**SE**	**n (sites)**
MB	2007 (9)	-0.007	0.023	37	-	-	-	0
NS and NB	2012 (4)	0.100	0.091	20	2012 (4)	0.085	0.242	7
ON	**2006 (10)**	**0.130**	**0.040**	**30**	2006 (10)	-0.107	0.247	21
QC	**2006 (10)**	**0.109**	**0.030**	**36**	2002 (10)	-0.163	0.245	23

At the time of writing this report, BBS trend analysis is thought to provide the most reliable source of information for Chimney Swift national trends (see above: Breeding Bird Survey section). However, monitoring chimneys for occupancy or abundance over longer periods than provided here (at least 14 years) will likely yield superior population monitoring data for assessing Chimney Swift population trends in the future.

Non-breeding (floater) individuals are notoriously difficult to monitor during the breeding season (Kokko and Sutherland 1998). Most targeted Chimney Swift surveys likely do monitor floater populations, in addition to breeding populations. However, little is known about how these groups fluctuate in abundance on temporal scales and whether this might affect trend estimates. Another potential issue with targeted surveys is that the availability or destruction of nesting and roosting chimneys may interact with the number of roosting birds using chimneys over time. For example, a chimney loss rate of 1-3% per year could displace birds into monitored chimneys, thereby maintaining or even increasing the number of birds recorded in a given chimney (i.e., stable trend), even though the overall population may be declining. Thus trends could represent minimum population decline rates. As other scenarios are also possible, careful interpretation is required using these trends.

Canadian Migration Monitoring Network - Réseau canadien de surveillance des migrations (CMMN-RCSM)

The Canadian Migration Monitoring Network - Réseau canadien de surveillance des migrations (CMMN-RCSM) involves the cooperative efforts of 25 bird observatory stations across Canada. Stations collect abundance data using a standardized protocol during the migration seasons (Crewe *et al*. 2008). However, only two Ontario stations (Long Point Bird Observatory [LPBO] and Pelee Island Bird Observatory [PIBO]) reported Chimney Swift observations consistently enough to estimate population trends. Ten-year (2004-2014) trends are reported for both stations, as well as 45-year (long-term) trends for LPBO, which parallels the timeframe of the BBS data. CMMN-RCSM trends are separated into spring and fall periods.

Abundance

Blancher *et al*. (2013) estimated the global population of Chimney Swift to be 7.8 million individuals, and Stanton (unpubl. data 2016) estimated the Canadian population to be about 70,000 individuals (95% credible interval (CI): 30,000, 150,000), about 1% of the global population. This is the only population estimate with confidence intervals available for Canada, although it may be an overestimate (see below). These estimates based on data from the BBS rely on several broad assumptions to extrapolate density estimates while accounting for detectability (Blancher *et al*. 2013).

Using point count data from the Ontario Breeding Bird Atlas (2001-2005), Blancher and Couturier (2007) estimated a Chimney Swift population size of 8,000 individuals for Ontario, using similar methods to Blancher *et al*. (2013). To date, no population estimates have been calculated for other recently completed atlases in Québec, the Maritimes or Manitoba.

Writers of the original COSEWIC Chimney Swift status report (COSEWIC 2007) estimated the Canadian Chimney Swift population size to be 11,800 mature individuals, based on a mixture of sources and methods. They used maximum numbers of birds observed during chimney inventories in Québec (mostly in 2005), the Blancher and Couturier (2007) estimates for Ontario, and a variety of "extrapolation" methods and "educated guesses" for other provinces (see COSEWIC 2007).

It is unclear what the most accurate population estimate is for Chimney Swift in Canada. It is likely that the BBS-derived estimate is an overestimate, while the COSEWIC 2007 estimate was likely an underestimate. Minimum estimates of population size can be determined from the NRMP, an annual spring Chimney Swift roost monitoring survey in Manitoba, Ontario, Québec, New Brunswick, and Nova Scotia, representing more than 100 known roost sites. Although these counts vary considerably by date, region, and year, they do provide absolute minimum estimates of the roosting population. These counts include both breeding and non-breeding individuals. The simultaneous maximum daily counts across all provinces in the spring for each survey year are: 2013 = 12,688; 2014 = 11,350; 2015 = 17,128; 2016 = 10,747; and, 2017 = 15,480 (Shaffer pers. comm. 2017). The maximum total of 17,128 (from 2014) is a minimum total estimate, as it does not account for additional birds in unknown or uncounted roosts, and other uncounted individuals. It is therefore likely that the Canadian population is in excess of 20,000 mature individuals, but less than the Stanton (2016) estimate of 70,000 mature individuals.

Fluctuations and Trends

Breeding Bird Survey

Long-term BBS data for Chimney Swift in Canada show a significant annual rate of decline of -4.9% per year (95% CI: -5.7 to -4.1) between 1970 and 2016, amounting to a population decline of about 90% since 1970 (ECCC 2017; Figure 4) in those largely rural areas covered by the BBS. Data from the most recent 14-year period (3 generations; 2002-2016) show a significant decline of 4.7% per year (CI: -6.9, -2.3), amounting to a total population loss of 49% since 2002 (ECCC 2017; Figure 5) in these areas. Rolling 14-year (short-term) trends are consistently in the range of -6% to -3.5% per year (Figure 5), suggesting that Canadian rates of decline are not changing to any great degree. For comparison, rolling 14-year (short-term) trends for the U.S. vary between -2% and -3%, and these rates of decline are becoming greater over time (Smith unpubl. data 2017).

Both long-term and short-term declines were statistically significant across all provinces except Manitoba (Table 1; ECCC 2017). In the U.S., 31 of 38 states (82%) had significant negative trends, averaging -2.5% (95% CI: -2.6, -2.3) annually across the country (Sauer *et al*. 2014).

Using BBS data, Michel *et al*. (2016) showed strong patterns of spatial concordance in population trends of Chimney Swift across North America. Significant declines were widespread, but were less severe in a wide swath of strata across the heavily industrialized 'Rust Belt' (a region stretching along the U.S. Atlantic coast between Virginia and New York, and extending west to Iowa and Minnesota, and north into southern Québec) compared to areas further north or south. Michel *et al*. (2016) proposed that this region, with its numerous industrial chimneys suitable for roosting, may have helped buffer Chimney Swift populations there somewhat from more severe declines experienced throughout the much of the range.

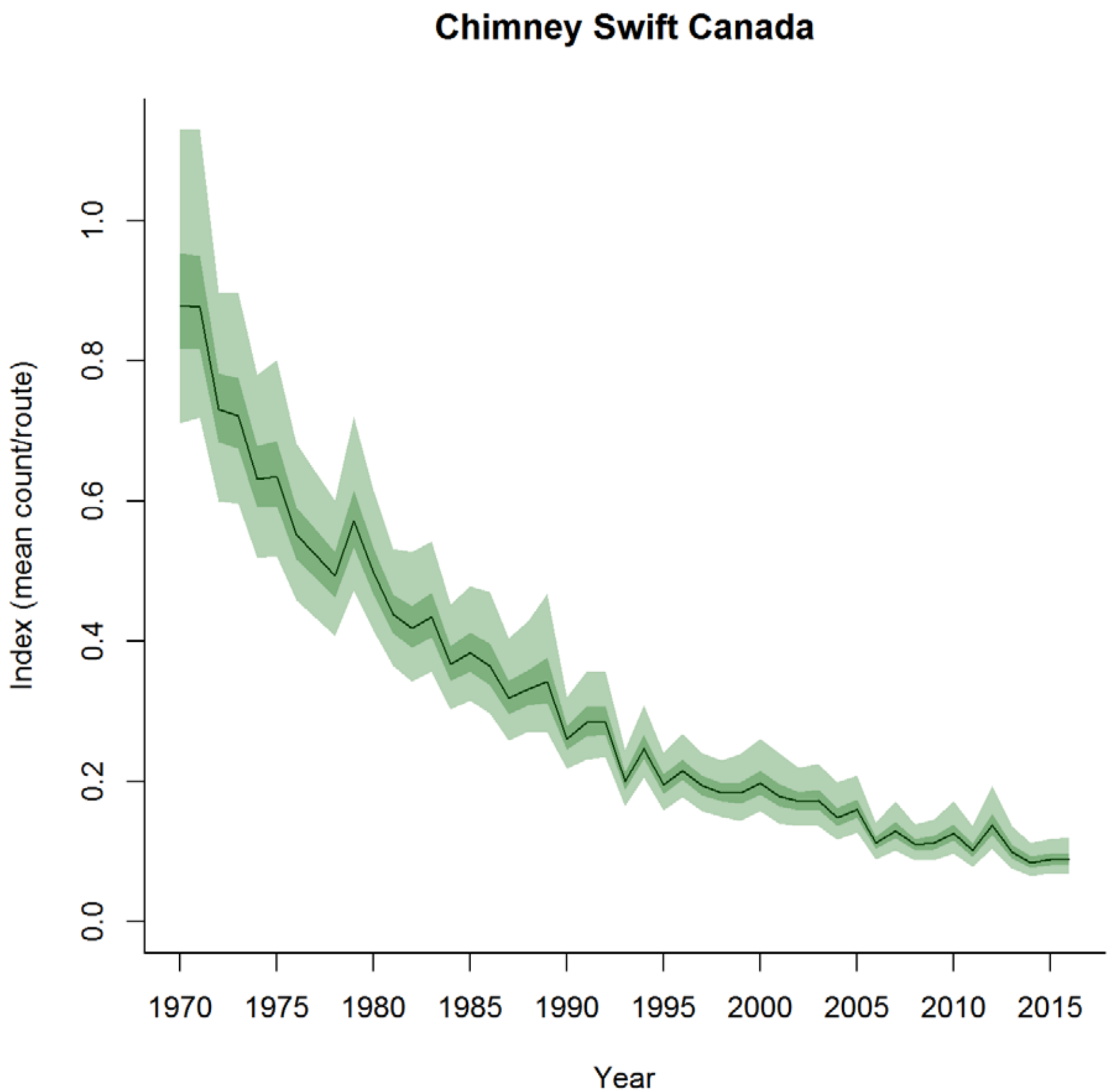

Figure 4. Annual index of Chimney Swift abundance in Canada between 1970 and 2016, based on Breeding Bird Survey data (ECCC 2017). Light and dark green shaded areas depict upper and lower 95% and 50% credible intervals, respectively.

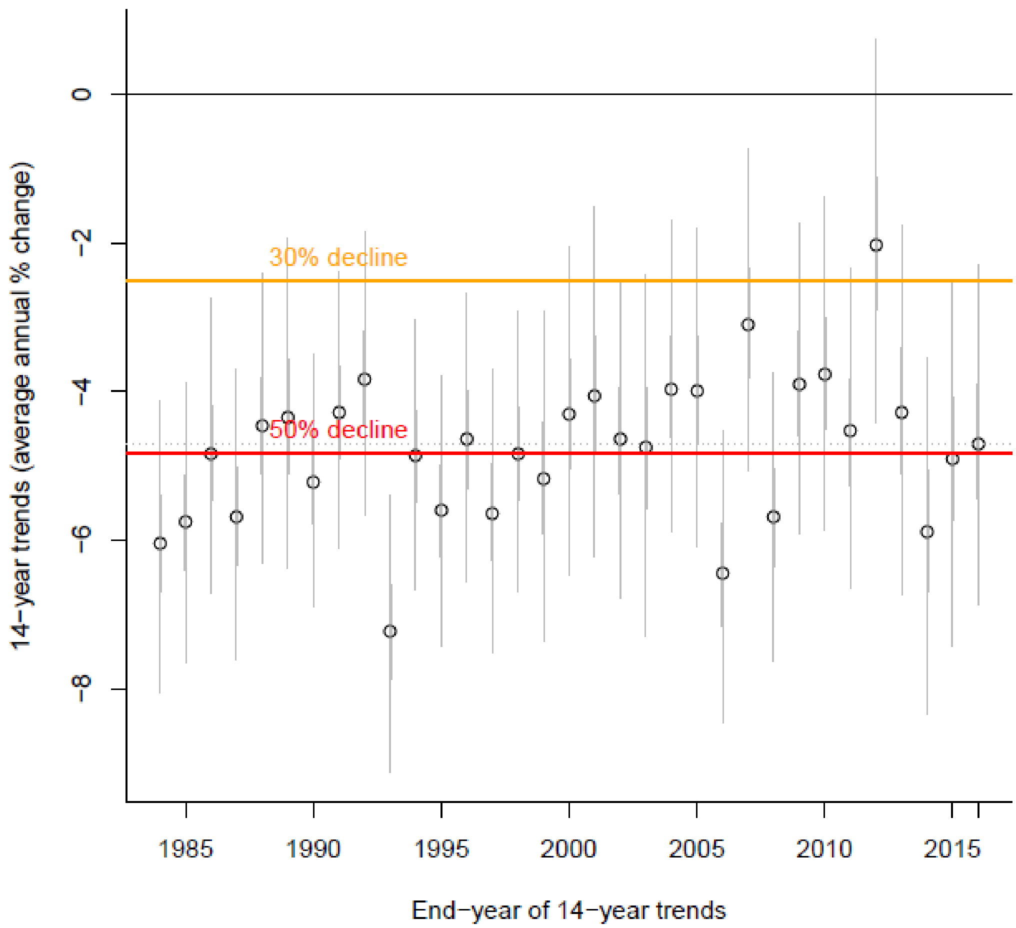

Figure 5. Rolling 14-year trends for Chimney Swift in Canada from 1970-1984 through to 2002-2016, based on Breeding Bird Survey data (A. Smith unpubl. data 2017). The vertical axis represents the last year of the 14-year rolling trend (e.g., 1984 is the trend for 1970-1984). Thick and thin grey vertical error bars depict 50% and 95% credible intervals, respectively. Orange and red horizontal lines depict 30% and 50% cumulative short-term decline rates, which represent COSEWIC criteria for assessing a species as Threatened and Endangered, respectively.

Another analysis of BBS data showed that the decline in many aerial insectivorous birds (including Chimney Swift) accelerated during the 1980s (Smith *et al*. 2015), similar to findings in Nebel *et al*. (2010).

Breeding Bird Atlases

Ontario

The statistical probability of observation of Chimney Swift significantly decreased by 46% in Ontario, during the 20-year period between first and second atlases (1981-1985 and 2001-2005; Cadman *et al*. 2007). Regionally, these declines were most pronounced in the Southern Shield (-58%), followed by Lake Simcoe-Rideau (-48%) and Carolinian (-32%) regions. Chimney Swift was recorded in 482 squares across Ontario during the second atlas, 61% fewer than in the first atlas (Figure 6), despite a 25% increase in survey effort in the second. However, most of the period over which this decline was documented preceded the last three-generation period (since about 2002).

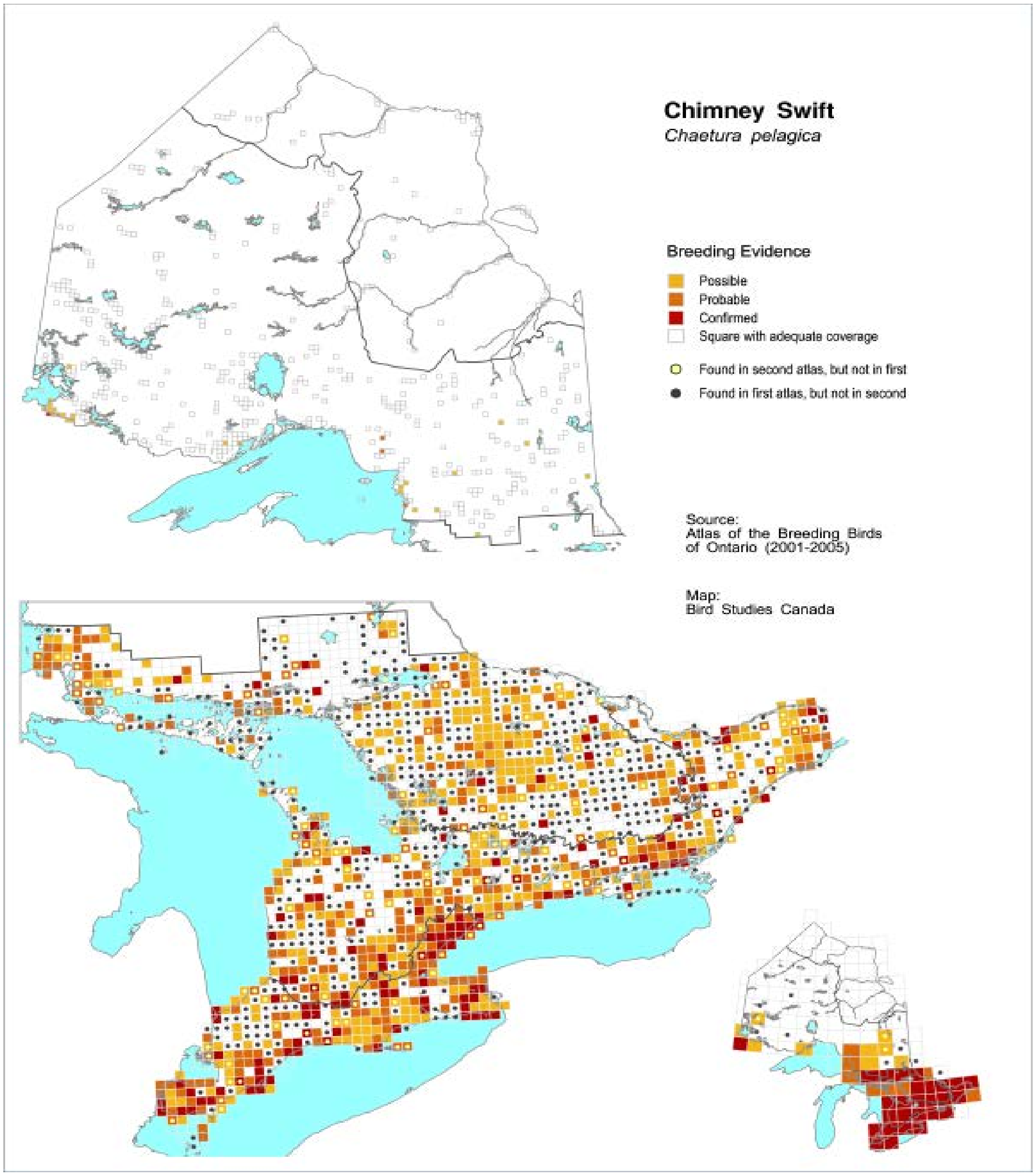

Figure 6. Chimney Swift breeding distribution in Ontario during 2001-2005, from the second Ontario Breeding Bird Atlas (Cadman *et al*. 2007). Black dots depict squares where Chimney Swifts were recorded during 1981-1985, but not in 2001-2005. Yellow dots depict squares where Chimney Swifts were not recorded during 1981-1985, but were in 2001-2005.

Maritime Provinces

Chimney Swift was observed in 178 squares during the second Maritimes breeding bird atlas (2006-2010), 38% fewer than in the first atlas (1986-1990; Figure 7; Stewart *et al*. 2015). Declines in the probability of observation were apparent across New Brunswick and Nova Scotia, and the species was found in two Prince Edward Island squares in the first atlas, but none in the second (Manthorne, in Stewart *et al*. 2015). Observer effort (hours), and the number of atlas squares surveyed were greater in the second atlas by 14% and 10%, respectively. However, much of the period over which this decline was documented preceded the last three-generation period.

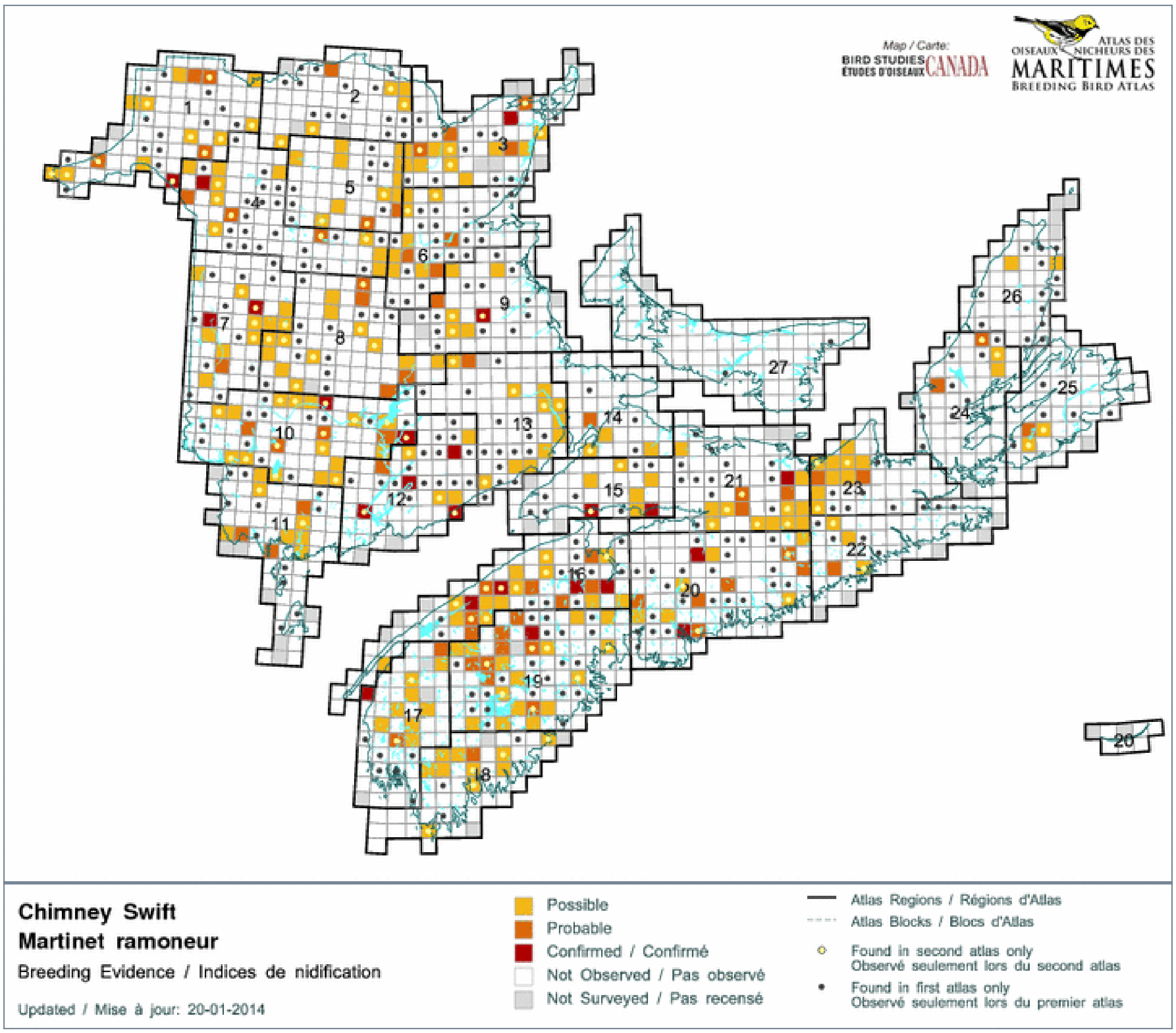

Figure 7. Chimney Swift breeding distribution in the Maritime Provinces during 2006-2010, from the second Maritimes Breeding Bird Atlas (Stewart *et al.* 2015). Black dots depict squares where Chimney Swifts were recorded during 1986-1990, but not in 2006-2010. Yellow dots depict squares where Chimney Swifts were not recorded during 1986-1990, but were in 2006-2010.

Québec

Chimney Swift was observed in 112 squares during the second Québec breeding bird atlas (2010-2014), 16% fewer than in the first atlas (1984-1989; QBBA 2016). The actual distributional loss is likely higher than this, as survey effort was substantially greater in the second atlas. Local extinctions appear to be evenly spread across southern Québec (Figure 8). However, much of the period over which this decline was documented preceded the last three-generation period.

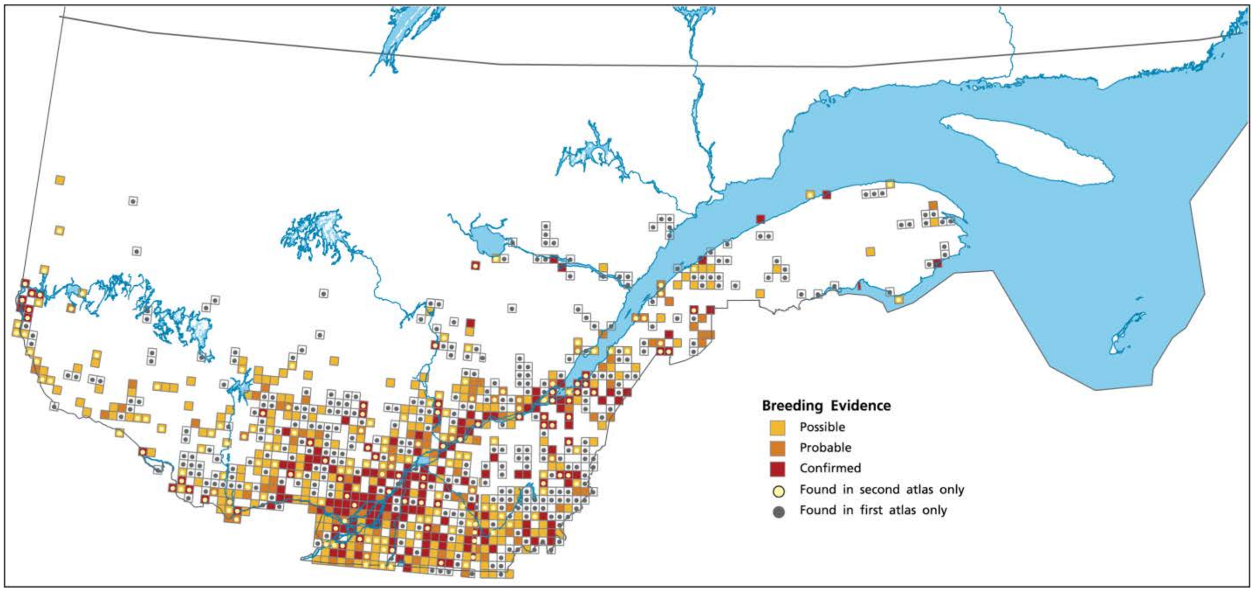

Figure 8. Chimney Swift breeding distribution in southern Québec during 2010-2014 (data source: Québec BBA. Map courtesy of A. Couturier, Bird Studies Canada). Black dots depict squares where Chimney Swifts were recorded during 1984-1989, but not in 2010-2014. Yellow dots depict squares where Chimney Swifts were not recorded during 1984-1989, but were in 2010-2014.

<u>Targeted Chimney Swift monitoring</u>

Population trends determined from targeted Chimney Swift surveys in Manitoba, Ontario, Québec and the Maritime Provinces vary. Spring trends for Ontario and Québec show statistically significant increases in the number of observed birds per chimney (Table 2; Figure 9). Fall trends are non-significant for all provinces (Table 2; Figure 10). Thus, contrary to other sources, these surveys indicate that the number of roosting birds in spring is either stable or increasing over the last 4-10 years. Interestingly though, in both Ontario and Québec, spring roost size is (significantly) increasing while fall roost size is (non-significantly) decreasing. Although it is unclear what is driving these patterns, spring roosts may appear to be stable or increasing due to maintenance of or increases in the floater population (rather than the breeding population) over this trend period (i.e., about 2 generations). Fall declines may represent a tendency for decreased recruitment rates over this period. Ongoing targeted monitoring is needed to explore these patterns further, and careful interpretation of these trends is advised (see **Sampling Effort and Methods**).

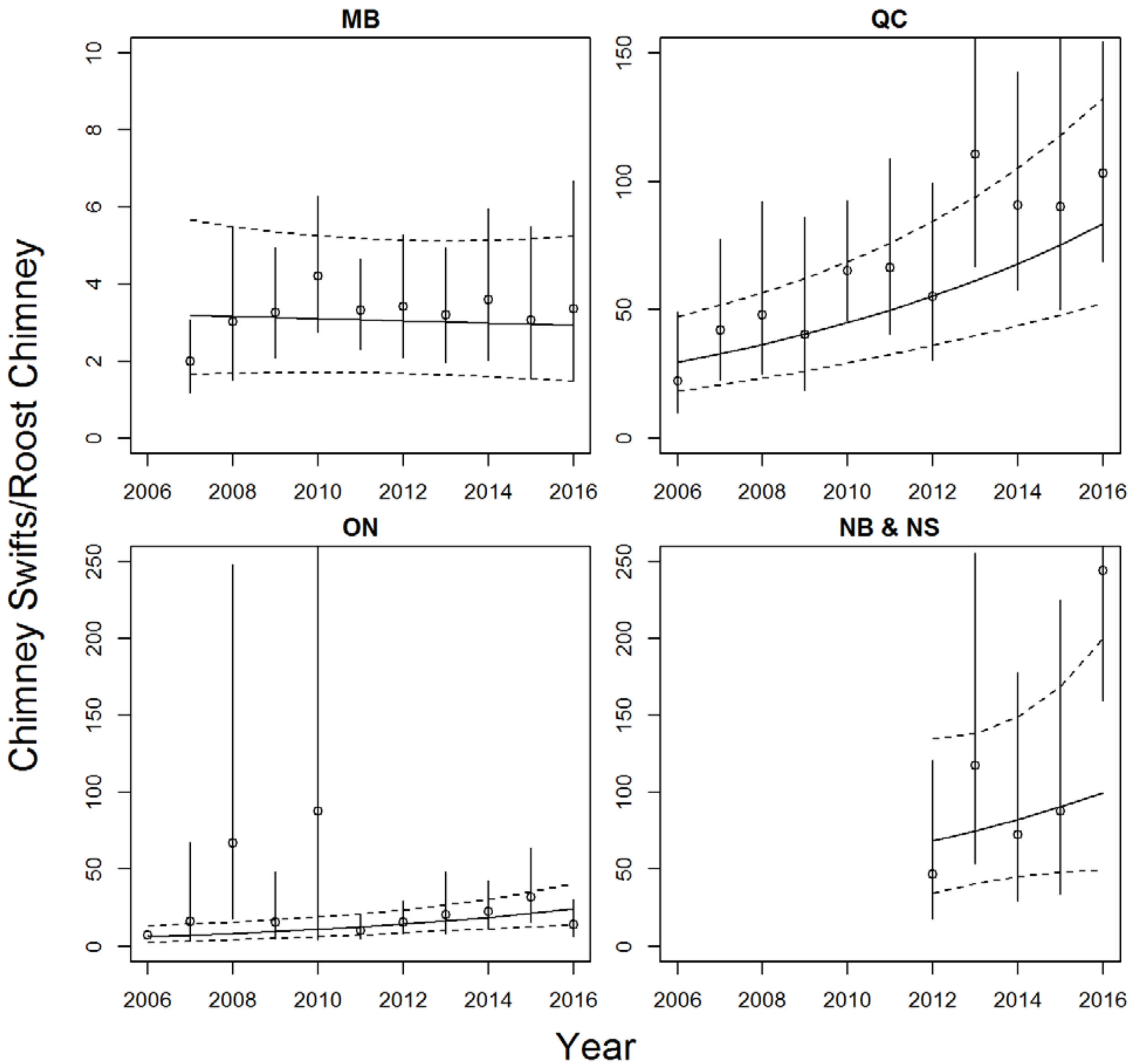

Figure 9. Regional spring population trends for Chimney Swift, based on targeted roost monitoring surveys in Manitoba, Québec, Ontario and the Maritimes (New Brunswick and Nova Scotia). Trend periods are 10 years for Ontario and Québec, 9 years for Manitoba, and 4 years for the Maritimes. Dashed lines represent 95% confidence limits of the linear trend. Points and vertical error bars show mean annual counts of birds per roost chimney, with 95% confidence intervals.

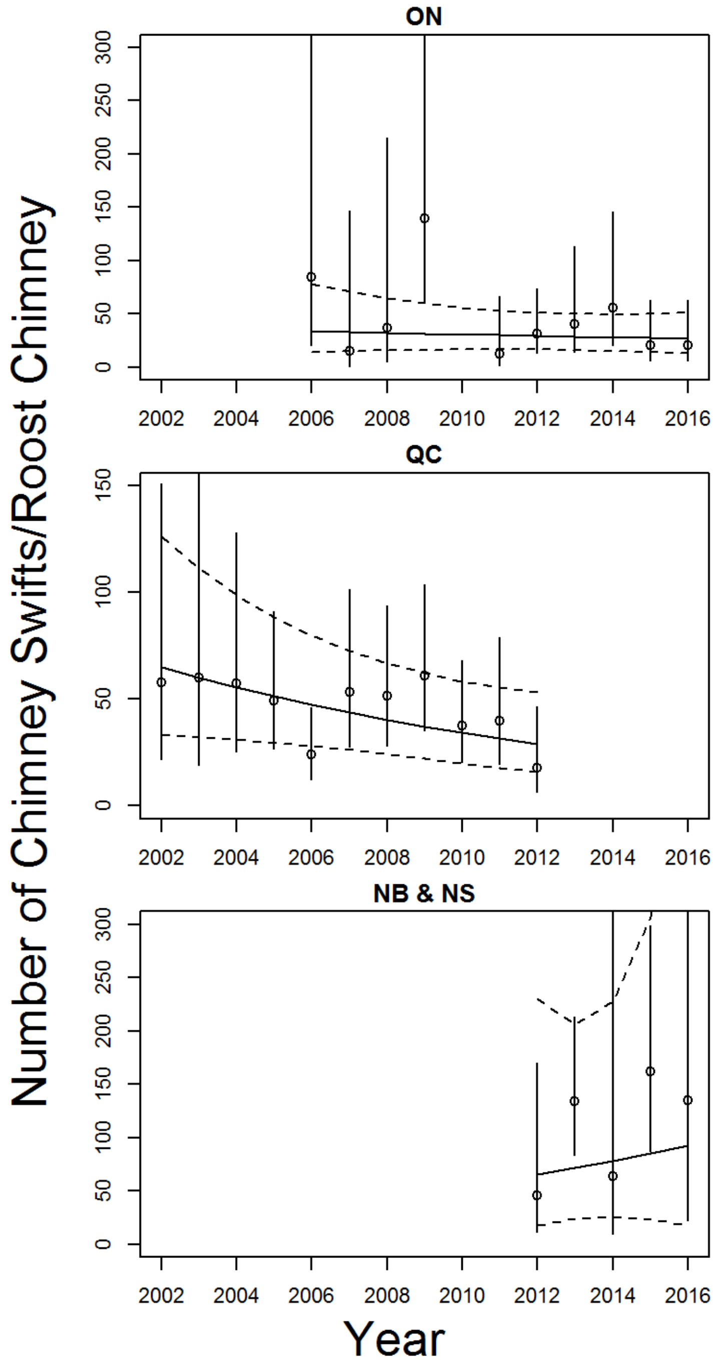

Figure 10. Regional fall population trends for Chimney Swift, based on targeted roost monitoring surveys in Ontario, Québec and the Maritimes (New Brunswick and Nova Scotia). Trend periods are 10 years for Ontario and Québec, and 4 years for New Brunswick and Nova Scotia (combined). Dashed lines represent 95% confidence limits of the trend. Points and vertical error bars show mean annual counts of birds per roost chimney, with 95% confidence intervals.

Canadian Migration Monitoring Network - Réseau canadien de surveillance des migrations (CMMN-RCSM)

Long-term (1968-2014) trends at LPBO indicate a non-significant increase of +2.3% per year in the number of migrating Chimney Swift during both spring and fall periods. Short-term (2004-2014) trends at LPBO indicate non-significant increases of 0.1% per year in spring, and non-significant declines of -10% per year during fall. Short-term (2004-2014) trends for PIBO indicate significant declines of -16% and -19% per year for spring and fall periods, respectively. These data indicate there are some regional or local differences in trends. More station trends are needed to explore regional patterns in trends.

Rescue Effect

The Chimney Swift population in the U.S. is about 100 times the size of the Canadian population (Blancher *et al*. 2013). U.S. BBS trend data indicate statistically significant declines of -2.4% per year from 1970 to 2016, and -2.8% per year from 2002 to 2016 (ECCC 2017). BBS trend data indicate that Chimney Swift populations in most states bordering Canada, which would be most likely to serve as source populations for rescue, are experiencing widespread declines. Short-term trends show significant declines in Maine, New York, Ohio, and Pennsylvania, non-significant declines in New Hampshire, Wisconsin, Minnesota, and Michigan, and non-significant increases in Vermont and North Dakota. Breeding Bird Atlas data from New York, Michigan, Pennsylvania, Vermont, and Ohio consistently show evidence of substantial reductions in the area of occupancy for Chimney Swift (McGowan and Corwin 2008; Chartier *et al*. 2011; Wilson *et al*. 2012; Renfrew 2013; Rodewald *et al*. 2016).

Despite the presence of the much larger U.S. Chimney Swift population, continuing population declines across the northern U.S. suggest that there is little potential for rescue from the U.S., unless population declines there are reversed in the future and dispersal movements are sufficiently extensive.

THREATS AND LIMITING FACTORS

Chimney Swift is part of a guild of aerial insectivores, together with swallows, nightjars, and flycatchers, which is experiencing significant population declines throughout Canada (Nebel *et al.* 2010; Sauer *et al.* 2014; Smith *et al.* 2015; ECCC 2017). Numerous factors have been proposed as possible explanations for the recent population declines of aerial insectivores, many of which are related to changes in the availability of insect prey (Nebel *et al.* 2010; Calvert 2012). They are outlined below.

Threats

Chimney Swifts breeding in Canada are likely affected by the cumulative impacts of threats experienced on the breeding grounds, during the post-breeding dispersal period, during spring and fall migration, and while over-wintering in South America. Threats to

Chimney Swift reviewed below are categorized following the IUCN-CMP (International Union for the Conservation of Nature – Conservation Measures Partnership) unified threats classification system, based on the standard lexicon for biodiversity conservation of Salafsky *et al.* (2008). They are presented in decreasing order of severity of impact, ending with those for which scope or severity is unknown. The assigned overall threat impact is High (see **Appendix 1** for details).

7.0 Natural system modifications (High-Medium)

7.3 Other ecosystem modifications.

As reproductive success of insectivorous birds is correlated with insect abundance (Strehl and White 1986: Rodenhouse and Holmes 1992: Marshall *et al*. 2002), this factor can limit their population growth rate (Martin 1987; Boutin 1990). Use of pesticides to control pest insects, weeds, and fungi is widespread globally. Pesticides can be transported over long distances in air or water, and many are relatively volatile, evaporating quickly after application and dispersing in the atmosphere (Poissant and Koprivnjak 1996). Reduced abundance of aerial insects may result from pesticide use in agricultural, forested, or urban areas (Scott-Dupree *et al.* 2009; Van Dijk 2010), with indirect effects on Chimney Swift populations.

Pesticide use in South American countries has been rapidly increasing over the last several decades (Schreinemachers and Tipraqsa 2012). Nocera *et al*. (2014) found that the amount of money spent on insecticides was a good predictor of the index of abundance of aerial insectivores throughout the non-breeding range (i.e., Central and South America). Nocera *et al*. (2012) documented a significant change in the diet of Chimney Swift (a decrease in Coleoptera and an increase in Hemiptera) associated with heavy DDT use in the 1950s, which may have resulted in nutritional costs for swifts. This shift in prey was similar to that reported in a similar study of Vaux's Swifts in British Columbia (Pomfret *et al*. 2012). Furthermore, Erskine (1992) expressed concern that aerial spraying for fenitrothion to control spruce budworm (*Choristoneura fumiferana*) outbreaks in New Brunswick, from 1952 to 1993, may have reduced flying insect numbers and affected the Chimney Swift population in the province. Even relatively "eco-friendly" insecticides (e.g., *Bacillus thuringiensis israelensis* [*Bti*]) have been shown to reduce reproductive success in aerial insectivores, such as House Martins (*Delichon urbicum*; Poulin *et al.* 2010). The role of neonicotinoid pesticides in the decline of aerial insect prey should also be carefully considered due to the pesticide's systemic nature, uptake into non-targeted environments, and persistence in soil and aquatic systems (Van Dijk 2010; Mason *et al*. 2013; Van Dijk *et al*. 2013; Morrissey *et al*. 2015).

Filling or drainage of wetlands for mosquito control, or targeted spraying of insecticides for the same purpose, in Chimney Swift's breeding, migratory, and wintering areas may lead to decreases in aquatic emergent insect availability, and as a result, reduced food availability for swifts. Wetland filling was commonly used as a long-lasting mosquito control technique in North America, especially near urban areas. However, this practice is apparently now less common, due to increased awareness of negative impacts of wetland loss and stricter permitting requirements in many jurisdictions (Rey *et al.* 2012).

<u>1.0 Residential and commercial development (Medium)</u>

1.1 Housing and urban areas, and 1.2 Commercial and Industrial areas.

Chimney Swift is abundant in urban areas, where it depends on human-made structures (e.g., chimneys) for nesting and roosting. As a consequence, Chimney Swift is highly susceptible to habitat loss and degradation when chimneys are demolished or modified (e.g., screened, capped or lined). The loss of suitable open chimneys in housing and urban buildings (e.g., on schools, churches, apartment and commercial buildings) is a widespread and ongoing threat (see **Habitat Trends** section), with the growing use of electrical and natural gas heating sources that do not use chimneys (Fitzgerald *et al.* 2014). Furthermore, many municipalities require that active chimneys (i.e., those used for heating) have spark arresters and that inactive chimneys be closed or capped (Lamoureux 2012), and building owners may prevent Chimney Swift from accessing chimneys to comply with home insurance policies (Manthorne 2013). Capping chimneys or installing metal liners during the nesting season may also result in swifts becoming trapped (Manthorne 2013). The installation of metal liners without properly fitting spark arrestors may also result in a Chimney Swift entering a flue and becoming trapped there (Manthorne 2013).

Several studies have assessed the availability of suitable nesting chimneys for Chimney Swift, based on the dimensions and modification characteristics of existing chimneys. In North Carolina, only 20% of chimneys surveyed were available and suitable for use by swifts (Mordecai 2008). A study in southern Ontario found that only 25% of suitable chimneys were occupied by Chimney Swift, suggesting that nest site availability is not currently a limiting factor in that portion of the swifts' range (Fitzgerald *et al*. 2014). In Connecticut, 45% of suitable chimneys surveyed were occupied by swifts (Kearney-McGee 2012). Subsequent visits to those sites between 2008 and 2011 revealed that chimneys were being capped at a rate of 5% per year (Kearney-McGee 2012). Chimney availability may not currently be the main limiting factor for breeding swifts in all parts of the range, but the supply of suitable chimneys is finite and declining. The number of sites suitable for roosting and nesting is projected to continue to decline over the next few decades, with relatively few sites remaining 15 years from now (Gauthier *et al*. 2007) (see **Habitat Trends** section).

Due to their dependence on aerial insects, loss or degradation of insect-producing habitat may negatively affect Chimney Swift productivity. Wetlands and aquatic habitats support emergent aquatic insects consumed by swifts (e.g., mayflies, stoneflies; Steeves *et al.* 2014), and thus wetland drainage or filling for residential and commercial development may result in reduced insect prey availability for this species. In southern Canada and the U.S., wetland loss and degradation is ongoing, especially in areas with dense human populations (Bedford 1999; Gibbs 2000). For example, over 85% of the original wetlands in southwestern Ontario have been lost, in part due to conversion of wetlands to built-up land for residential and commercial development (Ducks Unlimited 2010).

5.0 Biological resource use (Low impact)

5.3 Logging and wood harvesting.

Loss of mature, old-growth forest through logging, as well as removal of dead, hollow trees for human safety, may result in reduced availability of natural nesting sites in hollow trees and tree cavities. Chimney Swift appears to require trees greater than 50 cm DBH for nesting and roosting, although suitable trees of this size are now uncommon in most forests within Chimney Swift breeding range (Zanchetta *et al*. 2014). Short rotation periods in harvested stands do not allow trees to attain the size and age required for development of extensive heart rot and hollow cavities for use by nesting and roosting swifts (Savignac and Machtans 2006; Tozer *et al*. 2012). However, Ontario's Tree Marking Guide (Ontario Ministry of Natural Resources 2004) currently directs tree markers in partial harvest systems to retain trees with Pileated Woodpecker cavities, as well as super-canopy trees which normally contain heart rot, thus providing some potential Chimney Swift nesting or roosting habitat. It is unknown whether the current supply of trees suitable for nesting and roosting is sufficient to compensate for ongoing loss of chimneys (Zanchetta *et al*. 2014), or whether the availability of hollow trees and tree cavities in managed forests may be limiting Chimney Swift populations.

Because Chimney Swift also roosts in hollow trees in its South American winter range (Brackbill 1950), the species is likely threatened by intensive logging and fires in the Amazon forest. However, information on effects of wood harvesting in the winter range is not available. In addition, large quantities of pesticides are often used to control insects after forests are cleared for farmland, which may further impact swifts (Gauthier *et al*. 2007).

6.0 Human intrusions and disturbance (Low impact)

6.3 Work and other activities.

Chimney cleaning may be a threat to Chimney Swift during its nesting period, and public misunderstanding and concerns about swifts may result in incidental or intentional removal of nests during cleaning. Swifts may be confused with more problematic bird species, such as the European Starling, leading to intentional removal of swift nests (COSEWIC 2007). A survey of 10 professional chimney sweeps in the Maritimes indicated that most maintenance occurs during the fall (September to November), when it would not impact nesting swifts (Lightfoot 2014). However, cleaning may occur at almost any time of year, and surveys conducted in Québec revealed that some municipalities often requested chimney sweeping to occur during the summer (i.e., during the breeding season; Lang and Perreault 2016).

Swifts roosting in chimneys may occasionally die from asphyxiation or burning when chimneys are used for heating in cold weather (Deane 1908). Many birds may be killed in a single roost; for example, Musselman (1931) reported that 3,000-5,000 swifts died one October in an Illinois chimney. Additionally, some chimneys are used for heating or other purposes during the breeding period, preventing their use by swifts for nesting or potentially destroying nests or killing adults.

9.0 Pollution (Unknown)

9.3 Agriculture and forestry effluents.

The direct effect of pesticides used in agriculture and forest industries on insectivorous birds varies depending on the class of chemicals. Organophosphates and carbamates are well known to cause acute poisoning and sub-lethal effects to birds. Bishop *et al.* (2000) showed that Tree Swallows (*Tachycineta bicolor*) breeding in orchards using these conventional pesticides exhibit reduced egg fertility, hatching success, and fledging success. Although systemic pesticides (e.g., neonicotinoids) are considered relatively safe to insectivorous birds, population declines in insectivorous birds were more significant in areas with higher surface-water concentrations of imidacloprid, a widely-used neonicotinoid (Hallman *et al.* 2014). Acute exposure to neonicotinoid and organophosphate insecticides has been shown to reduce migratory ability in a seed-eating bird (Eng *et al.* 2017).

9.5 Airborne pollutants.

Exposure to persistent organic pollutants, heavy metals, and acid precipitation in the environment may cause deleterious effects to Chimney Swift populations. Identifying sources of specific pollutants is problematic as many are air-borne and travel long distances from emission sources, and Chimney Swift can be exposed to pollutants anywhere within their large range due to their migratory behaviour. Despite this, current evidence for an impact of pollution on Chimney Swift populations is speculative.

Mercury contamination and bioaccumulation poses a serious concern for wildlife health. Most studies of mercury contamination tend to ignore small insectivorous birds, but some evidence suggests they often have heavy mercury burdens comparable to levels in fish-eating birds (Seewagen 2010; Jackson *et al.* 2011). There is strong evidence to suggest that mercury exposure can reduce reproductive success, compromise immune function, and cause avoidance of high-energy behaviours in birds (Brasso and Cristol 2008; Whitney and Cristol 2017).

11.0 Climate change and severe weather (Unknown)

Changes in climate and weather patterns will likely have widespread and long-lasting effects on Chimney Swift populations in Canada. However, the impacts of these changes and the time-frames over which they may operate are largely uncertain.

Aerial insectivores are particularly sensitive to temperature variations, which directly affect insect abundance and availability. Climate warming may lead to dynamic shifts in the community composition and phenology of aquatic emergent insects (Jonsson *et al.* 2015). This could result in a mismatch (i.e., differences in timing) between energy requirements of Chimney Swift and its young and peak availability of insect food (Both *et al.* 2006; Calvert 2012), although evidence of such a mismatch is lacking for aerial insectivores (Dunn *et al.* 2011).

Cold, rainy weather events lasting 2-3 days are known to cause mortality in swifts and swallows, due to the reduction in the availability of airborne insects (Walker 1944; Elkins 1988). For instance, 109 swifts were found dead on the hearth of the François Pilote Museum chimney in La Pocatière, Québec on 23 May 1990, apparently killed by low temperatures, snow, and their effect on flying insects (Aubry *et al*. 1990). Between 1999 and 2003, a video camera installed at the tower in Lévis, Québec confirmed that swifts did not venture out of the chimney to forage during periods characterized by consecutive days of cold and rain (COSEWIC 2007).

Temperature and precipitation may also have a direct impact on Chimney Swift breeding success (Chantler 1999), and heavy rain can detach nests from chimney interior walls, destroying eggs and nestlings (Dexter 1952, 1960, 1969; Kyle and Kyle 2005). However, the young may occasionally survive and climb back up the wall, where the parents continue to feed them (Dexter 1952, 1960, 1985). Stewart and Stewart (2013) found that breeding success rates were lowest in years (2011 and 2012) that had extreme weather patterns (e.g., consecutive days of continuous rain, extended periods of extreme heat, high humidity, and strong winds).

Climate change could also affect the frequency, intensity, and trajectories of hurricanes. The mean annual number of major fall storms in eastern North America between 1995 and 2005 (13 storms/year) was markedly higher than the mean for an earlier, slightly longer time period (1970-1994; 8.6 storms/year; NOAA 2005). Fall storms are particularly damaging to swift populations, as they often occur during periods of southbound migration. In October 2005, more than 2,000 Chimney Swifts were pushed north from staging areas into Atlantic Canada (Nova Scotia, New Brunswick, and Newfoundland), Saint-Pierre and Miquelon (France), and Maine (USA) by Hurricane Wilma (Dionne *et al.* 2008). In addition, at least 700 swifts were found dead in the Maritimes after the same hurricane, either from excessive loss of body weight or indirectly by seeking shelter in chimneys currently in use for heating (Dionne *et al*. 2008).

Temperature extremes and the increased frequency in freeze-thaw cycles could cause considerable damage and accelerated erosion to stone or brick chimneys, leading to increased loss of nesting and roosting habitat sites (Gauthier *et al.* 2007).

Limiting Factors

In many respects, Chimney Swift is a specialized species that lacks the flexibility to respond effectively to many changes in the environment. This aerial forager is highly adapted morphologically to feeding on insects within the air column while on the wing, and rarely exhibits alternate foraging methods (Sutton 1928; Macbriar 1963). Swifts display extreme sensitivity to fluctuations in weather features, which affect the birds themselves as well as food availability. Few alternatives for nesting and roosting habitat exist when suitable chimneys, structures, or natural tree cavities are unavailable for swifts. Given their specific characteristics, such as relatively low reproductive potential, high breeding site fidelity of adults, and vulnerability to localized threats, swift populations have a relatively limited capacity for quick recovery following large mortality events or continued loss of nest sites.

Number of Locations

The number of locations of this species in Canada cannot be quantified, although it is much higher than the COSEWIC threshold of 10. This species is dispersed in many sites across multiple jurisdictions, and the most serious threats faced in Canada are likely site-based factors caused by thousands of individual landowners.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Chimney Swift is protected under the *Migratory Birds Convention Act* (MBCA; S.C. 1994, c. 22), and is currently listed as Threatened in Canada under the *Species at Risk Act* (SARA; S.C. 2002, c. 29). SARA prohibits damaging or destroying individuals of Chimney Swift and its residences, regardless of where they are located in Canada. Under the MBCA, it is illegal to disturb, destroy, or take a nest or egg of Chimney Swift anywhere in Canada. A national SARA Recovery Strategy for Chimney Swift in Canada is in preparation.

Chimney Swift is listed as Threatened under the *Manitoba Endangered Species and Ecosystems Act* (C.C.S.M. c. E111); Threatened under the *Ontario Endangered Species Act* (S.O. 2007, c. 6); Threatened under the *New Brunswick Species at Risk Act* (SNB 2012, c 6); and Endangered under the *Nova Scotia Endangered Species Act* (S.N.S. 1998, c. 11). In Québec, this species is protected under the *Act Respecting the Conservation and Development of Wildlife* (RSQ, c C-61.1) and is also included in the *Liste des espèces susceptibles d'être désignées menacées ou vulnérables,* which is developed according to the "*Loi sur les espèces menacées ou vulnérables*" (RLRQ, c E-12.01) (LEMV). Chimney Swift is also protected in Saskatchewan under the *Wildlife Act* (1998) and in New Brunswick under the *New Brunswick Fish and Wildlife Act* (S.N.B. 1980, c. F-14.1).

Chimney Swift is not listed or considered as a candidate for listing under the *U.S. Endangered Species Act* (US Fish and Wildlife Service (USFWS) 2016), but is granted protection in the U.S. under the *Migratory Birds Treaty Act (1918)*.

Non-Legal Status and Ranks

Globally, Chimney Swift is considered Near Threatened according to the IUCN Red List of Threatened Species (IUCN 2017) and is ranked as Apparently Secure (G4) by NatureServe (2017). It is also recognized as a Common Bird in Steep Decline by Partners in Flight (Rosenberg *et al*. 2016).

Nationally, Chimney Swift is considered Secure (N5B) in the United States (NatureServe 2017) and has been identified as a Regional Species of Greatest Conservation Need in the USFWS - Northeast Region (Northeast Fish and Wildlife Diversity Technical Committee 2015).

In Canada, this species is considered Apparently Secure (N4B) (NatureServe 2017). At the subnational level, it is ranked as Imperilled (S2B) in Manitoba, Imperilled/Vulnerable (S2S3B) in New Brunswick and Nova Scotia, Apparently Secure (S4B,S4N) in Ontario, Imperilled/Vulnerable (S2S3) in Québec, and Imperilled (S2B) in Saskatchewan (NatureServe 2017).

Habitat Protection and Ownership

In Nova Scotia, some of the more well-known roosting sites (e.g., in Wolfville, NS) are under the protective care of local volunteers, and written stewardship agreements, although not legally binding, are in place for many roosting chimneys in the Maritime provinces (Manthorne pers. comm. 2017). There are no specific arrangements in place for the conservation of chimney roost and nest sites. In those provinces with a Chimney Swift monitoring program, some building owners are aware of the presence of swifts, and stewardship efforts are sometimes undertaken to maintain the availability of chimneys.

In Québec, Regroupement QuébecOiseaux undertook an initiative to contact the owners of chimneys being used by swifts. A total of 183 managers were informed about the presence of swifts in their building by telephone or in person, and the majority (86%) agreed to cooperate in protecting the sites (50% verbally and 36% signed a letter of intent; Lang and Perreault 2016). The Ottawa Stewardship Council mailed information packages to 22 landowners with Chimney Swift habitat sites in Ottawa, Ontario, in 2011, but only received a response from one landowner (Ottawa Stewardship Council 2011). In London, Ontario, Nature London gave stewardship information and certificates of appreciation to landowners of 38 chimneys with swifts. Twenty-three of these chimneys (61%) are still available for swifts, but 15 (39%) of the chimneys have been capped or demolished since receiving a certificate (Wake 2017). In fact, chimneys that did not receive a certificate of appreciation had a higher survival rate than chimneys that did. Of 101 swift-occupied chimneys that did not receive certificates, 73 (72%) are still available to swifts and 28 (28%) have been capped or demolished (Wake 2017). In New Brunswick and Nova Scotia, Bird

Studies Canada attempted to contact owners of 94 sites known to have been used by swifts at least once. Contact was made by telephone, email, or an in-person meeting with 68 landowners (72% of sites). Of those 68 landowners, 51 (75%) agreed to cooperate in protecting the habitat (Manthorne pers. comm. 2017).

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List of Authorities Contacted

Nicholas Bayly, Coordinador Especies Migratorias - Migratory Species Manager, SELVA: Investigación para la Conservación en el Neotropico, Bogotá, Colombia.

Ron Bazin, Species at Risk Biologist, Canadian Wildlife Service, Stewardship Unit, Environment and Climate Change Canada, Winnipeg, Manitoba.

Andrew Boyne, Head - Species at Risk Recovery Unit, Canadian Wildlife Service, Environment and Climate Change Canada, Dartmouth, Nova Scotia.

Josée Brunelle, Analyst, Hunting, Fishing and Trapping Coordinating Committee, Montréal, Québec.

Mike Cadman, Songbird Biologist, Canadian Wildlife Service, Environment and Climate Change Canada, Burlington, Ontario.

Ken De Smet, Species at Risk Specialist, Wildlife and Ecosystem Protection Branch, Manitoba Department of Conservation and Water Stewardship, Winnipeg, Manitoba.

Alain Filion, Scientific and GIS Project Officer, COSEWIC Science Support, Canadian Wildlife Service, Environment and Climate Change Canada, Gatineau, Québec.

Chris Friesen, Coordinator, Manitoba Conservation Data Centre, Winnipeg, Manitoba.

Isabelle Gauthier, Biologiste, Ministère des Forêts, de la Faune et des Parcs, Québec. Québec.

Michel Gosselin, Collection Manager (Birds), Canadian Museum of Nature, Ottawa, Ontario.

Colin Jones, Provincial Arthropod Zoologist, Ontario Natural Heritage Information Centre, Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario.

Neil Jones, Scientific Project Officer and ATK Coordinator, COSEWIC Secretariat, Canadian Wildlife Service, Environment and Climate Change Canada, Gatineau, Québec.

John Klymko, Zoologist, Atlantic Canada Conservation Data Centre, Sackville, New Brunswick.

Amy-Lee Kouwenberg, Acting Coordinator, Maritimes SwiftWatch, Bird Studies Canada, Sackville, New Brunswick.

Stéphane Légaré, Head, Terrestrial Unit, Canadian Wildlife Service, Environment and Climate Change Canada, Québec, Québec.

Allison Manthorne, Coordinator, Maritimes SwiftWatch, Bird Studies Canada, Sackville, New Brunswick.

Arne Moores, Professor, Simon Fraser University, Burnaby, British Columbia.

Patrick Nantel, Office of the Chief Ecosystem Scientist, Parks Canada, Gatineau, Québec.

Joe Nocera, Assistant Professor, Forestry and Environmental Management, University of New Brunswick, Fredericton, New Brunswick.

Annie Paquet, Centre de données sur le patrimoine naturel du Québec, Ministère des Ressources naturelles et de la Faune de Québec, Québec, Québec.

Geneviève Perreault, Biologist, Regroupement QuébecOiseaux, Montréal, Québec.

Karen Potter, Wildlife Biologist, Canadian Wildlife Service, Environment and Climate Change Canada, Dartmouth, Nova Scotia.

Scott Reid, Research Scientist, Aquatic Biodiversity and Watersheds Unit, Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario.

Rich Russell, Wildlife Biologist, Canadian Wildlife Service, Environment and Climate Change Canada, Ottawa, Ontario.

Mary Sabine, Biologist, Species at Risk Program, Fish and Wildlife Branch, Department of Energy and Resource Development, Fredericton, New Brunswick.

François Shaffer, Biologist, Canadian Wildlife Service, Environment and Climate Change Canada, Québec, Québec.

Adam C. Smith, Senior Biostatistician, National Wildlife Research Centre, Canadian Wildlife Service, Environment and Climate Change Canada, Ottawa, Ontario.

Tanya Taylor, Information Analyst, Natural Heritage Information Centre, Ministry of Natural Resources and Forestry, Peterborough, Ontario.

Peter Thomas, Wildlife Biologist – Landbirds, Canadian Wildlife Service, Environment and Climate Change Canada, Sackville, New Brunswick.

Jenny Wu, Scientific Project Officer, COSEWIC Science Support, Canadian Wildlife Service, Environment and Climate Change Canada, Gatineau, Québec.

Greg Wilson, A/Head – Conservation Planning Unit, Canadian Wildlife Service, Environment and Climate Change Canada, Edmonton, Alberta.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Kristyn Richardson is a Stewardship Biologist with Bird Studies Canada (BSC). She has seven years of experience working on aerial insectivore conservation and bird species at risk recovery in Ontario. She completed her Master of Natural Resources Management at the University of Manitoba, studying the forest management advisory committee process in Canada. Richardson is an author on the Recovery Strategies for both the Barn Swallow and Bank Swallow in Ontario. She coordinated and conducted Chimney Swift monitoring in Ontario from 2010 to 2015.

Myles Falconer is a Senior Project Biologist with BSC and has 15 years of professional experience working as an ornithologist. He completed his Master of Science at Trent University examining habitat quality differences in the breeding ecology of Eastern Wood-Pewee in deciduous forests and conifer plantations. Since 2010, Falconer has led BSC research and monitoring projects on aerial insectivores, most notably on Bank Swallows. He is the lead author of the COSEWIC Bank Swallow Status Report and the Bank Swallow Recovery Strategy in Ontario.

Liz Purves is a Project Biologist with BSC and has two years of experience coordinating the Ontario SwiftWatch program. She has worked as a biologist on other aerial insectivore projects, including Barn Swallow, Bank Swallow, and Eastern Whip-poor-will research projects. She completed her Master of Science at Queen's University, investigating the role of habitat loss in the decline of Eastern Whip-poor-will populations in Canada.

COLLECTIONS EXAMINED

No collections were examined in the preparation of this report.

Appendix 1. Threat Calculator results for the Chimney Swift.

THREATS ASSESSMENT WORKSHEET

Species or Ecosystem Scientific Name	**Chimney Swift** *Chaetura pelagica*
Element ID	
Elcode	
Date:	24/07/2017
Assessor(s):	Kristyn Richardson, Liz Purves and Myles Falconer (writers); Richard Elliot (COSEWIC Birds SSC Co-chair); Mary Sabine (NB); François Shaffer and Celine Maurice (CWS Québec Region), Mike Cadman and Ken Tuininga (CWS Ontario Region), Karen Potter (CWS Atlantic Region), Amy-Lee Kouwenberg (BSC), Winnie Wake, Dwayne Lepitzki (Facilitator), Joanna James (COSEWIC Secretariat)
References:	

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	low range
A	Very High	0	0
B	High	1	0
C	Medium	1	2
D	Low	2	2
	Calculated Overall Threat Impact:	High	High

Assigned Overall Threat Impact:	**B = High**
Impact Adjustment Reasons:	An overall threat impact of High predicts a population decline of 10-70% over the next 10 years, without considering the unknown impact of climate change.
Overall Threat Comments	The generation time for Chimney Swift is 4.5 years, therefore the time period for this threats calculator is 13.5 years. A consideration when considering scope is that there are more breeding Chimney Swifts in southern Ontario, southern Québec, New Brunswick and Nova Scotia than in the Prairie provinces.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development	C	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	Cumulative scope from 1.1 & 1.2.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.1	Housing & urban areas	D	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)	Reduced productivity due to ongoing loss of roosting or nesting sites, as a result of demolition or modification (e.g. screening, capping) of chimneys, silos, wells, barns, abandoned buildings, etc., and human use of chimneys during nesting period. Many municipalities now require that chimneys no longer used for heating must be closed or capped, and that active chimneys have spark arresters. This threat mainly applies to nesting sites on residential structures, including schools and churches, where it may result in burning or asphyxiation, as well as physical removal or closure of chimney and other nesting structures. This species is more abundant in urban areas, and thus more dependent on human-made structures there. Some loss and degradation of habitat used by forage species due to residential development (e.g. drainage and filling of wetlands) may reduce availability of insect prey. Note that the scope assigned to this threat is closer to the higher end of the range provided (30%).
1.2	Commercial & industrial areas	D	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)	Most comments from section 1.1 also apply to commercial buildings. Reduced productivity due to ongoing loss of nesting sites (e.g. demolition or modification/capping of chimneys and similar man-made nesting structures). Loss and degradation of habitat used by forage insect species by commercial development (e.g. drainage and filling of wetlands for commercial development) reduces availability of insect prey.
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						Reduction in availability of insect prey may occur due to loss of wetlands due to agricultural intensification, and habitat loss and degradation through conversion of perennial cultures e.g. pastures) into annual crops. Impact is unknown but likely to be small.
2.2	Wood & pulp plantations						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						Potential loss of habitat and mortality from collisions with turbines at windfarms. Impact is unknown but likely to be small.
4	Transportation & service corridors		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Chimney Swift is susceptible to being killed by vehicle strikes when foraging for insects at low levels, especially over roads near waterbodies, although as it generally forages at greater heights, such vehicle strikes are rare.
4.2	Utility & service lines		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	This species may occasionally be at risk from collisions with communications towers.
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Intentional or incidental removal of swift nests during chimney cleaning due to concerns of fire risk.
5.2	Gathering terrestrial plants						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.3	Logging & wood harvesting	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Fragmentation and loss of mature and old growth forest through logging, including removal of dead, hollow trees for human safety, with loss of potential natural nest-sites in large, hollow (primarily deciduous) trees. It is unknown whether nest-site availability in forested areas is locally limiting. Similar effects of logging in South American wintering range likely reduces availability of roosting sites in hollow trees, although information is not currently available on effects of wood harvesting in winter. As most current logging practices do not allow for the retention of old trees (snags), except in those provinces where some trees with woodpecker cavities or tree rot are retained, wood harvesting is unlikely to have an increased effect in the next 10-year period. Overall, the scope for this threat was assessed as small and severity as slight, because this is not a new threat.
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
6.1	Recreational activities		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	Public observation of swift activities, especially at communal roosts in urban areas, likely increases public awareness of concerns for declining swift numbers in Canada, and may lead to more effective conservation initiatives and encourage the preservation of chimneys and other roosting or nesting structures. Large groups of birders are unlikely to disturb roosting swifts, and the overall impact of birding is considered neutral or beneficial.
6.2	War, civil unrest & military exercises						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.3	Work & other activities	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Disturbance by human intrusion, including chimney sweeping or use of chimneys during the nesting period. Sweeping may occur from spring through to the fall, overlapping with the Chimney Swift nesting period, with most activity likely in the fall after swifts have left their nests. Some chimneys are used in summer, preventing their use for nesting and potentially destroying nests or killing breeding adults.
7	Natural system modifications	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	
7.1	Fire & fire suppression		Unknown	Unknown	Unknown	High (Continuing)	Fire may be a threat to this species on its wintering grounds in South America, although there is insufficient information available to rate the scope and severity of this threat.
7.2	Dams & water management/use						
7.3	Other ecosystem modifications	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	Broad-scale ecosystem modifications in many parts of breeding, migration and wintering areas due to a range of causes, including the use of pesticides and conversion of wetlands, leads to ongoing changes in insect abundance and community composition with the potential for marked decreases in populations of aerial insects. This likely results in reduced food availability for Chimney Swift at key times of the year, with impacts on survival of individuals, although the lack of data makes it difficult to quantify this threat (hence the wide range in Severity).
8	Invasive & other problematic species & genes		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species/diseases						Potential competition for roost and nest sites with European Starling, may lead to site abandonment. A large Québec chimney roost was abandoned in 2010 and 2011, when a pair of starlings nesting under the chimney collar chased swifts away from the roost, and a Québec church roost used in 2016 was abandoned in 2017 when used by nesting starlings (Céline Maurice pers. obs.). Although Chimney Swift appears on the list of bird species found dead in the U.S.A. that tested positive for West Nile Virus (Centers for disease control and prevention, 2013), no cases of WNV infection have been reported in Canada.
8.2	Problematic native species/diseases		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Several native species may at times negatively impact Chimney Swift populations, including: Merlin, Peregrine Falcon (predation), Herring Gull, American Crow, Raccoon (competition for nesting sites), and Grey Squirrel (*Sciurus carolinensis*).
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution		Unknown	Large (31-70%)	Unknown	High (Continuing)	
9.1	Domestic & urban waste water						
9.2	Industrial & military effluents						Potential for impacts of chemical or heavy metal contaminants from industrial activities in urban areas that affect prey availability.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.3	Agricultural & forestry effluents		Unknown	Large (31-70%)	Unknown	High (Continuing)	Use of pesticides, including neonicotinoid compounds, which results in pesticide contamination through direct exposure and consumption of contaminated prey, including insecticides/herbicides/fungicides, etc. These can reduce the availability of insect prey, and result in increased body contaminant levels and potential eggshell thinning, contributing to reduced productivity and increased mortality. Some individual swifts likely consume insects with high pesticide loads, especially in the U.S. and Central/South America. However, there is no evidence that this is an issue, and little information on how this species would be affected.
9.4	Garbage & solid waste						
9.5	Air-borne pollutants		Unknown	Large (31-70%)	Unknown	High (Continuing)	Mercury and acid rain may affecting some Chimney Swift populations with unknown severity, especially if birds consume insects that emerge from contaminated wetlands. There is no information on the effects of mercury on this species.
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	It is likely that Chimney Swifts are being and will continue to be affected by climate change. Although it is unclear what specific effects will be, they may be widespread, collectively significant and ongoing, although most effects will only occur over a longer period than ten years. As these effects remain largely speculative, climate change is scored at Level 1 only.
11.1	Habitat shifting & alteration						Changes in weather and climate may change timing of insect emergence, resulting in increased mismatch in timing of insect abundance and key periods for feeding of young and adults, reducing food availability at key times.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.2	Droughts						Insects may be less abundant in dry years, and other aerial insectivores such as the Barn Swallow are less productive in dry years.
11.3	Temperature extremes						Increasing temperature extremes may causing increased mortality of adults, and dehydration and mortality of nestlings.
11.4	Storms & flooding						Heavy rains or severe cold weather may affect adult survival by causing reduction in food supply and increasing mortality. Increased hurricane incidence in eastern North and Central America may cause higher mortality on fall migration.
11.5	Other impacts						Changes in wind patterns with increased numbers of windy days have affected nesting patterns and productivity in the Tree Swallow in Alaska. Similar changes in wind pattern could affect Chimney Swift nesting habits, although this has not been explicitly studied.
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							