

Recovery Strategy for the Common Nighthawk (*Chordeiles minor*) in Canada

Common Nighthawk



2015



Recommended citation:

Environment Canada. 2015. Recovery Strategy for the Common Nighthawk (*Chordeiles minor*) in Canada [Proposed]. *Species at Risk Act Recovery Strategy Series*. Environment Canada, Ottawa. vi + 48 pp.

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Également disponible en français sous le titre
« Programme de rétablissement de l'Engoulevent d'Amérique (*Chordeiles minor*)
au Canada [Proposition] »

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ISBN

Catalogue no.

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¹ <http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1>

PREFACE

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

The Minister of the Environment and the Minister responsible for the Parks Canada Agency are the competent ministers for the recovery of Common Nighthawk and have prepared this strategy, as per section 37 of SARA. It has been prepared in cooperation with the Provinces of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec (Ministère des Forêts, de la Faune et des Parcs), New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador, as well as the territories of Yukon and Northwest Territories and others as per section 39(1) of SARA.

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

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

² <http://registrelep-sararegistry.gc.ca/default.asp?lang=En&n=6B319869-1%20>

ACKNOWLEDGMENTS

This recovery strategy was prepared by Julie McKnight, Krista Baker (Environment Canada, Canadian Wildlife Service (EC-CWS) - Atlantic Region) and Andrew Horn. Early drafts were reviewed by members of the National landbird recovery planning team [Andrew Boyne, Peter Thomas, Becky Whittam (EC-CWS – Atlantic Region), Vincent Carignan, Gilles Falardeau, Mireille Poulin (EC-CWS – Quebec Region), François Fournier and Junior Tremblay (EC – Science & Technology – Quebec region), Kevin Hannah, Rich Russell, Kathy St. Laurent, Ken Tuininga, Russ Weeber (EC-CWS – Ontario Region), Connie Downes, Manon Dubé, Carolyn Seburn, (EC-CWS – National Capital Region), Mark Bidwell, Donna Bigelow, Lisa Mahon, Lisa Pirie, Samantha Song, Steve VanWilgenburg, Karl Zimmer (EC-CWS - Prairie & Northern Region), Saleem Dar, Wendy Easton, Megan Harrison, Craig Machtans, Nancy Mahony, Wendy Nixon, Pam Sinclair (EC-CWS - Pacific & Yukon Region)]. Other contributors provided detailed comments on this recovery strategy: Adam Smith (EC-CWS-National Capital region), Stephen Davis and Samuel Haché (EC-CWS-Prairie & Northern Region). Acknowledgement and thanks are also given to all other parties that provided advice and input used to help inform the development of this recovery strategy including various Aboriginal Organizations and individuals, provincial and territorial governments, other federal departments (e.g., Department of National Defense), landowners, citizens, and stakeholders.

Environment Canada would like to acknowledge the contribution of the thousands of volunteers who generously donate their time and expertise to bird monitoring programs throughout North America, as well as the many professional biologists and technicians working for various government agencies and non-government organizations in Canada and the United States who helped to establish, design, run, and analyze the Breeding Bird Survey and Breeding Bird Atlas results.

EXECUTIVE SUMMARY

Common Nighthawk is a medium-sized mottled grey-brown bird usually seen or heard overhead at dusk and dawn, with long pointed white-barred wings and unique bounding flight. The species is listed as Threatened on Schedule 1 of the federal *Species at Risk Act* (SARA), because of significant long- and short-term declines across the portion of its range covered by bird population monitoring programs. The species is known to breed in every province and territory except Nunavut. Ten percent of the global population of Common Nighthawks is estimated to breed in Canada (Rich et al. 2004).

Common Nighthawk nests on the ground in open land or forest clearings, and on gravel roofs in cities. Foraging nighthawks require open areas with flying insects and this need is met in a wide range of habitats. Almost any site with shade, camouflage from predators, and an unobstructed flight path for access from the air can be used for roosting. There is virtually no information on habitat needs during migration and wintering habitat is not well known except that a variety of open areas are used for foraging much like at other times of year.

Many threats to Common Nighthawk have been postulated, but data are still lacking to directly link a single threat to observed population declines. The threats to the species are found within the following categories: natural system modifications (e.g., reduced insect prey and fire suppression), habitat loss and degradation, climate change and severe weather, accidental mortality, pollution, and problematic native and invasive non-native species.

The recovery of the Common Nighthawk in Canada is considered feasible; however, there are several unknown factors associated with its potential for recovery. Despite these unknowns and in keeping with the precautionary principle, this recovery strategy has been prepared as per section 41(1) of SARA.

The short-term population objective for the Common Nighthawk in Canada is to halt the national decline by 2025 (i.e., 10 years after this recovery strategy is posted on the Species at Risk Public Registry), while ensuring the population does not decrease more than 10% over this time. The long-term (after 2025) population objective is to ensure a positive 10-year population trend for the Common Nighthawk in Canada.

Broad strategies to be taken to address the threats to the survival and recovery of Common Nighthawk are presented in section 6.2: Strategic Direction for Recovery.

At present, the available information is not adequate to identify the habitat necessary for the survival or recovery of the Common Nighthawk in Canada. A schedule of studies is included to obtain the information needed for the identification of critical habitat.

One or more action plans for Common Nighthawk will be posted on the Species at Risk Public Registry within the five years following the posting of this recovery strategy.

RECOVERY FEASIBILITY SUMMARY

Based on the following four criteria outlined by the Government of Canada (2009), there are unknowns regarding the feasibility of recovery for Common Nighthawk. In keeping with the precautionary principle, a recovery strategy has been prepared as per section 41(1) of SARA, as would be done when recovery is determined to be feasible. This recovery strategy addresses the unknowns surrounding the feasibility of recovery.

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

Yes. The species is still found throughout much of its range and breeding individuals are currently distributed throughout the Canadian range as well as in the United States. The Canadian population is estimated to be 900,000 individuals as determined by the Partners in Flight Science Committee (2013). It is believed that there are currently adequate numbers of individuals available to sustain the species in Canada or improve its abundance.

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

Unknown. Sufficient suitable breeding habitat (e.g., nesting and roosting substrate) is probably available, and more could be made available through management, restoration, or creation. There is much still unknown about the distribution and abundance of this species as well as its habitat preferences and as such, it is not possible to identify available but currently unoccupied habitat that may be needed for recovery.

There is only a vague understanding of where Common Nighthawks spend their winters and less is known about how they migrate to wintering areas; it is unknown whether sufficient suitable habitat remains for this species on their migration routes or on their wintering grounds.

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

Unknown. Disparate species of aerial insectivores are in decline suggesting that several factors are likely acting together. Possible threats to Common Nighthawk have been identified, but most have not been well researched specifically in relation to Common Nighthawk and the trigger of population declines remains elusive. Possible threats include natural system modifications (e.g., reduced availability of insect prey), habitat loss or degradation, climate change and severe weather, pollution (e.g., pesticides, mercury, and acid rain) and invasive and other problematic species.

Population levels of Common Nighthawk's prey, aerial insects, are not monitored on a large scale. Very little is known about aerial insect population dynamics or trends and without these data, it is not possible to conclude that there is a sufficient suitable food supply available to Common Nighthawks and other aerial insectivores. It is unclear whether potential threats could be avoided should they be verified by research.

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

Unknown. Habitat management and habitat stewardship may be effective recovery techniques for this species. However, it will be a challenge to undertake research that elucidates suitable habitat elements throughout the species' life cycle and to enact changes in land use practices that will benefit the species. Mitigating potential threats such as reduced availability of insects and habitat availability on the wintering grounds will be a continuing challenge. A particular challenge will be to conduct the necessary research on the importance of wintering habitat loss and work toward protecting existing key habitats and restoration of formerly key habitats.

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1. COSEWIC* SPECIES ASSESSMENT INFORMATION

Date of Assessment: April 2007

Common Name (population): Common Nighthawk

Scientific Name: *Chordeiles minor*

COSEWIC Status: Threatened

Reason for Designation: In Canada, this species has shown both long and short-term declines in population. A 49% decline was determined for areas surveyed over the last three generations. Reduction of food sources has apparently contributed to the decline of this species, as with several other aerial insectivores. Reductions in habitat availability, caused by fire suppression, intensive agriculture, and declines in the number of gravel rooftops in urban areas, may also be factors in some regions.

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

COSEWIC Status History: Designated Threatened in April 2007.

*Committee on the Status of Endangered Wildlife in Canada

2. SPECIES STATUS INFORMATION

The species was listed as Threatened in Canada under Schedule 1 of SARA (c. 29) in 2010. Under provincial endangered species legislation, Common Nighthawk is listed as Special Concern in Ontario (ESA 2007) and Threatened in Manitoba (C.C.C.S.M. c. E111 1990), New Brunswick (S.N.B. 2012, c. 6), Nova Scotia (ESA 2002), and Newfoundland and Labrador (SNL2001 CHAPTER E-10.1 [Amended: 2004 cL-3.1 s27; 2004 c36 s11]). In Quebec, the species is listed on the "Liste des espèces susceptibles d'être désignées menacées ou vulnérables" (list of wildlife species likely to be designated threatened or vulnerable). This list is produced according to the "Loi sur les espèces menacées ou vulnérables" (RLRQ, c. E-12.01) (Act respecting threatened or vulnerable species) (CQLR, c. E-12.01). The species is not currently listed in Yukon, the Northwest Territories, British Columbia, Alberta, Saskatchewan, or Prince Edward Island. Although the species is not listed in the USA, it is considered an imperilled (S2) or critically imperilled (S1) breeder in Connecticut, Rhode Island, New Hampshire, Vermont, Delaware, and Massachusetts. Table 1 provides conservation status ranks for Common Nighthawk.

Table 1. Conservation status ranks for Common Nighthawk (NatureServe 2013).

| Global (G) Rank | National (N) Rank | Sub-national (S) Rank ^a |
|-----------------|---|--|
| G5 (secure) | Canada: N4B (apparently secure) United States: N5B (secure) | Yukon (S2B) Northwest Territories (S2B) British Columbia (S4B) Alberta (S4) Saskatchewan (S4S5B, S4/S5M) Manitoba (S3B) Ontario (S4B) Quebec (S3) New Brunswick (S3B) Prince Edward Island (S1B) Nova Scotia (S3B) Newfoundland (NR) and Labrador (S2B) |

^aSub-national (S) Rank: S1: Critically Imperiled; S2: Imperiled; S3: Vulnerable; S4: Apparently Secure; S5: Secure; B: Breeding; and M: Migrant

3. SPECIES INFORMATION

3.1 Species Description

Common Nighthawk is a medium-sized, slender bird with very long, pointed wings, most commonly heard overhead near dawn or dusk. Its long pointed wings, erratically bounding flight, white bar between the bend and tip of the wing, and nasal *peent* call are distinctive. Territorial males produce a distinct booming sound caused by air rushing through feathers. This sound is characteristic to Common Nighthawks and is an important indicator of breeding activity. When resting on the ground or a tree branch, it lies flat against the substrate and is well camouflaged by its mottled brown, grey, and black plumage. Males have a white tail band as well as a white throat patch, which is buffy in females and mottled brown in juveniles. Common Nighthawk is most easily distinguished from similar birds, such as Eastern Whip-poor-will (*Antrostomus vociferous*), by the white bar across its wings and its call (Brigham et al. 2011).

3.2 Population and Distribution

The breeding range of Common Nighthawk includes most of North and Central America (Figure 1). Approximately 37% of the species' breeding range is found in Canada (Rich et al. 2004). It is known to breed in every province and territory except Nunavut, and in every U.S. state except Alaska and Hawaii. It winters in the northeastern half of South America (Figure 1), where its distribution is poorly known, although it might be especially frequent in southern Brazil and eastern Ecuador and Peru (COSEWIC 2007).



Figure 1. Common Nighthawk distribution map (adapted from BirdLife International and NatureServe (2014), using data from Haché et al. (2014), and eBird (2014)).

Ten percent of the global population of Common Nighthawks is estimated to breed in Canada (Rich et al. 2004) and the species' population in Canada, based on Breeding Bird Survey results, was estimated in COSEWIC (2007) as 400,000 adults and underwent an 80% decline between 1968 and 2005 (average: -4.2% per year; Downes et al. 2005). More recently, the Partners in Flight Population Estimates database was updated and now provides the most comprehensive information on North American landbirds. The Canadian population of Common Nighthawks is now estimated to be 900,000 adults (Partners in Flight Science Committee 2013). This does not represent an actual increase in the population but rather is the result of newer analytical techniques and a refined detection distance used to estimate density.

A new approach to produce population trend estimates from Breeding Bird Survey data provides more precise trend estimates and the results show an annual population change of -3.58% (95% credible intervals (CI): -5.33 to -2.1) from 1973 to 2012,

and -2.265% (CI: -5.2 to 1.5) from 2002-2012 (Environment Canada 2014a). This annual change indicates that the population declined by almost 76% between 1973 and 2012 and by approximately 20% between 2002 and 2012 (Smith pers. comm. 2014).

There are fundamental problems with interpreting Breeding Bird Survey and other point-count survey data for Common Nighthawk. It should be emphasized that Common Nighthawks are not well represented by standard avian point counts because of their crepuscular behavior (i.e., most active at dawn and dusk). Also, the Breeding Bird Survey data does not sample the species' entire range at random, having lower coverage in the boreal forest, urban areas, and remote rocky areas (Status of Birds in Canada 2011, Haché et al. 2014). The majority of Breeding Bird Survey routes tend to be located in southern and disturbed areas of Canada which may bias population estimates of species with northern distributions such as Common Nighthawk (Machtans et al. 2014). Breeding Bird Survey data also tends to overestimate Common Nighthawk densities due to road-side bias (Haché et al. 2014). For these reasons, there is uncertainty in estimating population size for this species.

Regional surveys suggesting declines are reviewed in COSEWIC (2007). For a list of current and past surveys that monitor Common Nighthawk populations refer to section 6.1: Actions Already Completed or Currently Underway.

3.3 Needs of Common Nighthawk

Breeding

Common Nighthawks require open ground or clearings for nesting. The species breeds in a wide range of open habitats including sandy areas (e.g., dunes, eskers, and beaches), open forests (e.g., mixedwood and coniferous stands, burns, and clearcuts), grasslands (e.g., short-grass prairies, pastures, and grassy plains), sagebrush, wetlands (e.g., bogs, marshes, lakeshores, and riverbanks), gravelly or rocky areas (e.g., outcrops, barrens, gravel roads, gravel rooftops, railway beds, mines, quarries, and bare mountain tops and ridges), and some cultivated or landscaped areas (e.g., parks, military bases, airports, blueberry fields, orchards, cultivated fields) (Hunt 2005, Campbell et al. 2006, COSEWIC 2007). There is a wide range in published territory sizes, from less than one hectare to 28 hectares (Brigham et al. 2011). However, home ranges can include isolated foraging and roosting areas that may be greater than six kilometers apart (Fisher et al. 2004, Ng 2009). These home ranges can extend well beyond the defended area and range in size from 3.7 - 259 ha (mean = 86 ha; Ng 2009).

Nests have been observed in close proximity to each other (25 – 75 m apart) which suggests that more than one pair may nest in small patches of suitable nesting habitat (Sutherland 1963). There is evidence that some individuals return to the same general area to nest each year (Campbell et al. 2006, Brigham et al. 2011). The female lays the eggs directly on the substrate, sometimes in a depression or scrape. A wide range of substrates are used (Campbell et al. 2006), and primary microsite characteristics

include more open ground cover with low or no vegetation, adequate camouflage from predators, and nearby shade (Ng 2009, Lohnes 2010, Brigham et al. 2011, Allen and Peters 2012). Nestlings often change locations daily, moving greater distances (up to 48 m) as they age, perhaps mainly to seek shade and avoid disturbance from predators (Allen and Peters 2012, Kramer and Chalfoun 2012).

Foraging

Nighthawks forage in open areas with flying insects during crepuscular periods, although they sometimes forage during the day. This need is met in a wide range of habitats, although open water and artificial lighting are particularly favoured and can attract foraging flocks of a few to hundreds of individuals (Campbell et al. 2006 COSEWIC 2007, Ng 2009). The main prey of Common Nighthawk are beetles (Coleoptera), caddisflies (Trichoptera) and moths (Lepidoptera) (Tyler 1940, Cink 2002), some of which are considered agricultural pests.

Roosting

Suitable roost sites are most likely important for individual survival (Fisher et al. 2004). Almost any site can be used for roosting, including tree limbs, the ground, fenceposts, or rooftops that have shade from overheating, camouflage from predators, and unobstructed flight paths (Fisher et al. 2004, Campbell et al. 2006, Ng 2009).

Migration and wintering

Open areas are used during migration but detailed habitat needs during this stage are poorly known. Nighthawks can be seen in flocks of a few and up to thousands of individuals during fall migration, but undertake individual spring migrations (COSEWIC 2007, Brigham et al. 2011), suggesting that specific areas or habitat characteristics are optimal for flight efficiency and/or for foraging during migration. In particular, larger flocks are often associated with particular rivers or coastlines (Brigham et al. 2011). There is virtually no information on habitat needs during the winter except that a variety of open areas are used for foraging much like at other times of year (Brigham et al. 2011).

Limiting factors

Limiting factors influence a species' survival and reproduction, and play a major role in the recovery of a species. Common Nighthawk is a long-distance Neotropical migrant that arrives late on the breeding grounds and departs earlier than many other landbirds. This constrains the species to one brood per year and clutch size is small (2 eggs). As with all aerial insectivorous birds, the Common Nighthawk specializes in aerial insects which increases its vulnerability to inclement weather. These life history characteristics contribute to this species' intrinsic sensitivity to changes in their environment.

4. THREATS

4.1 Threat Assessment

Table 2. Threat Assessment Table

| Threat | Level of Concern ^a | Extent | Occurrence | Frequency | Severity ^b | Causal Certainty ^c |
|--|-------------------------------|-------------------------|------------|------------|-----------------------|-------------------------------|
| Changes in Ecological Dynamics or Natural Processes | | | | | | |
| Reduced availability of insect prey (Loss of insect-producing habitats, insect-breeding temporal mismatch, habitat acidification, pesticides, light pollution, increased extreme weather events) | High | Widespread | Current | Continuous | Moderate | Medium |
| Fire suppression | Medium | Widespread | Current | Recurrent | Moderate | Medium |
| Habitat Loss or Degradation | | | | | | |
| Loss of breeding habitat: habitat succession | Medium | Widespread (SE Canada) | Current | Continuous | Moderate | Medium |
| Loss of breeding habitat: change in roof construction and materials | Low | Localized (urban areas) | Current | One-time | Low | Medium |
| Loss of breeding habitat: residential and commercial development | Unknown | Widespread | Current | Continuous | Unknown | Low |
| Loss of breeding habitat: agriculture | Unknown | Widespread (S Canada) | Current | Continuous | Unknown | Low |
| Loss of breeding habitat: logging and wood harvesting | Unknown | Widespread | Current | Continuous | Unknown | Low |
| Loss of non-breeding habitat | Unknown | Widespread | Current | Continuous | Unknown | Low |
| Climate and Natural Disasters | | | | | | |
| Temperature extremes and storms | Medium | Widespread | Current | Seasonal | Moderate | Medium |
| Habitat shifting and alteration | Unknown | Widespread | Current | Continuous | Unknown | Low |
| Accidental Mortality | | | | | | |
| Collisions with vehicles, planes, and human structures | Medium | Localized | Current | Recurrent | Moderate | Medium |
| Pollution | | | | | | |
| Pesticides (direct effects) | Unknown | Localized | Current | Seasonal | Unknown | Low |
| Mercury | Unknown | Widespread (E Canada) | Current | Continuous | Unknown | Low |
| Acid precipitation | Unknown | Widespread (E Canada) | Current | Continuous | Unknown | Low |

| Threat | Level of Concern ^a | Extent | Occurrence | Frequency | Severity ^b | Causal Certainty ^c |
|---|-------------------------------|------------|------------|------------|-----------------------|-------------------------------|
| Exotic, Invasive, or Introduced Species/Genome | | | | | | |
| Problematic native and invasive non-native species | Unknown | Widespread | Current | Continuous | Unknown | Low |

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

If 'Severity' = Unknown and 'Causal Certainty' = Low: 'Level of Concern' = Unknown

^b *Severity: reflects the population-level effect (High: very large population-level effect, Moderate, Low, or Unknown).*

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

4.2 Description of Threats

Many threats to Common Nighthawk have been identified, but none have been directly linked to population declines of the species. At this time, it is unknown whether these population declines are driven by one particular threat or by cumulative effects of numerous threats. They are listed as above in the threat assessment table and are described in more detail below.

Reduced availability of insect prey (loss of insect-producing habitats, insect-breeding temporal mismatch, habitat acidification, pesticides, light pollution, increased extreme weather events)

Populations of aerial insectivores are showing dramatic declines, particularly in northeastern North America (Nebel et al. 2010). The trait common to all species in this diverse group is insectivory, which has led multiple researchers to implicate a reduction in available insect prey in breeding, migratory, and/or wintering areas as a probable contributing factor in the declining population trends (Nebel et al. 2010, Paquette et al. 2014).

Insect populations are exhibiting significant declines worldwide. A recent review of global faunal population trends, noted that 33% of all insects with available IUCN-documented population trends were declining and many also exhibited range retractions (Dirzo et al. 2014). These declines are considered a global pattern, but are more severe in heavily disturbed locations, such as the tropics (Dirzo et al. 2014). The possible causes for reduced availability of insect prey are identified and described below.

Insect-breeding temporal mismatch

Birds often exhibit a strong synchronization between their reproductive timing (i.e., hatching) and peak food abundance, but climate change has caused the timing of peaks in some insects to advance (Both et al. 2010). Warming is less severe in Common Nighthawk's wintering areas than in their breeding areas and they may experience migration cues at dates that are too late for them to arrive at breeding sites at the optimal time (Jones and Cresswell 2010). As a result, climate change is creating a temporal mismatch between reproduction and maximal prey abundance (i.e., insects) for species that are not adapting to the changing climate at the same rate as their prey (Strode 2003). Both et al. (2006) found that an aerial insectivore in the Netherlands, the Pied Flycatcher (*Ficedula hypoleuca*), had declined 90% between 1987 and 2003 in areas where the prey peaked too early in the breeding season to provide adequate food for nestlings. Great Tits (*Parus major*) have exhibited a mismatch between optimal timing of nestlings and peak caterpillar biomass as a result of recent warming (Visser et al. 2006). The weight of chicks and the number of chicks that fledged were both affected by their timing in relation to this peak (Visser et al. 2006). An insect-breeding temporal mismatch has also been linked to the population declines of migrant birds across Europe (Møller et al. 2008, Saino et al. 2011), and is believed to be

contributing to the declines of other avian species heavily reliant on invertebrates, such as Rusty Blackbird (*Euphagus carolinus*) (McClure et al. 2012).

Populations of migratory birds that exhibit long-distance migrations and breed in seasonal habitats (such as forests) are more vulnerable to climate change because the temporal mismatch is both more likely and more severe (Both et al. 2006, 2010). Although no species-specific data are currently available, Common Nighthawk is an insectivore that migrates long distances so a climate-induced mismatch between breeding and prey availability is plausible. Areas where the species breeds and forages in seasonal habitats (e.g., open forests) may be more susceptible to this threat (Both et al. 2010).

Loss of insect-producing habitats

Many insects are limited to specific habitats for some part of their life cycle and any process that diminishes these habitats may harm them. Over 90% of insect groups considered threatened are impacted by habitat loss or degradation (Price et al. 2011). A number of human activities alter or destroy natural habitats necessary for particular insect life stages, including wetland drainage and peat extraction, intensive agriculture, wetland destruction, industrial activities, and urban development (U.S. Bureau of Land Management 1978, Price et al. 2011, Benton et al. 2002, Brooks et al. 2012). Foster (1991) noted the drainage of wetlands and peat extraction as a significant threat facing insect populations. Benton et al. (2002) found arthropod numbers were lower when farming was more intense, that insect abundance was significantly related to agricultural practices, and that bird density was significantly related to insect abundance in the previous year. Differences in Diptera abundances change between landscapes as the breeding season of Tree Swallows (*Tachycineta bicolor*) progresses, setting up the potential for an 'ecological trap' in intensively landscaped areas (Paquette et al. 2013). Paquette et al. (2014) found that agriculture intensification did not influence adult body mass, but had a negative effect on the number of chicks fledged.

The effects of habitat loss for insects are not restricted to Common Nighthawk's breeding range, but could also be affecting their migrating and wintering range.

Habitat acidification

Since the 1980s, there has been a substantial decline in the rate of acid deposition, but acidifying compounds (e.g., sulphur dioxide and nitrogen oxide) are still being released into the environment (Shannon 1999, Environment Canada 2014b). Acidification of surface water can reduce the abundance and diversity of flying insects that are aquatic for part of their life cycle (Graveland 1998). Although some of Common Nighthawk's prey (e.g., some beetles and large moths) do not have an aquatic phase, abundance of caddisflies and populations of alternative prey may be affected by habitat acidification. Reduced reproductive success of Tree Swallows nesting near acidified wetlands in Ontario was linked to changes in available calcium-rich prey for nestlings (Blancher and McNicol 1991) and acidification of forests was implicated in the decline of Wood Thrush

(*Hylocichla mustelina*) (Hames et al. 2002). Nevertheless, a study in central Ontario showed no difference in forest songbird productivity between acidified and non-acidified sites (Mahony et al. 1997). At present, there is no evidence to support a range-wide effect of reduced insect prey as a result of habitat acidification, but it may have implications for Common Nighthawks in areas with local, severe acid deposition and in eastern North America where soil buffering is relatively poor due to low pH.

Pesticides (indirect effects)

Aerial insectivores breeding in North America and exhibiting population declines have wintering ranges that consist, or partially consist, of countries with high expenditures on insecticides; insecticide expenditures in wintering ranges was the best, significant predictor of the index of species abundance (Nocera et al. 2014). Nevertheless, the direct mechanisms for the population declines (e.g., reduced insect availability, lethal exposure) are unknown (Nocera et al. 2014).

Most organochlorine pesticides (chemicals in the same family as dichlorodiphenyltrichloroethane – DDT) have been banned in North America for decades, but there is some indication that Neotropical migrant insectivores are still being exposed to organochlorine pesticides throughout their ranges (Sager 1997, Klemens et al. 2000). These chemicals can have long-lasting effects on insect communities and thus the birds that rely on them. Chimney Swift (*Chaetura pelagica*) dietary records confirm a marked decrease in beetles (Coleoptera) and an increase in true bugs (Hemiptera) temporally correlated with a steep rise in DDT and its metabolites. Nocera et al. (2012) argued that DDT caused declines in beetles and dramatic (possibly permanent) shifts in insect communities, resulting in a nutrient-poor diet and ultimately a declining Chimney Swift population.

The harmful effects of chemical insecticides have led to the increased use of biological insecticides. Currently, insecticides used for forestry operations in Canada are mainly biological (*Bacillus thuringiensis* var. *kurstaki* - *Btk*) and target larval Lepidoptera such as Jack Pine Budworm (*Choristoneura pinus*) and Spruce Budworm (*C. fumiferana*). The average area sprayed per year with *Btk* across Canada's forests between 1988 and 2000 was 273,440 ha (range: 73,209-855,535 ha) (NFD 2014). In 2012, *Btk* was sprayed in the forests of four Canadian provinces: Quebec (98,044 ha), Manitoba (828 ha), Saskatchewan (15,639 ha), and British Columbia (116,012 ha) (NFD 2014). On average, Quebec sprays the most forest area with *Btk* per year (1988-2012) (NFD 2014). Although many microbial insecticides are considered non-toxic to birds, their indirect effects caused by changes in available prey items remains inconclusive. A 12,803 ha area of Vancouver Island, British Columbia, exhibited no difference in species richness or relative abundance of songbirds one year after being sprayed with *Btk* to control for Gypsy Moth (*Lymantria dispar*) (Sopuck et al. 2002). Holmes (1998) found that the nestling survival and growth of Tennessee Warblers (*Vermivora peregrina*) were unaffected by sites treated with *Btk* in Ontario, and although nests in sprayed sites had smaller clutches, smaller broods, and lower hatch rates, the differences were not significant. Other studies have found significant indirect impacts of

microbial pesticides to birds. Spruce Grouse (*Dendragapus canadensis*) chicks had significantly slower growth rates in an area treated with *Btk* in Ontario compared to chicks raised in study sites not treated with *Btk* (Norton et al. 2001). Norton et al. (2001) attributed this to the reduction in available Lepidoptera larvae as a result of spraying. In France, House Martins (*Delichon urbicum*) at sites treated with *Bacillus thuringiensis* var. *israelensis* (*Bti*) exhibited a change in diet from Nematocera (which are *Bti*-sensitive), spiders, and dragonflies (Nematocera predators) to flying ants (Poulin et al. 2010). This dietary change resulted in lower clutch size and fledgling survival (Poulin et al. 2010). *Bti* may be used for mosquito and black fly control programs throughout Common Nighthawk's breeding, migratory, and wintering range.

Neonicotinoid insecticides were introduced in the 1990s and although their rates of use are poorly known across Common Nighthawk's range, nearly 11 million hectares of cropland across the Canadian Prairies were estimated to be treated with neonicotinoids (Main et al. 2014). Neonicotinoids are generally used on agricultural lands, but have been detected in wetlands (Main et al. 2014) and waterways in Canada (Environment Canada 2011, Xing et al. 2013). Mineau and Palmer (2013) suggested that the effects of neonicotinoids to birds may not be limited to the farm scale, but likely expand to the watershed or regional scale. Neonicotinoids are adversely affecting insect populations and in 2013 the European Food Safety Authority declared that they posed 'unacceptable' risk to insects (Goulson 2014). In the Netherlands, neonicotinoid concentrations in surface waters were correlated with the declines in farmland insectivorous birds (Hallmann et al. 2014). Hallmann et al. (2014) suggested these declines were likely caused by a reduction of insect prey as a result of insecticide use. The indirect effects of these insecticides have also been noted in Skylark (*Alauda arvensis*), Yellowhammer (*Emberiza citronella*), Whinchat (*Saxicola rubetra*), Reed Bunting (*Emberiza schoeniclus*), and Corn Bunting (*Miliaria calandra*) (Boatman et al. 2004, Gibbons et al. 2014).

Light pollution

Many insects that are prey species for Common Nighthawk (beetles, caddisflies, and moths) are known to be drawn to artificial lights (Bruce-White and Shardlow 2011). Insects depend on natural light cycles to complete several stages of their life cycle. There is evidence that artificial light is affecting the breeding and survival of caddisflies (Trichoptera) and other aquatic invertebrates. Artificial light interferes with the cues that such species rely on for adult emergence and disorients adults and large mortality events have been recorded around light sources close to rivers (Bruce-White and Shardlow 2011). Artificial lighting is also likely to have adverse impacts on feeding, reproduction, and movements of insects. This can result in fragmentation and/or a decline in the populations of certain species and changes to the community of insects available to aerial insectivores (Bruce-White and Shardlow 2011, Davies et al. 2012).

Increased extreme weather events

Nighthawks and other aerial insectivores exploit patches of flying insects concentrated by frontal systems (Russell 1999, Taylor 2009). For example, Russell and Wilson (1997) counted 85 Common Nighthawks at a convergence zone in Florida during a single 10-minute point count. These frontal systems may be disrupted by increasing storm severity resulting from climate change. On the other hand, storm intensification may increase available habitat for Common Nighthawk through increased forest fires and windthrow.

More frequent and extended droughts as a result of climate change are expected to result in local and possibly regional declines of some insect species, particularly those reliant on aquatic environments (Haile 2000, Boulton and Lake 2008). But, droughts may also lead to dramatic increases (outbreaks) in other insect species (Haile 2000).

Fire suppression

Fire in a natural system may provide a mosaic of shifting breeding habitat for Common Nighthawks. Pre-settlement North American forests evolved under the influence of fire and the boreal forest, in particular, is strongly connected to the fire regime (FAO 2006). For much of the 20th century, suppression of wildfire to protect forest resources and rural communities was the management norm. In fact, the effectiveness of fire suppression programs in Canada is such that 97 percent of all forest fires are contained before they reach 200 hectares in size (Stocks et al. 2003). Even in the large boreal forest, Cumming (2005) concluded that fire suppression by initial attack has significantly impacted the area burned over recent decades and suggests this will persist into the foreseeable future. Decades of fire suppression have resulted in longer fire intervals with reduced open areas that are used by breeding Common Nighthawks. Availability of habitat in mesic prairie systems is also reduced because of natural succession to shrubland in the absence of natural fire regimes (McCracken 2005). Climate change modelling predicts an increase in fire frequency and intensity in Canada's boreal region (Natural Resources Canada 2013) which would lead to an increase in open habitat for Common Nighthawks. However, the ultimate benefit to Common Nighthawks is unknown especially because any increase in fire frequency may be met with increased fire suppression efforts by forest managers.

Loss of breeding habitat: habitat succession

Declines of several bird species that use open habitats, including Common Nighthawk, have been attributed in part to succession to forests of lands that were cleared after European settlement (Parody et al. 2001) and the encroachment of woody vegetation due to the abandonment of non-productive farmland. Substantial reforestation has been implicated in declines of native grassland habitat and agricultural land for grassland birds (Askins 1993). Furthermore, reforestation in Ontario and Quebec is contributing to the encroachment of woody vegetation in grassland habitat (Bollinger 1995).

The European Nightjar (*Caprimulgus europaeus*), a close relative with similar nesting habits, population increases in planted forests are directly related to the availability of forest clearings (Langston et al. 2007). Farmland abandonment creates early- and mid-successional forests that can, at first, provide suitable habitat for the species, but succession eventually leads to older forest stages, which are not preferred (Bushman and Therres 1988). In southeastern Canada, succession of abandoned farmland has been the trend in marginal areas (i.e., areas not capable of sustained production of cultivated field crops) (Despouts 1996, Cadman et al. 2007) and forest succession in these areas may have caused some degree of nesting/foraging habitat loss for Common Nighthawk (Mills 1987, Smith 1996).

Natural succession may also pose a problem in native prairies where fire suppression is used as a management technique (McCracken 2005).

Loss of breeding habitat: change in roof construction and materials

In urban environments, Common Nighthawks nest almost exclusively on roofs covered with pea gravel that provide a source of shade (Marzilli 1989). The change in roofing to tar, rubber, and other materials is thought to be a main cause of the species' decline in urban environments (Brigham et al. 2011). Such surfaces are unsuitable for nesting because rubber gets hotter than gravel in direct sun, does not provide camouflage for birds, and smooth surfaces may allow eggs to roll (Marzilli 1989, Brigham et al. 2011). Locally, declines have also been associated with changes from pea gravel to larger gravel (Wedgwood 1992), walled to unwallled, and drained to water-retaining roofs (Sandilands 2010). Acceptance of green roof technology is growing in North America (Dalglish 2012) but it is too early to tell whether, or how, an increase in green roofs will impact urban-nesting populations of Common Nighthawks.

Loss of breeding habitat: residential and commercial development

Residential and commercial development and urban areas in general, have encroached upon a large amount of Canada's land over the last few decades (Cocklin et al. 1983) and leads to permanent habitat loss. This loss of habitat may be associated with the decline of bird species that use open habitats (Valiela and Martinetto 2007). Urban development is a major contributing factor in Canada's diminishing supply of dependable agricultural land and forested lands. Urban development is considered the leading cause of deforestation in the United States, and a major contributing factor in Canada (17%), especially in southern Ontario and Quebec (Radeloff et al. 2005, Robinson et al. 2005 Sun et al. 2007, Masek et al. 2011).

The largest increases in urban and rural landscapes from 2000 to 2011 occurred in Ontario and Quebec (Statistics Canada 2013) and Ontario has the highest concentration of urban land in Canada. More than 10% of Ontario's prime productive land was permanently removed by urban growth between 1971 and 2001, representing a nearly 80% increase in the amount of urban land in Ontario (Hofman et al. 2005).

Loss of breeding habitat: agriculture

Agriculture is the largest source of deforestation in Canada (mainly in southern central Canada) (Masek et al. 2011). Forest clearing for agricultural expansion is particularly important in the boreal hardwood transition zone where 73% of the forest cover has been cleared, including a 25% loss from 1966 to 1994 (Hobson et al. 2002).

Market pressure and increased mechanization available to farmers leads to the elimination of edge and natural features and the conversion of many pastures and hayfields to cereal and row crops, which are less suitable for ground-nesting species (Jobin et al. 1996, Corace et al. 2009) because they provide little or no nesting cover and because the frequency of disturbance during the breeding season is too high.

Although the species is known to use human altered landscapes, the impacts of agriculture and, specifically agriculture intensification, have not been directly assessed for Common Nighthawk.

Loss of breeding habitat: logging and wood harvesting

Logging and wood harvesting is the third largest cause of deforestation in Canada, after agriculture and residential and commercial development (Masek et al. 2011). Rates of harvest in Canada are highest in Quebec, British Columbia, and Ontario. Harvest rates have been relatively stable in Canada since the 1980s, despite a steady increase in the area of harvest in Quebec over this time (Masek et al. 2011). Logging, in general, can have a short term negative impact on nesting birds by disrupting breeding activities (e.g., excessive disturbance, direct destruction of nests, eggs, and young) (Hobson et al. 2013) but some appropriately-timed practices may be beneficial for Common Nighthawks (e.g., through creation of open habitat that can be used for nesting). Although the species is known to use human altered landscapes, the impact of logging and wood harvesting has not been directly assessed for this species.

Loss of nonbreeding habitat

Migration is not 'well studied' for Common Nighthawk and there is virtually no information on habitat needs during migration or winter except that a variety of open areas are used for foraging (Brigham et al. 2011). It is not possible to assess the loss of nonbreeding habitat with so little information, but given similar declines in aerial insectivores which also migrate long distances, reduced habitat quality on either the wintering or migratory stopover areas may play a role in observed declines (Nebel et al. 2010).

Temperature extremes and storms

Tropical storms can kill aerial insectivores migrating in the autumn in large numbers; a single hurricane (Hurricane Wilma 2005) had a measurable effect on the population of another aerial insectivore, Chimney Swift (Dionne et al. 2008). Climatic fluctuations in

spring reduce survival and reproductive success, especially because nighthawks have a migration schedule that appears to rely on warm weather for flying insects (Brigham et al. 2011) (see section 4.2: Reduced availability of insects). A long period of cold wet weather in June 1903 decimated the nighthawk population throughout Massachusetts (Griscom 1949) and record high precipitation in 1990 resulted in reduced foraging and apparent starvation of nighthawks in British Columbia (Firman et al. 1993). The deleterious effects of cold wet weather during the breeding season are well known for other aerial insectivores (e.g., Brown and Brown 2000) and such weather extremes are expected to occur more frequently due to climate change (Huber and Gullledge 2011).

Habitat shifting and alteration

Migratory bird species which travel long distances are dependent on multiple, spatially disparate, habitats during their annual cycle (breeding, migration, and wintering) and this makes them particularly sensitive to the impacts of climate change because any change along the way could negatively impact the population (Robinson et al. 2008, Newson et al. 2009). There is little information to directly link climate change to the population decline of this species but Cumming et al. (2003) suggested a large potential for avian distributional shifts in response to climate change.

Collisions with vehicles, planes, and human structures

Common Nighthawks, especially males, often rest along gravel roads at night, where they are vulnerable to vehicle collisions (Poulin et al. 1998, Brigham et al. 2011). Red-necked Nightjars (*Caprimulgus ruficollis*) in Spain were attracted to paved roads (during migration and during cool temperatures while breeding) where the temperatures were significantly warmer than nearby gravel roads and bare ground (Camacho 2013). This behavior caused a significant increase in the number of road casualties (Camacho 2013). Road kills can also be particularly frequent where roads cross areas with concentrations of foraging nighthawks (Stevenson and Anderson 1994). Bishop and Brogan (2013) found *Caprimulgiformes* represented 1.9% of the birds reported in North American studies of bird mortalities resulting from collisions with vehicles, whereas Loss et al. (2014a) found Common Nighthawks represented 0.01% of the total bird-vehicle mortalities from studies compiled within the range of the Common Nighthawk in the United States. Although there are exceptions, in general, mortality rates due to vehicle collisions often increase with increasing traffic speed, road corridor width, and road elevation (i.e., when above surrounding land) (Baudvin 1997, Case 1978, Loss et al. 2014a). Nests and broods can also be destroyed by vehicle traffic in managed forests (Bender and Brigham 1995). Vehicle collisions are expected to become a growing source of mortality for Common Nighthawk, as development and associated road infrastructure expand into new parts of their range.

Common Nighthawks are also vulnerable to collisions with airplanes. Common Nighthawks concentrating for roosting and foraging at McConnell Air Force Base (Kansas, USA) accounted for 82% of bird strikes at the Air Base until corrective actions

were taken (Cumming et al. 2003). Management of migrating nighthawks on the Air Base is an ongoing issue because traditional hazing techniques are ineffective and birds quickly return to roosting spots which presents an even greater hazard to aircraft.

Collisions with buildings, telephone and power lines, communication towers, wind turbines, and other vertical human structures can also result in localized mortality for many bird species, particularly during migration.

Approximately 25 million birds (of many species) are killed each year in Canada from collisions with windows (Machtans et al. 2013) and between 365 and 988 million are killed each year in the United States (Loss et al. 2014b). Common Nighthawk is at 2.6 times lesser risk than the average species to mortality due to building collisions across all building types and has average risk of collisions with high-rise buildings when compared to other species (Loss et al. 2014b).

It is estimated that 2.5-25.6 million birds (of many species) are killed each year by transmission lines in Canada (Rioux et al. 2013) and between 12 and 64 million birds are killed each year by power lines in the United States (8-57 million of these by collisions, 0.9-11.6 million by electrocution) (Loss et al. 2014c). Common Nighthawks, especially adult males during courtship, are known to collide with telephone and power lines (Erikson 2005). The impact of these collisions has not been quantified for Common Nighthawk but it is presumed to be limited, though such collisions may increase as development expands.

An estimated 6.8 million birds (of many species) are killed by collisions with communication towers each year in the United States and Canada (Longcore et al. 2012). Mortality is most frequent for Neotropical migrants and nocturnal migrants attracted to tower lights (Longcore et al. 2013), but the estimated annual mortality due to collisions with communication towers is less than 1% of Common Nighthawk's total population (Longcore et al. 2013).

Approximately 23,300 birds of many species are killed each year from collisions with wind turbines (Zimmerling et al. 2014). Almost 50% of the deaths from collisions with wind turbines are predicted to occur in Ontario (Zimmerling et al. 2014).

Pesticides (direct effects)

Mineau and Whiteside (2013) suggest that pesticides be strongly considered in efforts to identify the causes of bird population declines in North America. They were unable to separate between the direct (i.e., toxic) and indirect (e.g., habitat or food chain) effects of pesticides and they concluded that both are likely occurring (Mineau and Whiteside 2013). Although largely undocumented for this species, pesticide use on both breeding and wintering grounds has been implicated in direct mortality and habitat loss of many avian species (e.g., Chamberlain et al. 2000, Boatman et al. 2004, Mineau 2005).

Most organochlorine pesticides (chemicals in the same family as dichlorodiphenyltrichloroethane: DDT) have been banned for decades in North America. Little is known about the extent to which Common Nighthawks and other Neotropical migrant passerines were exposed to organochlorine pesticides throughout their lifetime (Gard et al. 1993, Klemens et al. 2000) but there is some indication that Neotropical migrant insectivores are still being exposed to organochlorine pesticides in North America (Sager 1997, Klemens et al. 2000) either legally through loopholes in the restriction laws, or illegally, and they may still be in use in Central and South America (Klemens et al. 2000, Lebbin et al. 2010, Nebel et al. 2010). Endosulfan, which is primarily used on a wide variety of food crops is an exception to the ban of organochlorine pesticides but will be phased out of use in the U.S. by 2016 because it was deemed to pose an 'unacceptable' risk to farmworkers and wildlife (birds, in general, are fairly sensitive to endosulfan poisoning) (U.S. Environmental Protection Agency 2010). Several other countries have followed suit acting to ban the chemical through the Stockholm Convention on Persistent Organic Pollutants (an international environmental treaty signed in 2001) (Secretariat of the Stockholm Convention 2011).

Organophosphate and carbamate compounds have been used increasingly since the majority of organochlorine pesticides (e.g., DDT and dieldrin) were restricted in North America in the 1970s and banned in the 1980s (Commission for Environmental Cooperation of North America 2003). Birds and other vertebrate species are susceptible to these chemicals if they ingest or otherwise absorb enough organophosphate or carbamate pesticides; however, birds appear to be more sensitive than other vertebrates (Freedman 1995, Friend and Franson 1999-2001). Indeed, mass mortalities of other bird species feeding on insects poisoned by organophosphates have been documented on Common Nighthawk's wintering grounds (Goldstein et al. 1999).

Direct impacts of a relatively new class of pesticides, neonicotinoids, are unknown for insectivorous species such as Common Nighthawk, but studies show that seed-eating birds may be exposed to lethal doses of this pesticide (Mineau and Palmer 2013, Goulson 2014) while eating just a few treated seeds. Hallmann et al. 2014 recently published a study that correlated neonicotinoid concentrations in surface waters to declines in insectivorous birds in the Netherlands. Hallmann et al. 2014 suggest the declines are in relation to a reduction of insect prey (see section 4.2: Reduced availability of insects) but they could not rule out direct pathways in which the neonicotinoids may have had an effect on the birds.

Mercury

Mercury is a naturally occurring element that is enriched in the environment by human activities. Long-range atmospheric transport and deposition is the dominant source of mercury to many aquatic habitats over much of the landscape (Fitzgerald et al. 1998, USGS 2000) but inputs of waterborne mercury have occurred (and potentially are still occurring) in North America and especially the Northeast (Evers et al. 2005). Bio-available mercury is also mobilized within watersheds by forestry activities, hydroelectric reservoir creation, and various industrial-related activities (Porvari et al. 2003, Vuori *et al.* 2003, and Wiener et al. 2003). Large amounts of mercury accumulated over thousands of years in peatlands, and currently underlain by permafrost, also has the potential to release mercury to the environment (Rydberg et al. 2010) in some parts of their range. Mercury concentrations in aquatic food webs are usually correlated with low-pH levels, and as a result mercury concentrations increase from west to east across Canada in freshwater food webs (Depew et al. 2013).

Mercury exposure can decrease reproductive success, alter immune responsiveness, and cause behavioural and physiological effects in birds (Scheuhammer et al. 2007, Hawley et al. 2009). Research by Rimmer et al. 2010 and Keller et al. 2014 suggests that mercury is biomagnifying in terrestrial songbirds that eat invertebrates and although not currently documented for this species, this requires investigation because Common Nighthawk may be exposed in some parts of its range to elevated methylmercury (MeHg; toxic form of mercury) due to its consumption of predatory insects from acidic wetlands where mercury is easily converted to methylmercury (Evers et al. 2005, Greenberg and Matsuoka 2010, Evers et al. 2011, Edmonds et al. 2012). A recent large-scale study of mercury in an insectivorous bird, Rusty Blackbird, emphasized the potential threat of mercury, especially to the population in northeastern North America (Edmonds et al. 2010). The feathers of Rusty Blackbirds breeding in the Acadian forest ecoregion of New England and the Maritimes (Maine, New Hampshire, Vermont, New Brunswick, and Nova Scotia,) had mercury concentrations that were orders of magnitude higher than concentrations observed in the winter regions in the southern U.S. and breeding sites in Alaska (Edmonds et al. 2010).

Acid Precipitation

Acid precipitation has been identified as a contributing factor in the decline of spruce-fir forests throughout the Eastern United States (U.S. Environmental Protection Agency 2014) and this is presumably occurring in Canada as well. Acidification may modify habitat leading to altered soil invertebrate assemblages (see section 4.2: Reduced availability of insects), loss of favoured nesting, roosting, and/or foraging sites (Hames et al. 2002), increased vigilance, and increase predation risk (Brotons et al. 1998).

Acidification of forests also contributes to the leaching of calcium from soils, a phenomenon that is particularly marked in northeastern North America (Driscoll *et al.* 2001) where soil buffering is relatively poor due to low pH and nitrogen

saturation is occurring (i.e., nitrates can remove additional calcium from the soil) (U.S. Environmental Protection Agency 2014). Passerines must obtain calcium from their food during the egg-laying period (Hames et al. 2002) and calcium-deficiency during this time may lead to birds laying egg shells that are thin, weak, and more porous which can lead to breeding failure. Acidification has been implicated in the decline of Wood Thrush (*Hylocichla mustelina*) (Hames et al. 2002) as well as other passerine birds from northern Europe that nest in acidified parts of their range (Graveland and Drent 1997, Mand et al. 2000).

Problematic native and invasive non-native species

An increase in predators, such as cats (*Felis catus*), corvids (*Corvus* spp.), raccoons (*Procyon lotor*), and skunks (*Mephitis mephitis* and *Spilogale gracilis*) has been proposed as a threat to Common Nighthawks (COSEWIC 2007). Indeed, nest predation rates were highest for ground nesting bird species breeding in fragmented forest tracts near urban areas in a study by Wilcove (1985). Cats, being the number one source of human-related avian mortality in Canada (Calvert et al. 2013), could pose a threat to Common Nighthawks. An estimated two to seven percent of birds in Southern Canada are killed by cats annually (Blancher 2013). Predominately a roof-nester in urban centers, Common Nighthawks may be more susceptible to cat predation in rural areas and possibly during migration.

The spread of gulls nesting on roofs has been suggested as displacing nighthawks from nesting sites in Montreal (Ring-billed Gull, *Larus delawarensis*; COSEWIC 2007) and in cities of British Columbia (Glaucous-winged Gull, *L. glaucescens*; Campbell et al. 2006). This highlights the potential for nest predation by gulls in urban centers.

It is possible that invasive plant species could affect the quality of breeding habitat in forest openings. Any change to ground cover vegetation has the potential to negatively impact ground-nesting birds such as Common Nighthawk.

5. POPULATION AND DISTRIBUTION OBJECTIVES

It is not deemed feasible to halt population declines immediately due the number of potential threats to the species, their nature, and ultimately the uncertainty around the cause of the decline.

The short-term population objective for the Common Nighthawk in Canada is to halt the national decline by 2025 (i.e., 10 years after this recovery strategy is posted on the Species at Risk Public Registry), while ensuring the population does not decrease more than 10% over this time. The long-term (i.e., after 2025) population objective is to ensure a positive 10-year population trend for the Common Nighthawk in Canada.

The distribution objective for Common Nighthawk is to maintain the current extent of occurrence (i.e., the area that encompasses the geographic distribution of all known populations) in Canada.

The population objectives address the species' long-term decline, which was the reason for its designation as Threatened (COSEWIC 2007). Short-comings with the Breeding Bird Survey dataset for this species (see section 3.2: Population and Distribution) are acknowledged and this strategy includes approaches to improve monitoring for Common Nighthawk. As new information becomes available, population and distribution objectives might be revised, as appropriate for species recovery.

The 10-year time frame was deemed appropriate to assess population change in Common Nighthawk. This time frame was selected because halting the decline of a species is challenging, and cannot be done in just a few years, and because COSEWIC species assessments occur every 10 years. Their criteria for assessment include reviewing population change within 10-year windows.

These objectives will be reviewed during the development of the report required five years after this strategy is posted on the Species at Risk Public Registry to assess the implementation of this strategy and the progress towards meeting its objectives (s. 46 SARA).

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Currently Underway

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

- Common Nighthawk is considered and mitigative measures are established for land-use development projects and during environmental assessments across Canada.
- Environment Canada has completed some initial work in Yukon to determine appropriate seasonal and diurnal timing of surveys for Common Nighthawk.
- WildResearch's BC Nightjar Survey uses citizen-science road-side surveys to study Common Nighthawks in British Columbia. Volunteers conduct crepuscular passive point counts for nighthawks in priority regions across the province. Survey results are used to determine current population trends and identify landscapes that are important for conservation of nighthawk populations in British Columbia.
- The Government of Alberta published inventory guidelines for sensitive species including Common Nighthawk (Government of Alberta 2013).
- The Government of Saskatchewan published a Common Nighthawk Survey Protocol (Saskatchewan Ministry of Environment 2014).
- Opportunistic sightings of Common Nighthawks were collected during surveys for Common Poorwill (*Phalaenoptilus nuttallii*) by the Saskatchewan Wetland Conservation Corporation (now the Saskatchewan Water Security Agency).
- The Ontario Whip-poor-will project, conducted by Bird Studies Canada (BSC) (2010-2014), records incidental Common Nighthawk observations particularly in more northern routes (Central and Eastern Ontario).
- BSC piloted an urban Common Nighthawk count in 2013 and this volunteer survey was conducted again in 2014.
- Common Nighthawk data are collected as part of Ontario SwiftWatch (peak numbers and date of observations).
- Most Department of National Defense installations are conducting surveys or monitoring for the species.
- A volunteer survey of 25 permanent routes in agricultural landscapes has been implemented in Quebec.
- A project was launched in 2014 by Environment Canada in Quebec to assess the possibility of monitoring Common Nighthawk in the boreal forest using Song Meters programmed to record during periods of nighthawk activity and placed near stops on Breeding Bird Survey routes the night before the surveys are conducted.
- Common Nighthawk sightings are opportunistically collected as part of the Maritimes SwiftWatch.

- Incidental sightings of Common Nighthawk are collected by the Wildlife Division of the Newfoundland and Labrador Department of Environment and Conservation.

In Canada, there has been little conservation work specifically targeting Common Nighthawk. However, several conservation-oriented research, planning, and education projects have been implemented in Canada and the U.S. that either include the species in the framework of activities or specifically target the species as a focus of efforts. These include the following groups and/or projects:

1. The Boreal Avian Modeling Project (<http://www.borealbirds.ca/>)
2. The Boreal Songbird Initiative (<http://www.borealbirds.org/>)
3. The Canadian Boreal Initiative (<http://www.borealcanada.ca/>)
4. The Breeding Bird Survey (<https://www.pwrc.usgs.gov/BBS/> and <https://ec.gc.ca/reom-mbs/default.asp?lang=En&n=416B57CA-1>)
5. Breeding Bird Atlases throughout Canada (<http://www.bsc-eoc.org/volunteer/atlas>)

6.2 Strategic Direction for Recovery

Uncertainties around the cause of the species’ decline make it challenging to devise a strategic direction for its recovery. Monitoring and research is deemed to be the highest priority strategy, without which an understanding of recovery for the species cannot be reached. Research and management approaches may be amended when more information becomes available.

Table 3. Recovery Planning for Common Nighthawk

| Threat or Limitation | Broad Strategy to Recovery | Priority ^a | General Description of Research and Management Approaches |
|--|---|-----------------------|---|
| Knowledge gaps to recovery | Monitoring and research | High | <ul style="list-style-type: none"> • Develop and implement standardized protocols and survey designs (data collection and analysis) for the population, its insect prey populations, and their habitat characteristics; • Refine Canadian population estimate once appropriate surveys are established and data are assessed; • Determine migratory connectivity, migratory routes, winter distribution, and non-breeding habitats; • Determine key demographic parameter estimates throughout the annual cycle; • Determine relative importance of known and suspected threats to the species its prey and their habitats (see Appendix B for specifics); • Investigate factors affecting reproductive output, survival, and fidelity to breeding sites; • Determine proportion of the population nesting in areas of human habitation versus natural habitats and determine if areas of human habitation are disproportionately less important for the survival or recovery of the species; • Evaluate importance of aquatic systems for foraging and determine characteristics of frequently-used sites; |
| Habitat Loss or Degradation Changes in Ecological Dynamics or Natural Processes Pollution Exotic, Invasive or | Habitat and species conservation and management | High | <ul style="list-style-type: none"> • Conserve habitat for the species and its prey in breeding and non-breeding areas; • Encourage adherence to the principles of Integrated Pest Management and encourage use of environmentally benign pesticides at small scales; • Restore habitat and natural processes (e.g., prescribed burns, mechanical |

| Threat or Limitation | Broad Strategy to Recovery | Priority ^a | General Description of Research and Management Approaches |
|--------------------------------|--|-----------------------|---|
| Introduced Species/Genome | | Medium | thinning, prairie restoration) that provide breeding habitat for the species and its prey; <ul style="list-style-type: none"> • Create habitat for the species and its prey, if deemed necessary; • Control problematic species where feasible and deemed necessary; |
| All threats and knowledge gaps | Education and awareness, stewardship, and partnerships | High | <ul style="list-style-type: none"> • Foster cooperative relationships with government, landowners, the forest industry, farmers, industry, pet owners, and others to mitigate threats to the species, its prey, and their habitats; • Promote national cooperation and collaboration to fill knowledge gaps and to mitigate threats in Canada; • Promote international cooperation and collaboration to fill knowledge gaps and to mitigate threats outside the breeding season; • Promote volunteer participation in surveys and monitoring; • Promote compliance with Federal (e.g., SARA, <i>Migratory Birds Convention Act</i> (1994)), Provincial, and Municipal Acts and Policies as well as beneficial management practices that protect the species, its prey, and their habitats; |
| | | Medium | <ul style="list-style-type: none"> • Promote ecosystem conservation through private sector certifications if deemed effective for recovery of the species; • Create opportunities for public involvement in habitat conservation and other conservation initiatives; |
| All | Law and policy | Medium | <ul style="list-style-type: none"> • Develop beneficial management practices for the species, its prey, and their habitats; • Implement existing policies and reduction programs to reduce and/or mitigate the threat of pollution and develop new policies and programs where gaps exist; • Implement private standards and codes that are beneficial for the species |

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

6.3 Narrative to Support the Recovery Planning Table

Recovery of Common Nighthawk will require commitment, collaboration, and cooperation among federal, provincial and territorial jurisdictions, wildlife management boards, aboriginal people, local communities, landowners, industry, and other interested parties. Due to Common Nighthawk's widespread range across the country, it will be important to monitor habitat conditions, population trend, and the distribution of the species so that the effectiveness of the recovery efforts can be evaluated, and adjusted as necessary.

Monitoring and Research

Common Nighthawk is locally abundant but widespread, so an important first step in its recovery is to develop standardized protocols and survey designs for the collection and analysis of population data. There is a need to establish a monitoring program specific to this species to monitor the population trend using a consistent, comprehensive, and reliable survey method. Corresponding habitat models will need to be built to better understand where the species would be expected to breed on the landscape, and to assist with efforts to identify critical habitat.

The mechanisms driving population change in the species and its prey are far from clear (McCracken 2008) and there is simply too little information about the species to know whether any of its basic demographic parameters have changed over time. Even less information is known about the species outside the breeding season. There is only a vague understanding of where Common Nighthawks spend their winters in South America and little to no information on their migration routes and stopover sites. Gathering information on the species during the non-breeding period, what habitats it requires, and what threats it faces away from the breeding grounds will be a challenging, but necessary, endeavor.

Aerial ecology and the aerial biomass which Common Nighthawks utilize are poorly understood. Large-scale programs to monitor population levels of aerial insects are needed to understand how their population dynamics and trends affect aerial insectivore populations and research is needed to identify factors affecting prey species.

Because the population objective for this species includes halting the species' decline and ultimately increasing the population, potentially suitable but currently unoccupied habitat should be identified, as should any areas that are especially important passage or stopover sites during migration.

Habitat and species conservation and management

Conservation, management, and/or restoration of nesting habitat may be required in areas where important habitats have been lost or degraded, for example in grassland and agricultural areas. In some specific instances, it may be necessary to create nesting habitat where anthropogenic factors (e.g., residential and commercial development,

agriculture, logging and wood harvesting) have led to a significant reduction of suitable habitat. Trends in aerial insect population dynamics must be better understood to know whether maintaining, enhancing, and/or restoring insect-producing habitats will be of benefit to the species.

Integrated Pest Management is not a new concept in Canada and some regional programs and initiatives are already underway. Such programs may help reduce some of the threats faced by the species and its prey.

Ground-nesting species like Common Nighthawk are especially vulnerable to predation because they are susceptible to a greater range of predators. Development of long-term solutions to address the problem of elevated levels of predator populations will be required in some areas where Common Nighthawks nest in high densities. Attention to predators in environmental assessment reviews will help curb the proliferation of predators, most notably those related to agricultural projects, food and fish processing plants, and mink farms. Such reviews should recommend measures that will result in less favourable conditions for predators.

Roof-nesting gulls in urban centres are generally considered undesirable as they may cause significant property damage and disturbance to humans. Some occupied sites are already the target of control programs but gull management should be considered at a broad scale because displacement from one roof site undoubtedly leads to relocation to nearby sites (Dwyer et al. 1996).

Education and awareness, stewardship, and partnerships

To be effective, conservation and stewardship actions should be implemented throughout the species' range, including migratory stopovers and wintering grounds and this will require international collaboration for the approaches focused on maintaining habitat and reducing the threat of pollution. Cooperative relations should be fostered with landowners, the forest industry, farmers, industry, and pet owners to name a few, to implement beneficial management practices for the species and its habitat. The quantity of habitat available to Common Nighthawk and the degree of habitat protection on public lands is unknown but the species also nests on private land and this creates an opportunity for public involvement in habitat conservation and other conservation initiatives. Preserving and enhancing habitat for Common Nighthawk populations will require education and stewardship on a broad scale.

Ground-nesting birds like Common Nighthawk may be especially negatively impacted in urban areas by free-roaming cats and feral pet species. Education and stewardship will be required to reduce this threat.

The best management of breeding habitat will fail to recover the species unless wintering habitat and migratory stopovers are maintained. Thus, collaboration with international jurisdictions and non-governmental organizations to identify, preserve, restore, and enhance winter habitat is an equally important component of this strategy.

Such collaboration should have a synergistic effect on several other species at risk, whose winter ranges overlap with Common Nighthawk.

Law and policy

Like many other species at risk, there are legal means to protect Common Nighthawk and its habitat in Canada. It is important that these tools are fully realized and utilized for the protection of the species. Six Canadian Provinces presently have this species listed on their respective species at risk legislation, and fully utilizing the potential of those designations is important.

General prohibitions under the *Migratory Birds Convention Act* (1994) and its regulations protect Common Nighthawk nests and eggs anywhere they are found in Canada, regardless of land ownership. Nevertheless, nests and eggs can be inadvertently harmed or disturbed as a result of many activities. During the breeding period, potential destructive or disruptive activities should be avoided at locations where Common Nighthawks are likely to be encountered or known to occur (Environment Canada 2014c). This mitigation can also be accomplished through various avenues including planning policies and regulations, environmental assessments, etc.

Beneficial management practices for this species must be integrated with those for other bird species to maintain heterogeneous landscapes that are a dynamic mosaic of habitat conditions which will benefit several species. Beneficial management practices for governments, industry, and even individuals can play an important role for the ongoing efforts across the range of the species and will be needed to promote recovery of Common Nighthawk and conservation on a large scale across the continent and into South America.

Many species will benefit from reductions in air pollutants. Partnerships should be strengthened with government departments to encourage compliance with the Canadian Environmental Protection Act and to continue implementing the Canada-Wide Acid Rain Strategy for Post-2000, and various relevant provincial acts and regulations including the Energy Strategies and Climate Change Action Plans.

The same pesticides that may affect aerial insectivores are almost certainly affecting human health and the aerial insectivore guild may benefit from campaigns and policies aimed at reducing human reliance on pesticides. Indeed, an ecosystem approach to crop production and protection that combines different management strategies and practices is favoured by the Food and Agricultural Organizations of the United Nations to grow healthy crops and minimize the use of pesticides (Integrated Pest Management Program (Plant Production and Protection Division – UN 2013)).

Voluntary private sector standards and codes (e.g., third-party sustainable forest management certification and international rating systems that recognize excellence for green building) may help reduce some of the threats faced by the species and its prey.

7. CRITICAL HABITAT

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

7.1 Identification of the Species' Critical Habitat

An examination of the geographic range of the species, its habitat specificity, its population size, and threats indicates that critical habitat for Common Nighthawk should be identified at a landscape scale³. The current knowledge of the species, its wide breadth of nesting habitats, and the dynamic nature of landscapes that are used for nesting, roosting, and foraging impart a high degree of uncertainty in the identification of habitat necessary for the survival or recovery of the Common Nighthawk in Canada. Although some habitat suitability modelling has been done (Haché et al. 2014), model inconsistencies persist and, at present, it is unknown whether breeding habitat is limiting in Canada. The available information is not adequate to enable the identification of critical habitat at a landscape scale for the following reasons:

- There is a lack of understanding and data to indicate the appropriate landscape-scale biophysical attributes required by the species and their configuration at a landscape scale.
- Habitat requirements may vary across the range of the species. Management units (i.e., geographic units within which critical habitat would be managed) need to be identified in such a way to best reflect variation in habitat use and land planning processes.
- There is a lack of data related to presence, site usage where detected (e.g., foraging, roosting, defending a territory, nesting, transiting), and abundance in large portions of the species' range and the northern limit of the species' range is unknown. Without this information any model used to predict critical habitat with current data may have a limited ability to do so.
- For Common Nighthawk, it is unknown whether certain habitats with specific biophysical attributes may be functionally more important than others. For example, specific habitats may have greater densities of individuals or pairs and/or result in higher reproductive success.
- The relationships between anthropogenic disturbance and habitat quality are poorly known. A better understanding of these relationships is needed to ensure sufficient suitable habitat is currently available for Common Nighthawk and to

³ Environment Canada recognizes three broad approaches in identifying critical habitat: site-level (small/localized geographic range, narrow habitat specificity), area-level (intermediate geographic range, wide or narrow habitat specificity), and landscape-level (large geographic range, wide habitat specificity). These three conceptual scales are used to help provide context for the critical habitat identification, its presentation, and description of activities likely to destroy critical habitat (Environment Canada 2013).

identify at what scale and intensity activities would be likely to destroy critical habitat.

Locating nests is difficult and determining general nesting locations is problematic using typical point-count survey methodology. Common Nighthawks defend a large area and their foraging habitats can be separated from nest sites by many kilometers, so it is not possible to determine how an individual is using the habitat where it is detected (e.g., foraging, defending a territory, transiting). Furthermore, traditional point-count survey methodology in the morning is not appropriate for this crepuscular species (Government of Alberta 2013; Saskatchewan Ministry of Environment 2014).

A schedule of studies has been developed to provide the information necessary to identify the critical habitat that will be sufficient to meet the population and distribution objectives. The identification of critical habitat will be included either in a revised recovery strategy or an action plan.

7.2 Schedule of Studies to Identify Critical Habitat

To inform the Schedule of Studies, a recent project was undertaken by the Boreal Avian Modelling group to help inform habitat use by Common Nighthawk (Haché et al. 2014). Haché et al. (2014) assessed habitat use for Common Nighthawk across Canada based on avian point counts and available land classification metrics (i.e., land cover and topography), and environmental data (i.e., disturbance and climate). The small number of observations available for the modelling exercise may have resulted in inconsistencies reported among habitat models for Common Nighthawk and likely prevented findings of important habitat relationships (i.e., landscape-scale biophysical attributes) (Haché et al. 2014). The dataset available for the modelling exercise was the most comprehensive dataset for the species available to date in Canada.

The following Schedule of Studies is required to complete the identification of critical habitat.

Table 4. Schedule of Studies

| Description of Activity | Rationale | Timeline |
|---|--|----------|
| Determine the appropriate management units based on habitat requirements across the species' range. | Habitat requirements may vary across the range of the species. Management units need to be identified in such a way to best reflect this variation in habitat use. | 2016 |

| Description of Activity | Rationale | Timeline |
|--|---|-----------------|
| Increase monitoring using newly developed protocols for the species. | Common Nighthawks are not well captured by standard point counts resulting in fewer observations than required to identify important habitat relationships and define biophysical attributes at a landscape scale. The northern limit of the species' breeding range is uncertain at present and is required to identify all habitat that is necessary for its survival or recovery. Monitoring using newly developed protocols is necessary to validate and improve recent habitat models (i.e., Haché et al. 2014). | 2016-2022 |
| Determine the appropriate configuration of landscape-scale biophysical attributes. | In order to identify critical habitat at a landscape scale, it is necessary to understand the biophysical attributes required by the species at this scale and to determine how these should be configured to meet the species' needs. | 2017-2020 |
| Determine habitat quality across and within management units. | Information on abundance, productivity, and other measures of habitat quality may lead to the identification of areas that contribute disproportionately to the survival or recovery of the species. | 2018-2022 |
| Determine the scale and intensity at which suitable habitat would likely be destroyed by anthropogenic activities. | A better understanding of the relationship between anthropogenic disturbance and habitat quality is needed to ensure sufficient suitable habitat is currently available for Common Nighthawk and to identify at what scale and intensity activities would be likely to destroy critical habitat. | 2018-2022 |
| Determine how much suitable habitat is required to meet the population and distribution objectives. | It is uncertain whether habitat is limiting in Canada for Common Nighthawk. An assessment of whether there is sufficient habitat in Canada to meet the population and distribution objectives is required. | 2022 |
| Develop and validate habitat models to determine where biophysical attributes are present in required quantity, quality, and configuration within each management unit to meet population and distribution objectives. | Results from studies listed above will allow models to be built to identify the location, quantity, and quality of habitat that should be identified as critical habitat for Common Nighthawk. | 2023 |

8. MEASURING PROGRESS

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

- In the short term (i.e., by 2025), declining population trends have been halted or reversed to a point where Canadian populations of Common Nighthawk have declined no more than 10% during this time.
- In the long term (after 2025), a positive 10-year trend is achieved (i.e., the population is increasing).
- The breeding extent of occurrence for Common Nighthawk is maintained throughout Canada.

9. STATEMENT ON ACTION PLANS

One or more action plans for Common Nighthawk will be posted on the Species at Risk Public Registry within the five years following the posting of this recovery strategy.

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APPENDIX A: EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the [Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals](#)⁴. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the [Federal Sustainable Development Strategy](#)'s⁵ (FSDS) goals and targets.

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

All species that depend on aerial insects for prey such as bats, swallows, and flycatchers and specifically, bird species at risk including: Chimney Swift, Eastern Whip-poor-will (*Antrostomus vociferus*), Olive-sided Flycatcher (*Contopus cooperi*), Acadian Flycatcher (*Empidonax vireescens*) may benefit from the recommended approaches for Common Nighthawk.

Nonetheless, some species, including other species at risk, may prefer different habitat conditions than Common Nighthawk which needs open areas for nesting. Examples of such species include, but are not limited to Canada Warbler, Bicknell's Thrush, and Rusty Blackbird. Recovery actions for the species must be integrated with beneficial management practices for other bird species, especially where such practices may conflict.

The possibility that the present recovery strategy inadvertently generates negative effects on the environment and on other species was considered. Some gull species may be negatively affected by predator management where they nest on roofs. Such predator management is already underway in many urban and industrial areas in Canada. It was concluded that this strategy will not result in any significant adverse effects.

⁴ <http://www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1>

⁵ <http://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=CD30F295-1>

APPENDIX B: ADDITIONAL RESEARCH FOR KNOWN AND SUSPECTED THREATS TO THE SPECIES, ITS PREY, AND THEIR HABITATS

The following list is not exhaustive, but illustrates some of the research required to understand the threats to the species, its prey, and their habitats.

Natural System Modifications

- Determine potential links between insect availability and breeding productivity;
- Determine if a temporal mismatch between reproduction and maximal prey abundance is occurring;
- Determine the effects of habitat loss (particularly in wintering areas) on the species' prey availability;

Habitat Loss or Degradation

- Determine the relative importance of nonbreeding versus breeding habitat supply in population declines;
- Once non-breeding habitats are identified, identify threats to the species, its prey, and their habitats;
- Determine availability of suitable roof-nesting sites;
- Determine the cause(s) of nest loss for roof-nesting Common Nighthawks;

Climate Change and Severe Weather

Determine the impacts of climate change on the species and its habitat;

Accidental Mortality

- Monitor frequency of collisions and determine site characteristics contributing to high collision rates;

Pollution

- Determine Common Nighthawks' exposure to pollution (pesticides, mercury) and identify impacts;
- Determine if acidification of the species' environment is negatively affecting Common Nighthawk and its habitat (e.g., through loss of favoured nesting, roosting, and/or foraging sites, increased vigilance, and increase predation risk, calcium deficiency during egg laying and chick rearing phases);

Invasive and Other Problematic Species

- Determine if gull species are displacing Common Nighthawks from nesting sites in urban areas;
- Determine human-related predation risk in urban areas (e.g., by cats and other species with increased populations due to human habitation).