



# Cerulean Warbler

*(Setophaga cerulea)* in Ontario

## Ontario Recovery Strategy Series

2022

# About the Ontario Recovery Strategy Series

This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the *Endangered Species Act 2007* (ESA) and the Accord for the Protection of Species at Risk in Canada.

## What is recovery?

Recovery of species at risk is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

## What is a recovery strategy?

Under the ESA a recovery strategy provides the best available scientific knowledge on what is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

## What's next?

Nine months after the completion of a recovery strategy a government response statement will be published which summarizes the actions that the Government of Ontario intends to take in response to the strategy. The implementation of recovery strategies depends on the continued cooperation and actions of government agencies, individuals, communities, land users, and conservationists.

## For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of Environment, Conservation and Parks Species at Risk webpage at: [www.ontario.ca/speciesatrisk](http://www.ontario.ca/speciesatrisk)

## Recommended citation

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## Declaration

The recovery strategy for the Cerulean Warbler (*Setophaga cerulea*) was developed in accordance with the requirements of the *Endangered Species Act, 2007* (ESA). This recovery strategy has been prepared as advice to the Government of Ontario, other responsible jurisdictions and the many different constituencies that may be involved in recovering the species.

The recovery strategy does not necessarily represent the views of all individuals who provided advice or contributed to its preparation, or the official positions of the organizations with which the individuals are associated.

The recommended goals, objectives and recovery approaches identified in the strategy are based on the best available knowledge and are subject to revision as new information becomes available. Implementation of this strategy is subject to appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

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.

## Responsible jurisdictions

Ministry of the Environment, Conservation and Parks  
Environment and Climate Change Canada – Canadian Wildlife Service, Ontario  
Parks Canada Agency

## Executive summary

The *Endangered Species Act, 2007* (ESA) requires the Minister of the Environment, Conservation and Parks to ensure recovery strategies are prepared for all species listed as endangered or threatened on the Species at Risk in Ontario (SARO) List. Under the ESA, a recovery strategy may incorporate all or part of an existing plan that relates to the species.

The Cerulean Warbler (*Setophaga cerulea*) is listed as threatened on the SARO List. The species is listed as endangered under the federal *Species at Risk Act* (SARA). Environment and Climate Change Canada prepared the Recovery Strategy for the Cerulean Warbler (*Setophaga cerulea*) in Canada in 2021 to meet its requirements under the SARA. This recovery strategy is hereby adopted under the ESA. With the additions indicated below, the enclosed strategy meets all of the content requirements outlined in the ESA.

The Critical Habitat section of the federal recovery strategy provides an identification of critical habitat (as defined under the SARA). Identification of critical habitat is not a component of a recovery strategy prepared under the ESA. However, it is recommended that the approach used to identify critical habitat in the federal recovery strategy, along with any new scientific information pertaining to the Cerulean Warbler and the areas it occupies, be considered if a habitat regulation is developed under the ESA.

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## 1.0 Adoption of federal recovery strategy

The *Endangered Species Act, 2007* (ESA) requires the Minister of the Environment, Conservation and Parks to ensure recovery strategies are prepared for all species listed as endangered or threatened on the Species at Risk in Ontario (SARO) List. Under the ESA, a recovery strategy may incorporate all or part of an existing plan that relates to the species.

The Cerulean Warbler (*Setophaga cerulea*) is listed as Threatened on the SARO List. The species is listed as Endangered under the federal *Species at Risk Act* (SARA). Environment and Climate Change Canada prepared the Recovery Strategy for the Cerulean Warbler (*Setophaga cerulea*) in Canada in 2021 to meet its requirements under the SARA. This recovery strategy is hereby adopted under the ESA. With the additions indicated below, the enclosed strategy meets all of the content requirements outlined in the ESA.

### 1.1 Species assessment and classification

The following list is assessment and classification information for the Cerulean Warbler (*Setophaga cerulea*). Note: The glossary provides definitions for the abbreviations and technical terms in this document.

- SARO List Classification: Threatened
- SARO List History: Threatened (2011), Special Concern (2010)
- COSEWIC Assessment History: Endangered (2010)
- SARA Schedule 1: Endangered
- Conservation Status Rankings: G-rank: G4; N-rank: N3B,NUM; S-rank: S2B

### 1.2 Species description and biology

#### Species description

In addition to the information that is provided in the federal recovery strategy, Cerulean Warblers are difficult to locate by sight given their preference for upper canopies of forests. It has been suggested that an effective tool to identify their territory and habitat is through their distinctive buzzy, ascending song (given only by the male) (Hyde et al, 2000).

### **1.3 Area for consideration in developing a habitat regulation**

Under the ESA, a recovery strategy must include a recommendation to the Minister of the Environment, Conservation and Parks on the area that should be considered in developing a habitat regulation. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below will be one of many sources considered by the Minister, including information that may become newly available following completion of the recovery strategy should a habitat regulation be developed for this species.

The Critical Habitat section of the federal recovery strategy provides an identification of critical habitat (as defined under the SARA). Identification of critical habitat is not a component of a recovery strategy prepared under the ESA. However, it is recommended that the approach used to identify critical habitat in the federal recovery strategy along with any new scientific information pertaining to the Cerulean Warbler and the areas it occupies, be considered if a habitat regulation is developed for the species under the ESA.

As the species tends to spend long periods of time in the canopy, out of sight, additional species presence criteria (e.g., probable breeding evidence) may also be considered if habitat guidance is developed for the species under the ESA.



## Glossary

**Committee on the Status of Endangered Wildlife in Canada (COSEWIC):** The committee established under section 14 of the Species at Risk Act that is responsible for assessing and classifying species at risk in Canada.

**Committee on the Status of Species at Risk in Ontario (COSSARO):** The committee established under section 3 of the *Endangered Species Act, 2007* that is responsible for assessing and classifying species at risk in Ontario.

**Conservation status rank:** A rank assigned to a species or ecological community that primarily conveys the degree of rarity of the species or community at the global (G), national (N) or subnational (S) level. These ranks, termed G-rank, N-rank and S-rank, are not legal designations. Ranks are determined by NatureServe and, in the case of Ontario's S-rank, by Ontario's Natural Heritage Information Centre. The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by the letter G, N or S reflecting the appropriate geographic scale of the assessment. The numbers mean the following:

1 = critically imperilled

2 = imperilled

3 = vulnerable

4 = apparently secure

5 = secure

NR = not yet ranked

NU = Unrankable—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

In some cases, taxa are also assigned Breeding Status Qualifiers following their conservation status rank (NatureServe 2021):

**B = breeding**—Conservation status refers to the breeding population of the species in the nation or state/province.

**N = non-breeding**—Conservation status refers to the non-breeding population of the species in the nation or state/province.

**M = migrant**—Migrant species occurring regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. Conservation status refers to the aggregating transient population of the species in the nation or state/province.

***Endangered Species Act, 2007 (ESA):*** The provincial legislation that provides protection to species at risk in Ontario.

***Species at Risk Act (SARA):*** The federal legislation that provides protection to species at risk in Canada. This Act establishes Schedule 1 as the legal list of wildlife

species at risk. Schedules 2 and 3 contain lists of species that at the time the Act came into force needed to be reassessed. After species on Schedule 2 and 3 are reassessed and found to be at risk, they undergo the SARA listing process to be included in Schedule 1.

Species at Risk in Ontario (SARO) List: The regulation made under section 7 of the *Endangered Species Act, 2007* that provides the official status classification of species at risk in Ontario. This list was first published in 2004 as a policy and became a regulation in 2008.

## List of abbreviations

COSEWIC: Committee on the Status of Endangered Wildlife in Canada

COSSARO: Committee on the Status of Species at Risk in Ontario

CWS: Canadian Wildlife Service

ESA: Ontario's *Endangered Species Act, 2007*

ISBN: International Standard Book Number

MECP: Ministry of the Environment, Conservation and Parks

NDMNRF: Ministry of Northern Development, Mines, Natural Resources and Forestry

SARA: Canada's *Species at Risk Act*

SARO List: Species at Risk in Ontario List

## References

Hyde, D., Thomson, D., and J. Legge. 2000. Special Animal Abstract for *Dendroica cerulea* (Cerulean warbler). Michigan Natural Features Inventory, Lansing, MI. 4pp.

NatureServe. 2021. NatureServe Explorer [web application]. [Statuses](#). NatureServe, Arlington, Virginia. Available <https://explorer.natureserve.org/AboutTheData/Statuses>. (Accessed: August 30, 2021).

## **Appendix 1. Recovery strategy for the Cerulean Warbler (*Setophaga cerulea*) in Canada**

# Recovery Strategy for the Cerulean Warbler (*Setophaga cerulea*) in Canada

## Cerulean Warbler



2021



Government  
of Canada

Gouvernement  
du Canada

Canada

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**Official version**

The official version of the recovery documents is the one published in PDF. All hyperlinks were valid as of date of publication.

**Non-official version**

The non-official version of the recovery documents is published in HTML format and all hyperlinks were valid as of date of publication.

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

**Cover illustration:** Karl Egressy

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<sup>1</sup> [www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html](http://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html)

## Preface

The federal, provincial, and territorial government signatories under the [Accord for the Protection of Species at Risk \(1996\)](#)<sup>2</sup> agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Quebec is not a signatory to the Accord, but has agreed to work in collaboration and complementarity with Canada under the *Cooperation Agreement for the Protection and Recovery of Species at Risk in Quebec (2012-2022)*. Under the *Species at Risk Act (S.C. 2002, c.29) (SARA)*, the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Cerulean Warbler and has prepared this recovery strategy, as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the Provinces of Ontario and Quebec, 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 and Climate Change Canada and the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Cerulean Warbler and Canadian society as a whole.

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

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

In the case of critical habitat identified for terrestrial species including migratory birds, SARA requires that critical habitat identified in a federally protected area<sup>3</sup> be described

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<sup>2</sup> [www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2](http://www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2)

<sup>3</sup> These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.



## Acknowledgments

This recovery strategy was prepared by John Brett (Environment and Climate Change Canada-Canadian Wildlife Service (ECCC-CWS) - Ontario Region), with contributions from Bruno Drolet (ECCC-CWS - Quebec Region), Rich Russell, Angela Darwin (ECCC-CWS - Ontario Region), Al Harris (Northern Bioscience), and Véronique Connolly (private consultant, formerly ECCC-CWS - Quebec Region). Mike Burrell and Don Sutherland (Ontario Natural Heritage Information Centre [NHIC]) provided updated population estimates for Ontario. Judith Girard, Krista Holmes and Elisabeth Shapiro (ECCC-CWS - Ontario Region) provided comments, advice and input during the development of this document. This document benefited from comments provided by the Ontario Ministry of Natural Resources and Forestry and the Ontario Ministry of the Environment, Conservation and Parks.

The threats assessment was coordinated by Holly Bickerton and facilitated by Dwayne Lepitzki, with input provided by Bruno Drolet (ECCC-CWS – Quebec Region), Rich Russell, John Brett, Judith Girard, and Lee Voisin (ECCC-CWS – Ontario Region), Jon McCracken (formerly Bird Studies Canada), Mike Burrell (NHIC), and Marcel Gahbauer (Committee on the Status of Endangered Wildlife in Canada, COSEWIC).

We thank QuébecOiseaux and Birds Canada for supplying data and maps from the Ontario and Québec breeding bird atlases. We also thank the thousands of participants who helped collect these data.

## Executive Summary

The Cerulean Warbler (*Setophaga cerulea*) is a small songbird in the wood-warbler family (Parulidae) that breeds in southwestern and eastern Ontario and southwestern Quebec in Canada. It is found in older or mature deciduous forests in eastern North America, and winters in montane forests in the Northern Andes of South America. It was listed as Endangered on Schedule 1 of the *Species at Risk Act* in November 2017 due to its small population size, mostly found within a single sub-population.

The Canadian range for the species is concentrated mainly in two geographic breeding clusters in Ontario: i) in Carolinian forests between lower Lake Huron and Lake Ontario, and ii) in a band extending east from southeastern Georgian Bay toward the Frontenac Axis near the eastern end of Lake Ontario, where a relatively dense concentration occurs. There are a small number of breeding individuals in southwestern Québec, along with records of individuals without breeding confirmation. In addition, there have been sightings, but no confirmed breeding individuals, reported in Nova Scotia, New Brunswick, Newfoundland and Manitoba.

The continental decline of the Cerulean Warbler may be greater than that of any other wood-warbler. This situation may be reflected in Canada, where the results from the first and second Ontario Breeding Bird Atlases show a decline between atlas periods. In 2010, the Canadian population was estimated to be between 866 and 1086 mature individuals (COSEWIC 2010), though a recent estimate suggests that the population may now be much smaller.

The Canadian population of Cerulean Warbler is affected by threats in its breeding, migration, and wintering ranges, but the scope and severity of many individual threats, especially on the migration and wintering grounds, are uncertain. Habitat loss and degradation from a variety of sources on both the breeding and wintering grounds are likely the primary threats to this species, but other threats of unknown impact include collisions with utility and service lines, invasive non-native species, problematic native species, and habitat shifting and alteration.

The long-term (30 years) population and distribution objective for the Cerulean Warbler in Canada is to achieve a stable population of at least 1000 mature individuals and to maintain the species' range and maintain, or where biologically and technically possible, increase the species' area of occupancy within its current Canadian range. To support achievement of the long-term objective, a short-term (10 years) objective to halt the declining population trend is identified.

Broad strategies to be taken to address the threats to the survival and recovery of the Cerulean Warbler are presented in Strategic Direction for Recovery (Section 6.2).

The critical habitat that is identified for Cerulean Warbler is likely not sufficient to meet the population and distribution objectives. There are currently unknowns in the amount, type, and configuration of habitat that is needed to support breeding Cerulean Warblers

in varying Canadian forested landscapes. In addition, there are many locations throughout the Canadian range for which accurate, precise, and recent occurrence data are lacking. A schedule of studies has been developed to provide the information necessary to complete the identification of critical habitat.

One or more action plans for the Cerulean Warbler, in addition to the posted Parks Canada multi-species action plans that include Cerulean Warbler, will be posted on the Species at Risk Public Registry by 2025.

## Recovery Feasibility Summary

Based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility, there are unknowns regarding the feasibility of recovery of the Cerulean Warbler. In keeping with the precautionary principle, this recovery strategy has been prepared as per section 41(1) of SARA, as would be done when recovery is determined to be technically and biologically 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. Individuals capable of reproduction are available now, however some local populations in Canada may currently be dependent on immigration to persist. In addition, population levels are low and have shown a non-significant decline in Ontario (Francis 2007, COSEWIC 2010) and in Quebec (COSEWIC 2010). Populations in adjacent states are also declining (COSEWIC 2010), reducing the likelihood of rescue by immigration. Breeding Bird Survey trend data suggests that Cerulean Warbler declined in Michigan, Ohio, and Pennsylvania between 1996 and 2015 (Sauer et al. 2017), and the New York Breeding Bird Atlas shows that the number of blocks with records declined by 13% between atlas periods (McGowan and Corwan 2008). However, Partners in Flight has created continental objectives for this species which aim to stabilize and ultimately increase the size of the population, which, if supported by on-the-ground conservation efforts, could increase the availability of individuals to sustain the Canadian population.

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

Unknown. This species habitat preferences are specialized, and it favours relatively large tracts of mature hardwood forest for its breeding territories. Most available breeding habitat in Canada is in eastern Ontario where continuous or near-continuous mature forest can be found and where the greatest concentration of Cerulean Warbler breeding occurs in Canada (COSEWIC 2010). Habitat has become available in this region over the past century through

abandonment of agricultural fields, allowing for natural succession and an overall increase in forest cover (Oliarnyk and Robertson 1996). This process, however, takes decades and it is likely that the rate of land abandoned for succession has slowed. In southwestern Ontario, the landscape is under greater pressure from agriculture, industry and urban development and has experienced larger habitat loss and degradation, which may limit the feasibility of landscape-scale forest restoration.

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

Unknown. Habitat loss and degradation on both the breeding and wintering grounds, as well as along migration routes, are likely the biggest threats facing this species. While addressing at least some of these threats through habitat restoration and management is possible, it is unknown if efforts will be sufficient, especially on the wintering grounds outside of Canada, where the northern Andes montane forests experience some of the greatest deforestation rates in the neotropics (Bakermans et al. 2009).

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

Yes. While the primary threats to this species in Canada appear to be those related to habitat loss and degradation, techniques for minimizing and reversing habitat loss and degradation exist. Halting, and ultimately reversing, the population decline in Canada will depend on conservation and proper management of breeding, wintering and migratory stop-over habitat and require collaboration of multiple organizations and governments at both regional and continental scales. Forest management techniques (e.g., single-tree selection and group selection harvesting, rotating cuts) are available to landowners and managers, which maintain both the economic quality and ecosystem health of the forest. Much of the Cerulean Warbler's Canadian range occurs in a natural forest biome, where reforestation is feasible and the potential for succession to forest is high.

However, as the small Canadian population of Cerulean Warbler occurs at the northern part of its continental range, and the vast majority of its continental distribution and population occurs further south in the United States, it is important to note that population changes at the continental level may have a significant effect on recovery feasibility in Canada. As the continental population of the Cerulean Warbler is experiencing an ongoing downward population trend (Sauer et al. 2017), its range may contract away from the current periphery, and individuals may immigrate towards the centre of the range. In such a case, despite best efforts described in this strategy to ensure that sufficient suitable habitat is available and key threats are mitigated, the numbers of Cerulean Warbler in Canada may continue to decline.

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## 1. COSEWIC\* Species Assessment Information

**Date of Assessment:** November 2010

**Common Name (population):** Cerulean Warbler

**Scientific Name:** *Dendroica cerulea*\*\*

**COSEWIC Status:** Endangered

**Reason for Designation:** This sky-blue forest songbird is at the northern edge of its breeding range in Canada. Relying on relatively large tracts of undisturbed hardwood forest, it has rather specialized habitat requirements on both its breeding and wintering grounds. Its population has been experiencing significant declines across most of its range since the 1960s and the present Canadian population is estimated at about only 1000 individuals. These declines are believed to be driven mostly by loss and degradation of this species' wintering habitat, which is restricted to montane forests in the northern Andes of South America. It is also threatened by habitat loss and degradation on its breeding grounds. There is evidence for continuing declines. Also, new information on demographics suggests that chances for population rescue in Canada are lower than previously thought.

**Canadian Occurrence:** Ontario, Quebec

**COSEWIC Status History:** Designated Special Concern in April 1993. Status re-examined and confirmed in May 2003. Status re-examined and designated Endangered in November 2010.

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

\*\* The scientific name in the 2010 COSEWIC assessment was *Dendroica cerulea*. The scientific name of the Cerulean Warbler was changed to *Setophaga cerulea* in 2011 by the American Ornithologist's Union (Chesser et al. 2011).

## 2. Species Status Information

The global status of the Cerulean Warbler is G4 (Apparently Secure) with national ranks of N3B (Vulnerable, Breeding population) in Canada and N4B (Apparently Secure, Breeding population) in the United States (NatureServe 2018). In Ontario, the species is listed as S3B (Vulnerable, Breeding population) and in Quebec it is listed as S1B (Critically Imperiled, Breeding population; NatureServe 2018). A complete list of subnational status ranks and definitions is given in Appendix B. Due to continental and regional population declines, the Cerulean Warbler has been placed on the Partners in Flight Watch List of Species of Continental Concern for continental United States and Canada (Rosenberg et al. 2016). It is listed as a Priority Species in Bird Conservation Regions 12 (BCR 12, Boreal Hardwood Transition) and 13 (BCR 13, Lower Great Lakes/St. Lawrence Plain) in Ontario and Quebec (Environment Canada 2013a, 2013b, 2014a, 2014b).

The species is designated as Endangered under Canada's *Species at Risk Act*. In Ontario it is listed as Threatened under Ontario's *Endangered Species Act* (ESA) (S.O. 2007, c. 6), and receives species protection and general habitat protection under the ESA. In Quebec it is listed as Threatened under Québec's *Act Respecting Threatened or Vulnerable Species*<sup>4</sup>.

The Cerulean Warbler was designated by COSEWIC as Endangered due to its small population size in Canada (i.e. <2500 individuals) and >95% of the population occurring in a single subpopulation<sup>5</sup> (COSEWIC 2010).

Approximately 0.2% of the total global population occurs in Canada, based on data from the Ontario Breeding Bird Atlas, researchers from Queen's University, the Ontario Birds at Risk program, Frontenac Bird Studies, the Ontario Forest Bird Monitoring Program, and the SOS-POP database on Quebec's species at risk (SOS-POP 2009, COSEWIC 2010). However, a recent estimate provided by the Ontario Natural Heritage Information Centre suggests that the Canadian population of Cerulean Warbler may actually represent only 0.1% of the global population (M. Burrell pers. comm. 2018).

### 3. Species Information

#### 3.1 Species Description

The Cerulean Warbler is a small (11.5 cm in length, 8-10.5 g in weight) songbird in the wood-warbler family (Buehler et al. 2013). The adult male is deep blue above and white below with a dark band across the throat, whereas the adult female is blue-green above, white washed with yellow below, and has a white or yellowish eyebrow (Buehler et al. 2013). Both sexes have two prominent white wing-bars and white tail spots, and immature individuals (i.e. first-spring birds) are similar to adults, but tend to be duller and not as boldly marked (Buehler et al. 2013).

#### 3.2 Species Population and Distribution

Globally, the Cerulean Warbler breeds in eastern North America in the northeastern United States and parts of southeastern Canada (Figure 1). The species is not distributed evenly within this range, being widespread in some areas (e.g., southern Missouri, southern Wisconsin, eastern Kentucky, West Virginia, eastern Ohio), while very local in others (e.g., Illinois, northern Indiana, western Tennessee, western Kentucky (Buehler et al. 2013)). The species spends the winter in mountains of South America, on the east and west slopes of the Andes in Colombia and Ecuador,

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<sup>4</sup> Québec's *Act Respecting Threatened or Vulnerable Species* uses two designations, Vulnerable and Threatened, with species designated as Threatened being the most at risk.

<sup>5</sup> As per COSEWIC, subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less).

and on the east slopes in Venezuela, Peru, and Bolivia (Sullivan et al. 2009, Buehler et al. 2013). Spring and fall migrations mostly take place along the Mississippi and Ohio River valleys, along the coastal Atlantic states, across the Gulf of Mexico, and to a lesser degree, along the Caribbean coast of Central America and through parts of the Greater Antilles (Buehler et al. 2013).



Figure 1. Global range of the Cerulean Warbler (modified from Ridgely et al. 2007).

The Canadian range of the Cerulean Warbler is concentrated in two main geographic areas in Ontario: 1) in Carolinian forests between lower Lake Huron and Lake Ontario, and 2) in a more northerly band that extends from southeastern Georgian Bay east to a relatively dense concentration at the Frontenac Axis near the east end of Lake Ontario (Figure 2; Environment Canada 2011). A small number of individuals occur, with limited confirmed breeding, in the Outaouais and Montérégie regions of southwestern Quebec (see Figure 3; Environment Canada 2011, Quebec Bird Breeding Atlas 2017).



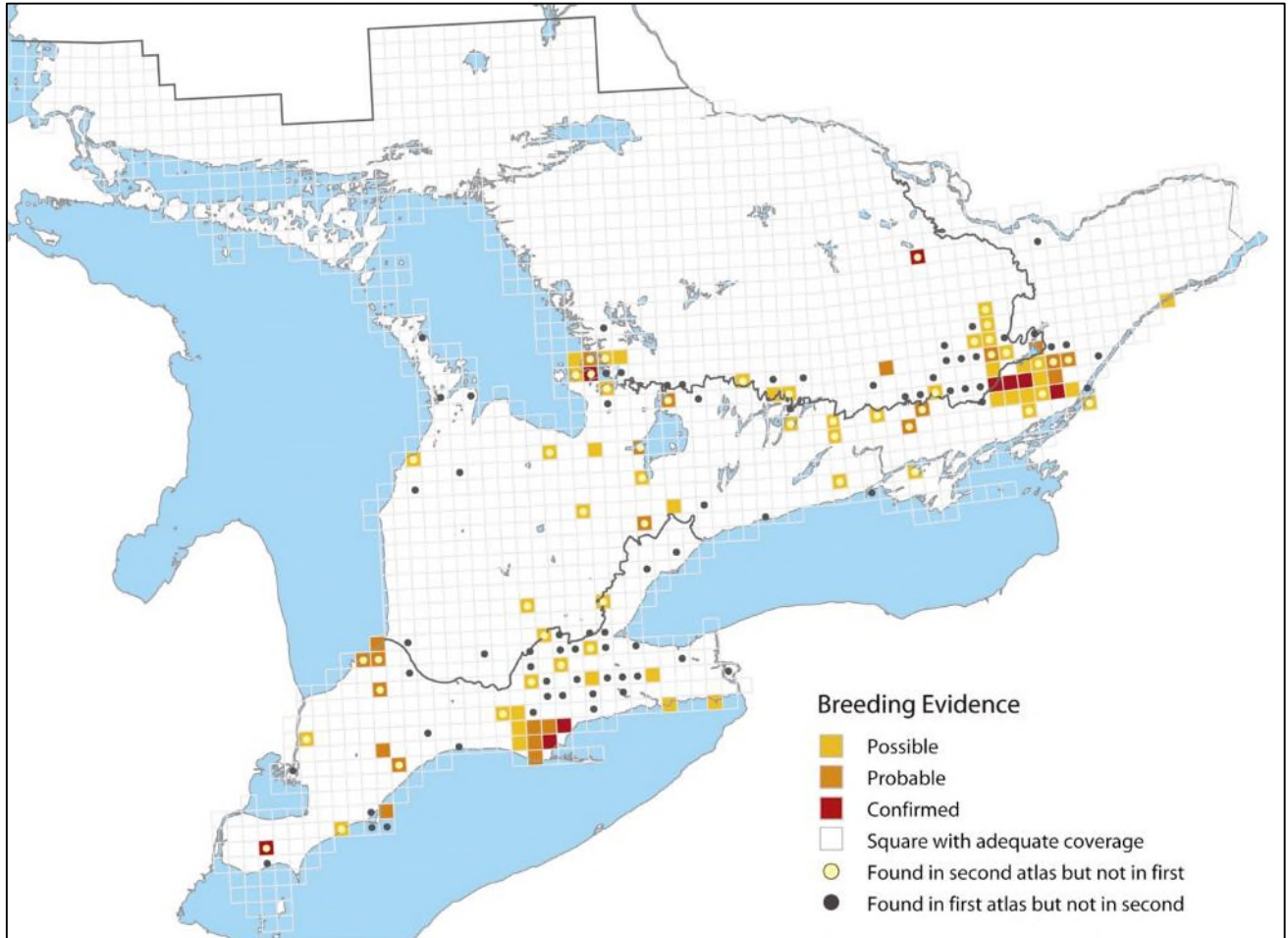


Figure 2. Distribution of the Cerulean Warbler in Ontario between 2001 and 2005 (second Ontario Breeding Bird Atlas; Cadman et al. 2007). Squares are 10 km x 10 km. Data collection for the first atlas was from 1981-1985.

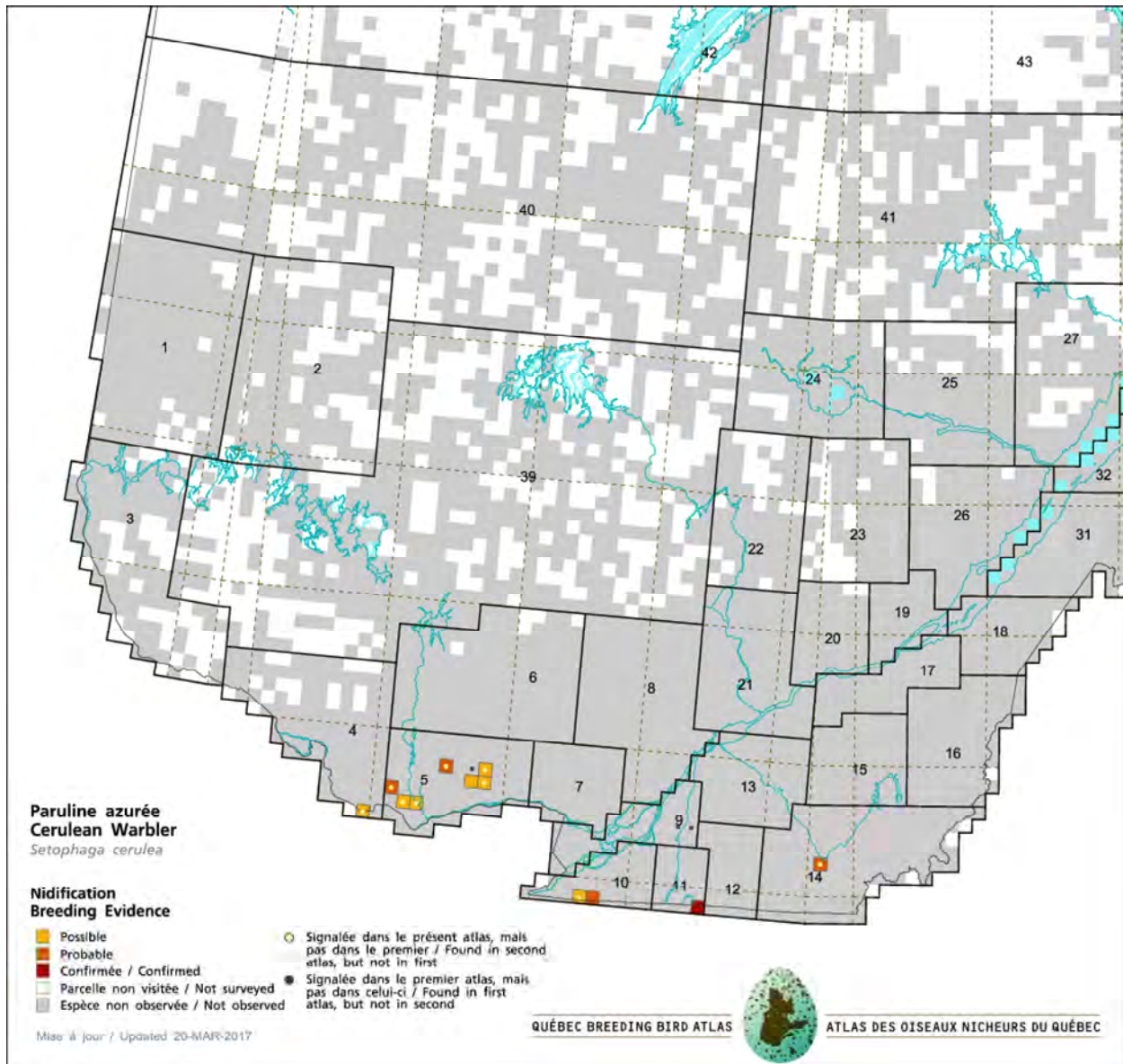


Figure 3. Distribution of the Cerulean Warbler in Quebec between 2010 and 2014 (second Quebec Breeding Bird Atlas; Quebec Breeding Bird Atlas 2017). Squares are 10 km x 10km. Data collection for the first atlas was from 1984-1989.

The global population of Cerulean Warblers is estimated at 570,000 individuals (Rosenberg et al. 2016). In 2010, the Canadian population of Cerulean Warblers was estimated at 433-543 pairs (866-1086 mature individuals), In 2018, the Ontario Natural Heritage Information Centre provided a revised estimate of 327 territorial males in Ontario (M. Burrell pers. comm. 2018). Some of these territorial males would likely be unpaired, so this estimate may represent fewer than 327 breeding pairs.

The North American Breeding Bird Survey (BBS) indicates long-term population declines at a continental scale (-2.63% annual population change from 1966 to 2015, Sauer et al. 2017). During this time period, populations in most states bordering Ontario

experienced annual population declines (e.g. Michigan (-3.41%); Ohio (-4.22%); and Pennsylvania (-2.48%)); while the trend in New York has remained stable (Sauer 2017). However, the BBS may not be particularly well-suited for monitoring Cerulean Warbler trends due to its interior forest habitat not being well-sampled by roadside point counts (COSEWIC 2010). While BBS data collected in Canada mirrors the continental trend, trends in Canada are based on three or fewer survey routes and are therefore of low reliability (Environment and Climate Change Canada 2017).

Results from the second Ontario Breeding Bird Atlas (2001-2005) show a decline of 30% ( $P = 0.18$ ) in the probability of occurrence<sup>6</sup> for the province as a whole between the first and second atlases, but a 47% decline ( $P = 0.08$ ) in the Carolinian region (Francis 2007). The species appears relatively stable in the Frontenac Axis (Francis 2007), but the low productivity in this population may not be sufficient to offset high adult mortality (Jones et al. 2004, Buehler et al. 2008). During data collection for the second Quebec Breeding Bird Atlas (2010-2014), the species was detected in 12 atlas squares compared to 9 during the first atlas period (1984-1989), but breeding was confirmed in only one of those (Figure 3; Quebec Breeding Bird Atlas 2017).

### 3.3 Needs of the Cerulean Warbler

#### Habitat

On the breeding grounds, the Cerulean Warbler is primarily associated with forested landscapes characterized by mature deciduous stands with large, tall trees and a closed or semi-opened canopy (Buehler et al. 2013). Cerulean Warbler breeding habitat can be identified at multiple scales, including the landscape, stand-level, nest patch, and nest site (Buehler et al. 2008, Boves et al. 2013b). In Ontario, the species prefers mature deciduous forest dominated by oak (*Quercus* spp.) and/or maple (*Acer* spp.) that is often associated with swampy bottomlands (COSEWIC 2010), but it also uses older second-growth deciduous forest (Environment Canada 2011). In Quebec, Cerulean Warblers use large, mature deciduous stands, where permanent creeks are often present (COSEWIC 2010).

Landscape-scale forest cover has been shown to be a predictor of Cerulean Warbler occurrence and abundance at various scales. In a Pennsylvania study, the presence of Cerulean Warblers was found to be positively related to the amount of forest cover within 1 km of the centre of surveyed sites (Rodewald 2004). In an analysis of local- and landscape-scale habitat composition surrounding river segments occupied by Cerulean Warblers in Missouri and Arkansas, the amount of forest cover within a 10 km radius was found to have a significant effect on abundance (Thompson et al. 2012). The effect of landscape-scale forest cover on Cerulean Warbler occurrence and abundance in Canada is not well-understood.

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<sup>6</sup> A standard term that expresses the probability that a species would be detected in an average atlas square (10 km x 10 km in size), during 20 hours of observation.

Cerulean Warblers are generally considered to be area-sensitive, and prefer larger tracts of continuous habitat (Environment Canada 2011a), but the minimum forest patch size for successful nesting appears to also depend on the amount of forest cover in the landscape and distance between patches (Thompson et al. 2012, Wood et al. 2013). Smaller forest patches are used in landscapes that are primarily forested (e.g. >75% forest cover within ~10 km) but are less likely to be occupied in landscapes that are dominated by agriculture (Thompson et al. 2012, Wood et al. 2013).

Minimum forest patch sizes of 700 and 1600 ha have been reported in east coast states and Tennessee, respectively (Buehler et al. 2013). The Ohio Breeding Bird Atlas reported that Cerulean Warblers prefer forest patches at least 50-75 acres (20-30 ha) in size, and normally avoid isolated woodlots that are less than 20-25 acres (8-10 ha; Peterjohn and Rice 1991), though it is not stated in the atlas how these estimates were determined. While breeding Cerulean Warblers have occupied forest patches as small as 10 ha in eastern Ontario's forested landscape (COSEWIC 2010, Jones pers. comm. 2019), it is unlikely that isolated patches of this size would support a viable Cerulean Warbler population in Canada. The minimum patch sizes needed to support viable local populations in Canada is not well understood, and may vary depending on landscape-scale forest cover and whether or not the region is dominated by agriculture. Patch size may influence Cerulean Warbler occupancy and breeding success through factors that correlate with fragment size. For example, nest predation or brood parasitism<sup>7</sup> by Brown-headed Cowbirds (*Molothrus ater*) may limit suitability of smaller, more isolated forest patches in some landscapes (reviewed in Buehler et al. 2013). In addition Cerulean Warblers may preferentially select forest stands large enough to support multiple territories (Roth and Islam 2007), but this has not been adequately studied.

Average territory size in eastern Ontario was reported to be 1.04 ha and ranged from 0.38 ha to 2.4 ha (Oliarnyk and Robertson 1996), though a more recent study found the area actually occupied by individuals to be smaller (i.e. 0.7 ha, ranged from 0.12 to 2.35 ha; Barg et al. 2005). In eastern Ontario, such core areas were found to have a high concentration of Bitternut Hickory (*Carya cordiformis*), which served as a highly preferred song-post tree (Barg et al. 2006) and has also been suggested to be an important foraging substrate (Gabbe et al. 2002). Sugar Maple (*Acer saccharum*), White Ash (*Fraxinus americana*), oaks (*Quercus* spp.), and American Elm (*Ulmus americana*) were also used as song-post trees by the Cerulean Warbler in eastern Ontario (Barg et al. 2006). In the United States, White Oak (*Quercus alba*) and Sugar Maple were selected as nesting trees by the Cerulean Warbler, while Red Oak (*Quercus rubra*) and Red Maple (*Acer rubrum*) were avoided for nesting, foraging or as song posts (reviewed in Buehler et al. 2013).

Nesting territories generally have large diameter, well-spaced trees, and structurally complex canopies (Wood et al. 2013, Boves et al. 2013b). However, in Indiana,

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<sup>7</sup> This refers to a parasitic relationship in which the parasitic species relies on a host species to raise their young, often at the cost of the hosts' own young. In this case, the Brown-headed Cowbird lays their eggs in the nest of Cerulean Warblers, causing the eggs to be hatched and reared by the warbler.

territories had smaller trees, possibly because these areas offer more foliage for foraging (Roth and Islam 2007). Nest patches and territories generally have greater canopy cover than non-used sites (Carpenter et al. 2011, Nemes and Islam 2017). In Ontario, preferred sites had dense overstory vegetation (> 18 m tall) and high mid-canopy (12 to 18 m tall) foliage cover (Jones and Robertson 2001). In the Appalachians, males in less forested landscapes preferred more closed-canopy forest, while males in highly forested landscapes preferred territories with canopy disturbance (e.g. open areas within a forest) (Boves et al. 2013a). The differences may be related to differing levels of predation, brood parasitism, or competition with other bird species, particularly Eastern Wood-Pewee (*Contopus virens*) and Black-throated Green Warbler (*Setophaga virens*) (Boves et al. 2013a).

Cerulean Warblers tend to select territories away from “hard” edges, i.e. abrupt transitions between forest and other habitat types (Wood et al. 2013). The presence of hard edges may increase predation and brood parasitism (see discussion in Sallabanks et al. 2000). In a West Virginia study, abundance of Cerulean Warblers increased with increasing distance up to 340 m from the forest edge (Wood et al. 2006). However, Cerulean Warbler territories are often associated with interior gaps within the forest canopy (Perkins and Wood 2014, Roth and Islam 2007, Wood et al. 2013), which may have higher productivity of vegetation and therefore more insect prey due to increased light penetration, greater soil moisture, and higher nutrients (Nemes and Islam 2017). The degree of use of canopy gaps may depend on forest structure and the surrounding landscape (Perkins and Wood 2014). In relatively intact forest landscapes, increased understory cover and decreased overstory may be attractive to Cerulean Warblers, but they may avoid these disturbances in more fragmented areas (Buehler et al. 2013).

While mixed and coniferous forest are not used by Cerulean Warbler for breeding, patches of coniferous forest within a mixed or deciduous forest matrix contributes to landscape-scale forest cover, and reduces hard edges. In addition, a recent study found that Cerulean Warbler territories were located closer to patches of coniferous forest than expected and based on availability of habitat (Kaminski and Islam 2013), though this could be due to a relationship with other habitat features – more study is needed.

Cerulean Warbler territories are often associated with sloping terrain (Roth and Islam 2007, Boves et al. 2013a, Barnes et al. 2016, Nemes and Islam 2017,). Slopes may promote more diverse vegetation structure by allowing light penetration below the canopy (Nemes and Islam 2017), or may have a higher proportion of super-canopy trees (i.e. trees exceeding the average height of the canopy) than flat areas. Within territories, nest patches are more often found on ridges and valleys and less often on mid-sloping terrain (Nemes and Islam 2017).

Less is known about the habitat used by the Cerulean Warbler during migration, but while migrating along the coast of Central America, the species has been found in primary and mature secondary forests, as well as in rustic shade coffee plantations (Welton et al. 2012, Buehler et al. 2013). The species winters in a narrow elevational range (850-2000 m; Fundación ProAves et al. 2010) in mature and relatively undisturbed broad-leaved evergreen forests on the slopes of the Andes, but it also

occurs in secondary forests and rustic shade coffee, cardamom and cacao plantations that retain native trees (COSEWIC 2010, Colorado et al. 2012, Buehler et al. 2013).

Cerulean Warblers appear to have an entirely insectivorous diet during the breeding season, but will also consume nectar resources during the non-breeding season (COSEWIC 2010).

### **Limiting Factors**

There are intrinsic factors that could be limiting to this species, including high site fidelity<sup>8</sup>, migratory connectivity<sup>9</sup>, and long distance migration routes. Adults show high site fidelity (Jones et al. 2004, Barg et al. 2005, 2006), and may not respond to habitat degradation at a particular breeding site by moving to more suitable habitat (COSEWIC 2003), which could result in breeding in suboptimal habitat and, potentially, reduced productivity. Migratory connectivity has been shown to exist in Cerulean Warblers and may hinder conservation of this species, as declines in a given wintering area will likely exacerbate declines in the corresponding breeding area, and vice versa (Jones et al. 2008). Migration has been suggested as a potential period of high mortality for this species and other wood-warblers (Sillert and Holmes 2002, Jones et al. 2004). A relatively long migration distance and extended migration periods in the spring (2 months) and fall (4 months) mean that Cerulean Warblers are subjected to a long duration of high physiological stress and an increased exposure to predation (Hamel 2000, COSEWIC 2010).

The Canadian population may also be limited by its dependence on immigration from neighbouring populations. At least one eastern Ontario location may not produce enough individuals to maintain a stable population and is perhaps relying on immigration from other locations (Jones et al. 2004). There continues to be gene flow between populations in Canada and the United States (Veit et al. 2005, Deane et al. 2013) but as the global population declines, the possibility of rescue through immigration is decreasing (Buehler et al. 2008, COSEWIC 2010). Area sensitivity may be another limiting factor leading to unviable populations; Cerulean Warbler may be less productive in landscapes with low forest cover, but may tolerate small patch sizes and distance between patches if forest cover in the landscape is high (Buehler et al. 2008, Thompson et al. 2012, Wood et al. 2013).

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<sup>8</sup> The tendency of an individual, pair, or population to return to the same previously occupied location each year.

<sup>9</sup> Individuals from a given breeding area are generally connected to a specific geographic area for the winter period

## 4. Threats

### 4.1 Threat Assessment

The Cerulean Warbler threat assessment is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system (Salafsky et al. 2008). Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered during this assessment process. For purposes of threat assessment, only present and future threats that are expected to affect the population over the next ten years are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in the Description of Threats section.

The scope and severity of many individual threats, especially on the wintering grounds, is unknown; more study is needed to determine the relative impact of breeding and wintering range threats on the Canadian population of Cerulean Warbler.

For this species, the impact of individual threats is estimated to be low or unknown. However, the cumulative effect of these threats is expected to have a much stronger impact on the population. For example, while habitat loss and degradation on the wintering grounds are thought to be the primary threats to Cerulean Warbler (COSEWIC 2010), individual activities responsible for this deforestation (e.g. agriculture, conversion to pasture, or forestry) each have a relatively limited scope, and consequently a low estimated impact.

**Table 1. Threat calculator assessment for Cerulean Warbler**

Threat # <sup>a</sup>	Threat Description	Impact <sup>b</sup>	Scope <sup>c</sup>	Severity <sup>d</sup>	Timing <sup>e</sup>
<b>1</b>	<b>Residential &amp; commercial development</b>				
1.1	Housing & urban areas	Low	Small	Extreme-Serious	High
1.2	Commercial & industrial areas	Low	Small	Extreme-Serious	High
<b>2</b>	<b>Agriculture &amp; aquaculture</b>				
2.1	Annual & perennial non-timber crops	Low	Small	Serious	High
2.3	Livestock farming & ranching	Unknown	Unknown	Extreme-Serious	High
<b>4</b>	<b>Transportation &amp; service corridors</b>				
4.2	Utility & service lines	Unknown	Pervasive	Unknown	High

<b>5</b>	<b>Biological resource use</b>				
5.3	Logging & wood harvesting	Low	Small	Serious	High
<b>7</b>	<b>Natural system modifications</b>				
7.3	Other ecosystem modifications	Unknown	Pervasive	Unknown	High
<b>8</b>	<b>Invasive &amp; other problematic species &amp; genes</b>				
8.1	Invasive non-native/alien species	Unknown	Unknown	Unknown	Unknown
8.2	Problematic native species	Unknown	Restricted	Unknown	High
<b>11</b>	<b>Climate change &amp; severe weather</b>				
11.1	Habitat shifting & alteration	Unknown	Large-Small	Unknown	Moderate
11.3	Temperature extremes	Unknown	Large-Small	Unknown	High
11.4	Storms & flooding	Unknown	Pervasive-Large	Unknown	High

<sup>a</sup> Threat numbers are provided for Level 1 threats (i.e., whole numbers) and Level 2 threats (i.e., numbers with decimals).

<sup>b</sup> **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

<sup>c</sup> **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

<sup>d</sup> **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

<sup>e</sup> **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

## 4.2 Description of Threats

The primary threat to Cerulean Warbler is loss and degradation of forests. Threats are discussed below under the Threat Level 1 headings which are listed here in the order in which they are presented in Table 1.



## **IUCN Threat 1. Residential & commercial development**

### *Threat 1.1 Housing & urban areas; 1.2 Commercial & industrial areas*

Most of the Cerulean Warbler's range in Canada occurs in southern Ontario, where approximately 36% of the country's human population is found (Statistics Canada 2017). In some areas where the species is particularly concentrated, the human population could grow by as much as 35% by 2041 (Ontario Ministry of Finance 2016). In Canada, residential and commercial development is the second most important cause of deforestation after agricultural development (Masek et al. 2011), and urban development has been identified as an important cause of deforestation in southern Ontario (MacIntosh et al. 2014, Ontario Biodiversity Council 2015). The conversion of mature deciduous woodlots into residential lands results in the loss and fragmentation of Cerulean Warbler's habitat, two stresses that have greatly contributed to the species' decline (COSEWIC 2010, Environment Canada 2011). Residential development may also cause the loss and degradation of stopover habitat used during migration (Barrow et al. 2005). However, the scope of these threats in the Canadian breeding range is thought to be small, as many of the mature forest patches that currently support Cerulean Warblers are within protected areas (e.g. parks and conservation areas) and are not expected to be converted to residential, commercial, or industrial land uses over the next ten years.

## **IUCN Threat 2. Agriculture & aquaculture**

### *Threat 2.1 Annual & perennial non-timber crops*

Agriculture poses an important threat to the species on the breeding grounds through the conversion of mature deciduous woodlots into agricultural lands, resulting in habitat loss and fragmentation. In Canada, and particularly in southern Ontario, agriculture is the lead cause of deforestation (Masek et al. 2011, MacIntosh et al. 2014, Ontario Biodiversity Council 2015), and the landscape throughout the Canadian range of the Cerulean Warbler is dominated by agricultural land.

The amount of habitat in Canada currently occupied by Cerulean Warblers that is expected to be converted to agriculture over the next ten years is likely negligible, which reduces the estimated impact of this threat. However, the historical conversion of forest to agriculture likely continues to affect local populations of Cerulean Warbler in Canada; in a highly fragmented agricultural landscape, Cerulean Warbler populations might not be viable (Buehler et al. 2008).

On the wintering grounds, agriculture (e.g., sun coffee plantations, banana plantations, and pastures) also contributes to habitat loss and is considered a threat to the Canadian population of Cerulean Warbler (COSEWIC 2010, Environment Canada 2011). While traditional shade coffee plantations have been shown to provide quality habitat on the wintering grounds (Bakermans et al. 2009), the increased conversion of traditional plantations to more intensive sun coffee plantations may contribute to future wintering habitat loss (COSEWIC 2010, Fundación ProAves et al. 2010).

Montane forests in the northern Andes, where the Cerulean Warbler is known to winter, have experienced some of the highest deforestation rates in the neotropics, with 60% to 90% of the northern Andes having been deforested to accommodate population growth and agriculture (Henderson et al. 1991, Moreno et al. 2006). Deforestation rates are increasing in some locations. Between 1990 and 2015, Colombia lost more than six million hectares of forest, with a 44% increase in deforestation from 2015 to 2016 (Murillo-Sandoval et al. 2018).

Protection of what remains of natural Cerulean Warbler habitat in the wintering range is either non-existent or rarely enforced (Fundación ProAves et al. 2010).

### *Threat 2.3 Livestock farming & ranching*

While not a concern on the breeding grounds, the conversion of suitable habitat to pasture is a threat to Cerulean Warbler on its wintering grounds (Bakermans et al. 2009, COSEWIC 2010). An estimated 17% of the clearing in the Andean foothills in Colombia is due to cattle grazing (Murillo-Sandoval et al. 2018). However, it is not known what proportion of wintering Canadian birds will be exposed to this threat, resulting in an unknown estimated scope and impact.

## **IUCN Threat 4. Transportation & service corridors**

### *Threat 4.2 Utility & service lines*

Tall, lighted structures, such as telecommunication towers, are known to be a particular threat to neotropical migrants, especially during nocturnal migration (Shire et al. 2000, Longcore et al. 2012, 2013). An 11-year study of a single TV tower in Florida yielded 93 dead Cerulean Warblers (Stoddard and Norris 1967). It has been suggested that events during migration or on the wintering grounds were probably responsible for most adult male mortality in this species, and that adult survival had a stronger effect on population growth rate than seasonal fecundity (Jones et al. 2004). As the number of telecommunication towers and other tall structures increase throughout the species' range, it is expected that this threat will increase over time although more studies are needed to determine its impact (COSEWIC 2010).

## **IUCN Threat 5. Biological resource use**

### *Threat 5.3 Logging & wood harvesting*

Cerulean Warblers use large stands of mature deciduous forest characterized by tall, large trees. Wood harvesting practices that favour the maintenance of young stands (e.g., short rotation harvesting) that are even-aged seem to be a threat to the species as they reduce the availability of mature forest (Buehler et al. 2013). Diameter-cut harvests, which remove most mature trees and reduce canopy cover, are common in Bird Conservation Region 13 (Lower Great Lakes/St. Lawrence Plain; Ontario Partners in Flight 2008). Studies indicate that Cerulean Warbler abundance (e.g., territory density) can actually be higher in moderately harvested stands compared to

unharvested ones (Boves et al. 2013a, Sheehan et al. 2014, Boves et al. 2015), but that reproductive success can be lower in stands that have been harvested (Boves et al. 2013a, Boves et al. 2015). This suggests that harvested stands can be an “ecological trap<sup>10</sup>” for Cerulean Warblers (Boves et al. 2015). Lower densities of Cerulean Warblers have been observed in heavily logged (e.g. clearcut stands; Wood et al. 2005). Logging can also lead to forest fragmentation, which has been shown to be detrimental to this area-sensitive species (Buehler et al. 2013). The scope of this threat is assumed to be low in Canada, as many of the mature forest patches that continue to support Cerulean Warbler are not subjected to harvest activities, and in the species’ core population in the Frontenac area, logging has had a minimal impact on forest cover in recent years (T. Beaubiah pers. comm. 2017). However, the historical clearing of forest for harvest may continue to affect local populations of Cerulean Warbler in Canada; in a highly fragmented landscape, Cerulean Warbler populations might not be viable (Buehler et al. 2008).

The scope, and overall impact, of this threat may be higher on the Cerulean Warbler’s wintering grounds. However, while overall deforestation of wintering habitat is a significant threat, the proportion of forest loss in the wintering grounds specifically due to harvesting activities may be lower than it is for other sources such as clearing for agriculture and ranching.

## **IUCN Threat 7. Natural system modifications**

### *Threat 7.3 Other ecosystem modifications*

Reductions in insect prey availability through the use of neonicotinoids and other insecticides in Canada could potentially affect Cerulean Warblers, since this forest-dwelling species often occurs in a landscape dominated by agricultural land. Neonicotinoids have a propensity to spread in the environment and have been shown to negatively affect insectivorous bird species through a reduction in invertebrate prey abundance (Hallmann et al. 2014). Mineau and Palmer (2013) suggested that the effects of neonicotinoids on birds may not be limited to the farm scale, but likely expand to the watershed or regional scale; therefore, neonicotinoids could be impacting insect and bird species found outside of the target farms.

Invasive non-native forest insects and tree diseases that can cause the loss of important tree species (e.g., oaks) for the Cerulean Warbler have been identified as a threat to the species in Canada (COSEWIC 2010, Environment Canada 2011, Environment Canada 2013a, 2013b, Environment Canada 2014a, 2014b). These include Gypsy Moth (*Lymantria dispar*), European Oak Borer (*Agilus sulcicollis*), Emerald Ash Borer (*Agilus planipennis*), Asian long-horned Beetle (*Anoplophora glabripennis*), Butternut canker, and Beech bark disease. Oak Wilt, a fungal disease that can result in defoliation and death of the oak species that are often found in Cerulean Warbler territories, has been reported in the states adjacent to the Cerulean

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<sup>10</sup> Suboptimal habitat that appears superficially suitable and therefore attracts individuals of a species, but contributes a net loss to the population.

Warbler's Canadian range. More studies are needed to assess the impact of these invasive non-native species on Cerulean Warbler's habitat. It is possible that, in some situations, these pests and diseases could create local canopy gap conditions that are suitable for Cerulean Warbler.

Like the invasive non-native species mentioned above, problematic native species that cause defoliation of the forest canopy and the loss of key trees can represent a threat to the Cerulean Warbler (Environment Canada 2011, Environment Canada 2013a, 2013b). For example, outbreaks of the forest tent caterpillar (*Malacosoma disstria*) resulting in moderate to severe defoliation have occurred within the range of the Cerulean Warbler in Canada (Ontario Ministry of Natural Resources 2012). Further studies are required to evaluate the impact of this threat to the Cerulean Warbler.

## **IUCN Threat 8. Invasive & other problematic species & genes**

### *Threat 8.2 Problematic native species*

Several studies have reported negative effects from nest predation (Oliarnyk and Robertson 1996, Barg et al. 2006, Rogers 2006, Buehler et al. 2008, Roth and Islam 2008). The predator community in eastern North America in habitat occupied by the Cerulean Warbler prior to European settlement was likely quite different than the community that occurs in human-altered landscapes today. Some native predators of the Cerulean Warbler (e.g., American Crow [*Corvus brachyrhynchos*], Blue Jay [*Cyanocitta cristata*], Eastern Gray Squirrel [*Sciurus carolinensis*], Red Squirrel [*Tamiasciurus hudsonicus*]) may respond positively to large-scale forest clearing and human activity (e.g. feeding), at least at a local scale. Cerulean Warbler nest predation rates can be higher in highly fragmented landscapes with low forest cover and increased edge (Buehler et al. 2008), especially from avian predators (Environment Canada 2013c).

The Brown-headed Cowbird is another problematic native species that has been identified as a threat to the Cerulean Warbler (COSEWIC 2010, Environment Canada 2011). European settlement and large-scale forest clearing allowed the Brown-headed Cowbird to expand in both population size and distribution, increasing the exposure of Cerulean Warbler to the threat of brood parasitism (Environment Canada 2013a, 2013b). Parasitism of Cerulean Warbler nests by this species was reported at a rate of 18% in southwestern Ontario (Peck and James 1987). This threat could be exacerbated by habitat fragmentation, as demonstrated in other species of forest-dwelling birds (e.g., Robinson et al. 1995, Hochachka et al. 1999, Thompson et al. 2000). However, the severity of the threat of brood parasitism remains uncertain. Brown-headed Cowbird populations have recently undergone a significant decline over most of their eastern North America range (Cox et al. 2012, Sauer et al. 2017). In Ontario, the species declined by 4.08% between 2005 and 2015 province-wide and declined by 2.58% in the Lower Great Lakes/St. Lawrence Plain Bird Conservation Region (Sauer et al. 2017). Brood parasitism rates decreased substantially in Missouri between 1991 and 2010 concurrent with a population decline (Cox et al. 2012).

## **IUCN Threat 11. Climate change & severe weather**

### *Threat 11.1 Habitat shifting and alteration*

Long-distance migrants like the Cerulean Warbler may be more susceptible to potential consequences of climate change such as shifting timing of plant and insect emergence (Miller-Rushing et al. 2008, COSEWIC 2010). Unlike short-distance migrants, who may use temperature or temperature-related indicators as cues to begin spring migration, long-distance migrants may rely on evolutionary cues or internal biological rhythms that are less flexible (Miller-Rushing et al. 2008). This could have implications if peak vegetation and food availability along migration routes and the breeding grounds become altered over time (Miller-Rushing et al. 2008).

### *Threat 11.3 Temperature extremes*

The occurrence of severe climate-related events such as cold spells early in the breeding season of Cerulean Warblers has been identified as a threat that can reduce the species' nesting success (COSEWIC 2010). Data on this effect are lacking in Canada, but an increased nest failure rate in Indiana in 2003 was attributed to cold spells (Roth and Islam 2008).

### *Threat 11.4 Storms & flooding*

Ice storms or thunderstorms damaging Cerulean Warbler habitat (e.g., causing a decrease in canopy foliage) have negatively affected the occurrence, abundance, and reproductive output of the species in Canada, at least in the short term (Bannon and Robert 1996, Jones et al. 2001, Morneau 2002, Wormington and Huebert 2008). Similarly, local declines following ice storms were documented in Missouri and Arkansas (Buehler et al. 2013). Considering the small population of Cerulean Warblers in Canada, the effects of such stochastic events at the population level are not negligible (Environment Canada 2011). Increased frequency and severity of storms with climate change may further increase the magnitude of this threat. However, it is possible that ice storm damage could result in canopy gaps that are suitable for this species, especially in the longer term.

As a long-distance migrant that travels along/across the Gulf of Mexico, the Cerulean Warbler has a relatively high exposure to tropical storms, especially during the fall migration period.

## **5. Population and Distribution Objectives**

The Cerulean Warbler was assessed as Endangered by COSEWIC due to its small population size in Canada (i.e. <2500 individuals), continuing decline, and >95% of the

population occurring in a single subpopulation<sup>11</sup> (COSEWIC 2010). Recent estimates of population size suggest that the population has continued to shrink, from approximately 1000 individuals in Canada in the late 2000s (COSEWIC 2010) to 327 territorial males in Ontario (where the majority of the Canadian population is located) in 2018 (M. Burrell pers. comm. 2018).

This species has experienced significant and largely irreversible changes to much of its habitat over vast areas of its breeding, migrating and wintering range, making the restoration of populations to historic condition likely unachievable. In addition, there are unknowns regarding the relative importance of factors driving the recent population declines observed in Canada. Finally, factors outside Canada, including the population trends of the regional/continental population, and the impact of migration/wintering range threats could have a larger impact on the Canadian population than threats or habitat availability within Canada. However, stabilizing and subsequently increasing the population in Canada may be feasible, especially if the Partners in Flight objective to slow and reverse the continental population decline<sup>12</sup> (Rosenberg et al. 2016) is achieved.

The population and distribution objectives for the Cerulean Warbler in Canada are to:

**Long-term (30 years):**

- Achieve a stable<sup>13</sup> population of at least 1000 mature individuals.
- Maintain the species' range<sup>14</sup> and maintain, or where biologically and technically possible, increase the species' area of occupancy<sup>15</sup> within its current Canadian range.

**Short-term (10 years):**

- Halt the declining population trend.

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<sup>11</sup> As per COSEWIC, subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less).

<sup>12</sup> The Partners in Flight continental objectives for Cerulean Warbler are to limit the 2016 – 2026 population decrease to 7% - 11%, and target a 2016 – 2046 population increase of 5% - 15% (Rosenberg et al. 2016).

<sup>13</sup> As measured by 10-year population trends.

<sup>14</sup> Currently measured using the extent of occurrence (EOO), i.e. the area included in a polygon without concave angles that encompasses the geographic distribution of all known populations of a wildlife species (COSEWIC 2015). As Cerulean Warbler primarily occurs in disjunct locations across a broad area of southern Ontario and Quebec, EOO may not be a suitable measure of range for this species in Canada. An action that aims to identify a quantitative baseline against which to measure changes in the species' range has been included in the Recovery Planning Table (Table 4).

<sup>15</sup> Area of occupancy is a biological measure of the occupied habitat within a wildlife species' range, estimated using an Index of Area of Occupancy (COSEWIC 2015).

In the long-term, increasing the population to at least the recently known population size of 1000 mature individuals (COSEWIC 2010), and stabilizing the population at this level, at a minimum, addresses the long-term recovery of the species. Achieving this objective is likely to be biologically and technically feasible if the condition of the regional/continental population improves in line with the continental objectives identified by Partners in Flight (Rosenberg et al. 2016). At the same time maintaining the species' range addresses the representativeness of the Canadian population, and maintaining or increasing the species' area of occupancy will help ensure the stability of the population.

In the short term, addressing the population trend (i.e. halting the decline) will improve the condition of the Canadian population of Cerulean Warbler, and will address the criterion under which it has been assessed Endangered by COSEWIC. Achieving this component of the objective will require the conservation of high-quality forest habitat capable of supporting productive breeding pairs that will contribute to a stable population trend.

As the Canadian population of the Cerulean Warbler occurs at the northern part of its continental range, and the vast majority of its breeding population occurs further south in the United States (Figure 1), it is important to note that population changes at the regional and continental scale may have a significant effect on recovery feasibility in Canada. As the continental population is currently experiencing a downward population trend (Sauer et al. 2017), the species' range may contract away from the current periphery, even if sufficient suitable habitat is available in Canada. In such a case, despite best efforts described in this strategy to ensure that sufficient suitable habitat is available and key threats are mitigated, the numbers of the Cerulean Warbler in Canada may continue to decline.

Both the short- and long-term population objectives, including the 10- and 30-year timeframes, align with the continental objectives set by Partners in Flight (Rosenberg et al. 2016). As the condition of the Canadian population may be closely tied to the condition of the regional/continental population, aligning Canadian objectives with continental objectives should be targeted where feasible.

## **6. Broad Strategies and General Approaches to Meet Objectives**

A number of high-priority recovery approaches have been identified in this recovery strategy in an effort to meet the population and distribution objectives. Halting the decline and ultimately reversing and stabilizing the population trend is expected to require three broad approaches: habitat conservation and management, monitoring and research, and outreach and communication.

## 6.1 Actions Already Completed or Currently Underway

### Ontario

- A targeted Cerulean Warbler survey protocol was developed for the Canadian Wildlife Service in 2011, and targeted surveys for Cerulean Warbler have been or are being conducted throughout the range in Ontario by the Canadian Wildlife Service, Bird Studies Canada, Parks Canada, Ontario Parks, the Ontario Natural Heritage Information Centre, and Frontenac Bird Studies;
- The *Frontenac Forests Important Bird and Biodiversity Area* was established by Birds Canada and Nature Canada, which was established to guide community-based conservation and stewardship efforts to benefit species like the Cerulean Warbler.
- Cerulean Warblers have been monitored as part of several bird monitoring initiatives, including the Ontario Breeding Bird Atlas (Cadman et al. 2007) and the Ontario Forest Bird Monitoring Program (COSEWIC 2010, ECCC 2018);
- The Ontario Ministry of Natural Resources developed and published *Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales*, which includes guidelines to direct forest management operations that could affect breeding habitat for Cerulean Warbler (Ontario Ministry of Natural Resources 2010).
- Bird Studies Canada developed and published *Beneficial Management Practices for Southwestern Ontario Forest Birds at Risk: A Guide for Woodlot Owners and Forest Practitioners*, which includes beneficial management practices for Cerulean Warbler in southwestern Ontario (Stewart 2017);
- The Nature Conservancy of Canada is working to conserve habitat for Cerulean Warblers throughout Ontario, including the Frontenac Arch, Southern Norfolk Sand Plain, Skunk's Misery and the Happy Valley Forest;
- The Carolinian Canada Coalition has led ecosystem-based rehabilitation, restoration and outreach projects that target Cerulean Warbler in southwestern Ontario;
- Parks Canada Agency included actions to support Cerulean Warbler recovery in *The Multi-species Action Plan for Georgian Bay Islands National Park of Canada* (Parks Canada Agency 2016a), *The Multi-species Action Plan for Point Pelee National Park of Canada and the Niagara National Historic Sites of Canada* (Parks Canada Agency 2016b), and *The Multi-species Action Plan for Thousand Islands National Park of Canada* (Parks Canada Agency 2016c);
- The federal Habitat Stewardship Program for Species at Risk and Aboriginal Fund for Species at Risk, as well as the provincial Species at Risk Stewardship Fund have funded several projects targeting Cerulean Warbler throughout Ontario;



## Quebec

- Directed surveys of Cerulean Warblers in the Parc de la Gatineau in southwestern Quebec were conducted in 2006 and 2007 (Savignac 2006, 2007), and 2008 (National Capital Commission 2008);
- Sites with past occurrence of Cerulean Warblers in southern Quebec are visited periodically as part of the avian species at risk yearly breeding site monitoring (SOS-POP 2009); the SOS-POP databank includes a registry for Cerulean Warbler nesting sites, and registries for threats and conservation actions are also being developed.
- The second Quebec Breeding Bird Atlas (Robert et al. 2019) provided updated distribution and breeding evidence information in the province.
- QuébecOiseaux has developed a model for identifying the potential extent of occurrence in the Le Haut Saint-Laurent Regional County Municipality (Broeckaert and Bussière 2011).
- Targeted Cerulean Warbler surveys were conducted at potential sites for the species in Le Haut Saint-Laurent Regional County Municipality in 2012.

## Range-wide

- This species benefits from protections through federal and provincial legislation, including the *Species at Risk Act*, the *Migratory Birds Convention Act, 1994*, Ontario's *Endangered Species Act, 2007* and *Provincial Parks and Conservation Reserves Act*, and Quebec's *Act Respecting Threatened or Vulnerable Species*.
- The *Partners in Flight 2016 Landbird Conservation Plan* listed Cerulean Warbler as a "Watch List" species, identified continental population objectives and recommended actions, and will serve to guide conservation initiatives throughout the range of the Cerulean Warbler (Rosenberg et al. 2016).

## 6.2 Strategic Direction for Recovery

**Table 2. Recovery Planning Table**

<b>Broad Strategy to Recovery</b>	<b>Threat or Limitation</b>	<b>Priority<sup>a</sup></b>	<b>General Description of Research and Management Approaches</b>
Habitat conservation and management	5.3	High	<ul style="list-style-type: none"> <li>• Work with industry partners (e.g. forestry) to incorporate and further develop and refine forest management recommendations for Cerulean Warblers into management plans for harvested forests in varying landscapes throughout the Canadian breeding range.</li> <li>• Work with landowners and other stakeholders to further develop and refine forest management recommendations for Cerulean Warblers into management plans for public and private forests in varying landscapes throughout the Canadian breeding range</li> </ul>
	All	High	<ul style="list-style-type: none"> <li>• Address Cerulean Warbler requirements in any new (or updated) management plans for public lands in Canada (protected areas, parks, etc.) that support populations, and incorporate appropriate forest management recommendations where appropriate</li> <li>• Incorporate Cerulean Warbler habitat needs in landscape-scale forest management initiatives that consider and balance the requirements of multiple at-risk species</li> </ul>
	1.1, 1.2, 2.1, 5.3, 7.3	High	<ul style="list-style-type: none"> <li>• Identify opportunities to slow/halt further loss of deciduous forest cover in landscapes where Cerulean Warblers are known to breed</li> <li>• Facilitate conservation of key breeding sites in Canada that are not currently conserved (e.g. through acquisition, stewardship actions, partnerships with conservation organizations, etc.), where possible</li> </ul>
	1.1, 1.2, 2.1, 5.3, 7.3	High	<ul style="list-style-type: none"> <li>• Promote deciduous reforestation, where feasible and appropriate, to a) increase the size of existing forest patches and b) increase forest cover in landscapes where Cerulean Warblers are known to breed</li> </ul>

Broad Strategy to Recovery	Threat or Limitation	Priority <sup>a</sup>	General Description of Research and Management Approaches
Monitoring and research	Knowledge gaps	Medium	<ul style="list-style-type: none"> <li>● Continue breeding bird atlas projects in Ontario and Quebec to obtain regular range-wide population status and distribution information</li> <li>● Conduct periodic/ongoing range-wide surveys outside of atlas projects, incorporating existing programs (e.g. Forest Bird Monitoring Program) where feasible and appropriate, to a) ensure that changes in population status and distribution can be evaluated using shorter time periods (e.g. every five or ten years), and b) sufficient information is available for future updates to critical habitat (see Table 3 in Section 7.2); include monitoring of land cover and habitat availability where feasible</li> <li>● Refine and compile geographical knowledge of Canadian populations, habitat, and land tenure</li> </ul>
	5.3, Knowledge gaps	High	<ul style="list-style-type: none"> <li>● Research landscape-scale and forest patch size effects on Cerulean Warbler occupancy, productivity, and survival in Canada; the results of these studies can be used to inform future conservation initiatives and updates to critical habitat; where available, incorporate Monitoring Avian Productivity and Survivorship (MAPS) data into analyses</li> <li>● Research the response of breeding populations (distribution, density, and productivity) to conservation activities and silviculture practices in varying landscapes in Canada; review and incorporate results from other areas/existing studies where feasible</li> <li>● Conduct research to identify relative importance of threats to Cerulean Warbler in Canada, so that conservation resources for this species can be focused effectively and efficiently</li> </ul>
	All	High	<ul style="list-style-type: none"> <li>● Work with researchers and international organizations to evaluate and mitigate threats facing Canadian populations of Cerulean Warbler, including those on wintering grounds and migration routes</li> </ul>
	Knowledge gaps	Medium	<ul style="list-style-type: none"> <li>● Identify/develop models to measure changes in the species' range (replacing/supplementing Extent of Occurrence if needed)</li> </ul>
	Knowledge gaps	Medium	<ul style="list-style-type: none"> <li>● Reduce knowledge gaps regarding demographics and improve the ability to monitor habitat and population trends and estimate population size on the breeding grounds at appropriate spatial scales</li> <li>● Identify quantitative population and distribution targets (e.g. geographically specific population targets) and targets for demographic rates where feasible</li> </ul>

Broad Strategy to Recovery	Threat or Limitation	Priority <sup>a</sup>	General Description of Research and Management Approaches
Outreach and communication	All	Medium	<ul style="list-style-type: none"> <li>• Ensure Canadian participation on international working groups that target Cerulean Warbler conservation actions on its breeding, migration, and wintering grounds</li> </ul>
	5.3	High	<ul style="list-style-type: none"> <li>• Promote Cerulean Warbler-compatible harvesting regimes and forest management recommendations on public and private woodlots</li> </ul>
	All	Medium	<ul style="list-style-type: none"> <li>• Promote and discuss status, conservation and management with other governments, conservation organizations, forest managers, and landowners, and promote multi-use strategies for habitat management that are compatible with needs of the Cerulean Warbler and other mature forest species</li> </ul>

<sup>a</sup> "Priority" reflects the degree to which the broad strategy contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species.

### 6.3 Narrative to Support the Recovery Planning Table

Cerulean Warbler recovery will require commitment and collaboration among international, federal and provincial jurisdictions, Indigenous people, local communities, landowners, industry and other interested parties. The recovery planning table identifies approaches that fall under three broad strategies (habitat conservation and management, monitoring and research, and outreach and communication), which together aim to improve the condition of the regional/continental population, increase productivity in Canadian populations and address the causes of high mortality in the non-breeding season.

Given that the Canadian population of the Cerulean Warbler is likely reliant on immigration (COSEWIC 2010), the ability to achieve a stable Canadian population is likely decreased without an improved regional/continental breeding population. Improving the condition of the regional/continental population will increase the chance that local Canadian populations can be maintained through immigration while efforts to address local threats take place. Approaches that support regional or continental scale conservation efforts should be undertaken where feasible.

Research suggests that while the eastern Ontario population may be currently stable, the reproductive output may not be sufficient to offset adult mortality (Jones et al. 2004, Buehler et al. 2008). In particular, an increase in the number of offspring may be required to support a stable local population. Improving the conditions on the breeding grounds, including improvements to the quality and quantity of breeding habitat and addressing other local threats, may be required to ensure a stable Canadian population.

In addition to low reproductive output, high adult mortality, especially in the non-breeding season, may limit the ability to achieve a stable population in Canada (COSEWIC 2010). Working with partners and supporting projects that address threats in the non-breeding (i.e. migration and wintering) range will likely be required to achieve the population and distribution objectives.

In addition to these broad approaches, research and monitoring will be required to ensure that knowledge gaps that limit the ability to direct and evaluate conservation measures are addressed.

## 7. Critical Habitat

### 7.1 Identification of the Species' Critical Habitat

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

In Canada, the persistence of the Cerulean Warbler likely depends on an area greater than that occupied by individuals of the species. It requires ecological or landscape features that promote and maintain the biophysical attributes<sup>16</sup> used by the bird and allow for natural processes related to population dynamics and reproduction to occur. Given that the minimum forest patch size for breeding Cerulean Warblers appears to depend on the amount of forest cover at a landscape scale (Wood et al. 2013), the habitat necessary for the survival or recovery is expected to require landscape-scale considerations, and the amount and configuration of critical habitat at a local scale may depend on the makeup of the surrounding landscape.

Although small forest patches are sometimes occupied by the species, this typically occurs in landscapes dominated by forest (Wood et al. 2013). As noted in Section 3.3, the importance of landscape-scale forest cover has been demonstrated at multiple scales in the Cerulean Warbler's range, including 1 km (Rodewald 2004<sup>17</sup>) and 10 km (Thompson et al. 2012). However, landscape-scale forest requirements for the Cerulean Warbler in Canada are not well understood, and more study is needed to identify a minimum area of critical habitat to be maintained at the landscape scale in Canada. While breeding Cerulean Warblers have been found in forest patches as small as 10 ha in eastern Ontario's forested landscape (COSEWIC 2010, Jones pers. comm. 2019), it is unlikely that isolated patches of this size would support a stable Canadian population of at least 1000 mature individuals, especially in areas dominated by agriculture. For

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<sup>16</sup> Suitable biophysical attributes are those habitat features (Section 7.1.2) that provide individuals of the species the necessary conditions (e.g. soil and moisture, light penetration, species composition and species interactions) to carry out essential life processes.

<sup>17</sup> Note that 1 km is the maximum scale used in the Rodewald 2004 study, so any relationships beyond 1 km were not explored.

this reason, critical habitat for Cerulean Warbler in Canada includes the habitat patch required to carry out breeding activities as well as the surrounding forest habitat, to ensure that the adjacent forest cover that contributes to the quality of occupied patches is maintained. A schedule of studies (section 7.2) has been developed to provide the information necessary to complete the identification of critical habitat that will be sufficient to meet the population and distribution objectives. In the meantime, and in the absence of confirmed Canada-specific landscape-scale requirements for Cerulean Warbler, a 1 km radius is used for critical habitat in this recovery strategy, which captures the habitat patches used directly for breeding activities, as well as the nearby contiguous forest cover that contributes to the suitability of those patches.

Critical habitat for the Cerulean Warbler in Canada is identified as the extent of biophysical attributes (see Section 7.1.2) wherever they occur within the areas containing critical habitat described in Section 7.1.1 (Appendix A – Figures A-1 to A-9).

For more information on critical habitat identification, contact Environment and Climate Change Canada – Canadian Wildlife Service at [ec.planificationduretablissement-recoveryplanning.ec@canada.ca](mailto:ec.planificationduretablissement-recoveryplanning.ec@canada.ca).

### 7.1.1 Areas Containing Critical Habitat

The areas containing critical habitat are identified based on sequential, additive application of the following:

- 1) Locations with a confirmed breeding<sup>18</sup> observation in any year from 2009 to 2018 or demonstrated multi-year occupancy<sup>19</sup> (i.e. with breeding season observations<sup>20</sup> in three separate years from 2009 to 2018<sup>21</sup>), and
- 2) The contiguous treed habitat within a 1 km radius of the locations described in 1)<sup>22</sup>.

Confirmed breeding evidence or demonstrated multi-year occupancy was used to identify locations that are important for Cerulean Warbler in Canada, and are expected to be necessary for the survival and recovery of the species. Evidence of Cerulean

<sup>18</sup> Breeding evidence categories are defined in Appendix C.

<sup>19</sup> Multiple-year occupancy is determined using observations within 1 km of each other.

<sup>20</sup> 10 May to 10 July is used as the estimated breeding season for the purposes of critical habitat identification. The predicted nesting period for Cerulean Warbler based on Rousseu and Drolet (2017), is 21 May to 7 July. To account for courtship and nest building, eight days were added at the beginning (Oliarnyk and Robertson 1996). A precautionary buffer of an additional three days was added to both the beginning and end of the resulting window.

<sup>21</sup> This window allows for incorporation of recent data collected as part of targeted surveys in the Frontenac Axis and southwestern Ontario, as well as data collected as part of the second Quebec Breeding Bird Atlas.

<sup>22</sup> As delineated using aerial imagery and land cover information available at the time of critical habitat identification. Patches of non-treed (e.g. agriculture, roads, built-up areas) and non-contiguous treed (e.g. separated by roads or other non-treed patches) habitat, where identifiable, were excluded from the areas containing critical habitat.

Warbler breeding is often difficult to confirm due to difficulties in observing individuals and nests high in the canopy. In the second Ontario Breeding Bird Atlas, breeding was only confirmed in 9 of 86 atlas squares where Cerulean Warbler was detected – and several of those confirmations were by crews studying the species (Francis 2007). For this reason, all observations (including possible, probable, and confirmed) within the breeding season, are used to determine multi-year occupancy as described above.

### 7.1.2 Biophysical Attributes of Critical Habitat

Within the areas containing critical habitat, critical habitat is identified where the following biophysical attributes occur. Biophysical attributes are grouped into 1) Breeding Habitat and 2) Landscape Forest Matrix, both of which support local breeding populations of Cerulean Warbler.

#### 1) **Breeding Habitat** (includes courtship, territory defence, nesting and foraging)

- Deciduous forest with the following characteristics<sup>23</sup>:
  - Presence of large diameter<sup>24</sup> (i.e.  $\geq 38\text{cm}$ ), AND
  - Basal area  $\geq 23\text{ m}^2/\text{ha}$ , AND
  - Presence of canopy gaps (gaps typically 40 to 100  $\text{m}^2$ , at densities of approximately 1 per 0.5 ha)

Or

#### 2) **Landscape Forest Matrix**

- Deciduous, mixed or coniferous forest

Given that the probability of breeding by the Cerulean Warbler is associated with the interaction between habitat quality at the local scale and habitat quality at the landscape scale (Wood et al. 2013), it is important to take both scales into consideration in defining the characteristics of suitable habitat.

While mixed or coniferous forest are not used by Cerulean Warbler for breeding, this local forest cover contributes to landscape-scale forest cover, and reduces “hard edges” (e.g. edges between forest and agriculture), which may reduce predation and parasitism (see discussion in Sallabanks et al. 2000). In addition, a recent study found that Cerulean Warbler territories were located closer to patches of coniferous forest than expected based on availability (Kaminski and Islam 2013), though this could be due to a correlation with other habitat features – more study is needed. While the relative value of mixed and coniferous forest patches to Cerulean Warbler at a landscape scale is for the most part unknown, these forest types are included in the biophysical attributes as a precautionary approach that serves to maintain landscape forest cover and provide an edge buffer for other suitable habitat types.

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<sup>23</sup> Based on Stewart 2017.

<sup>24</sup> Measured using “diameter at breast height” (DBH), which is the diameter of a tree stem at 1.3 m above ground level.

## 7.2 Schedule of Studies to Identify Critical Habitat

**Table 3. Schedule of Studies to Identify Critical Habitat**

Description of Activity	Rationale	Timeline
1) Develop, refine, and test habitat models jointly with productivity studies (see Table 6.2) to identify the size and configuration of landscape-scale habitat that is necessary to support local populations in varying landscapes. Incorporate results from other areas/existing studies where feasible.	There are currently unknowns in the amount, type, and configuration of habitat that is needed to support productive local populations in varying Canadian forested landscapes.	2021 to 2027
2) Obtain up-to-date observations from the survey and monitoring efforts described in Table 6.2 to identify important breeding locations in Canada.	There are many locations throughout the Canadian range for which accurate, precise, and recent observations are lacking.	2021 to 2027
3) Using the results from 1), identify key landscape features and habitat patch configurations that are necessary to support local populations throughout the Canadian range and use this information to update approach to critical habitat, as needed.	Once habitat requirements in varying landscapes are known, analyses will be needed to identify habitat that is necessary to achieve the population and distribution objectives.	2027 to 2028

## 7.3 Activities Likely to Result in the Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time.

Activities that are likely to result in the destruction of Cerulean Warbler critical habitat include, but may not be limited to those outlined in Table 4.



**Table 4. Examples of activities likely to result in the destruction of critical habitat.**

Description of Activity	Description of Effect in Relation to Function Loss	Details of Effect
Removal of forested areas (e.g. development, road construction, clearing for agriculture, etc.)	The removal of a forested area eliminates, either in whole or in part, the ecosystem/landscape upon which the species relies for basic survival, including the elements of the habitat that are used for breeding and foraging.	<p>If this activity occurs within critical habitat, at any time of year, the effects will be direct, and are certain to result in the destruction of critical habitat.</p> <p>Light selective harvesting of trees using best management practices for this species (i.e. Stewart 2017) may not result in the destruction of critical habitat.</p> <p>Removal of a limited number of trees that results in canopy gaps not exceeding 100m<sup>2</sup> at densities no greater than 1 per 0.5 ha should not be considered destruction of critical habitat, except where large-diameter deciduous trees are removed (see below) (Stewart 2017).</p> <p>Within mixed/coniferous forest, only those activities that clear mixed/coniferous forest should be considered destruction of critical habitat. Thinning of mixed/coniferous forests to facilitate re-establishment of native deciduous forests should not be considered destruction of critical habitat.</p>
Forest harvesting that results in unsuitable forest/stand conditions.	The modification of a forested area eliminates, either in whole or in part, the ecosystem features upon which the species relies for basic survival, including the elements of the habitat that are used for breeding and foraging.	<p>Harvesting activities in Cerulean Warbler critical habitat should be assessed on a case-by-case basis. Light selective harvesting of trees using best management practices for this species (i.e. Stewart 2017) may not result in the destruction of critical habitat.</p> <p>In mixed/coniferous forest, only harvesting that results in the removal of a forest area (see above) should be considered destruction of critical habitat. Harvesting of these forest types that maintains the overall amount of forest cover is likely not destruction of critical habitat.</p>

<p>Removal of large-diameter deciduous trees (i.e. trees <math>\geq 38</math> cm DBH) (Stewart 2017).</p>	<p>The modification of a forested area eliminates, either in whole or in part, the ecosystem features upon which the species relies for basic survival, including the elements of the habitat that are used for breeding and foraging.</p>	<p>If this activity occurs within critical habitat, at any time of year, the effects will be direct, and in most instances result in the destruction of critical habitat.</p> <p>This activity only applies to deciduous forest stands.</p>
<p>Creation/maintenance of edge habitat within forests via creation or maintenance of trails, skid roads, utility line construction etc. that results in unsuitable forest/stand conditions.</p>	<p>The modification of a forested area eliminates, either in whole or in part, the ecosystem features upon which the species relies for basic survival, including the elements of the habitat that are used for breeding and foraging. Habitat alterations could become permanent and irreversible.</p>	<p>If this activity occurs within critical habitat, at any time of year, the effects will be direct. Removal of a limited number of trees that results in interior canopy gaps not exceeding 100m<sup>2</sup> at densities no greater than 1 per 0.5 ha should not be considered destruction of critical habitat, except where large-diameter deciduous trees are removed (Stewart 2017). Destruction will be determined on a case by case basis.</p> <p>This activity only applies to deciduous forest stands.</p> <p>Since existing roads and utility lines are not included in the biophysical attributed described in section 7.1.2, maintenance of existing roads and utility lines is not considered an activity that is likely to result in the destruction of critical habitat, as long as the density of trees along roads and corridors are not reduced.</p>

## 8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives. Specific progress towards implementing the recovery strategy will be measured against indicators outlined in subsequent action plans.

Success of recovery strategy implementation will be measured against the following performance indicators:

- Population size and trends will be estimated to evaluate whether a) the declining population trend has halted within 10 years and b) a stable population of at least 1000 individuals have been achieved over the long term.
- Over the long term, the Extent of Occurrence<sup>25</sup> and Index of Area of Occupancy will be used to evaluate whether the species' range and area of occupancy, respectively, have been maintained or increased.

## 9. Statement on Action Plans

One or more action plans will be completed for the Cerulean Warbler by December 2025. Parks Canada multi-species action plans identify recovery measures specific to national parks and national heritage places where this species occurs (for a list of current multi-species action plans including the Cerulean Warbler, refer to the documents section of the Species at Risk Public Registry).

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<sup>25</sup> As Cerulean Warbler primarily occurs in disjunct locations across a broad area of southern Ontario and Quebec, Extent of Occurrence may not be a suitable measure of range for this species in Canada. An action that aims to identify a quantitative baseline against which to measure changes in the species' range has been included in the Recovery Planning Table (Table 4).

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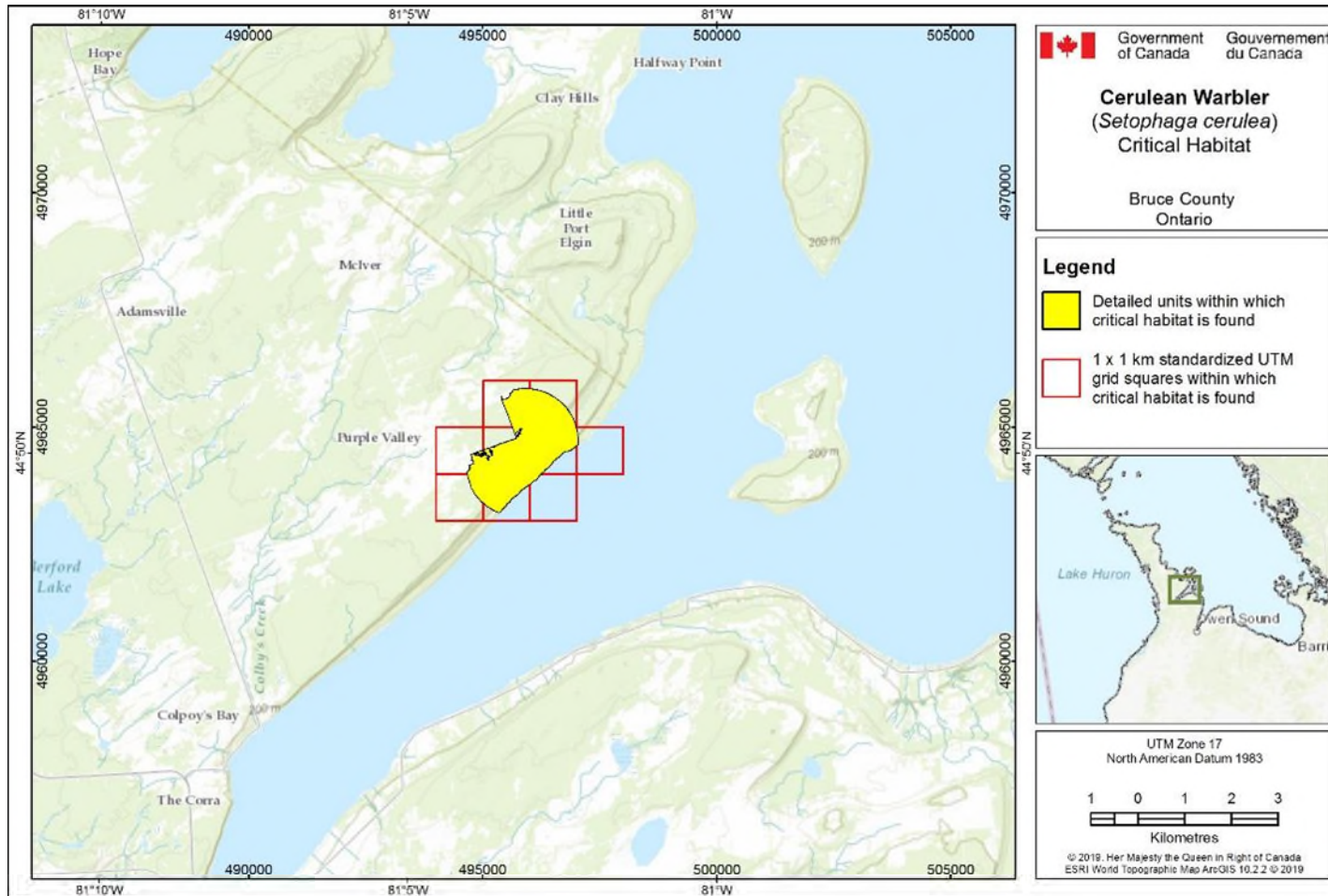
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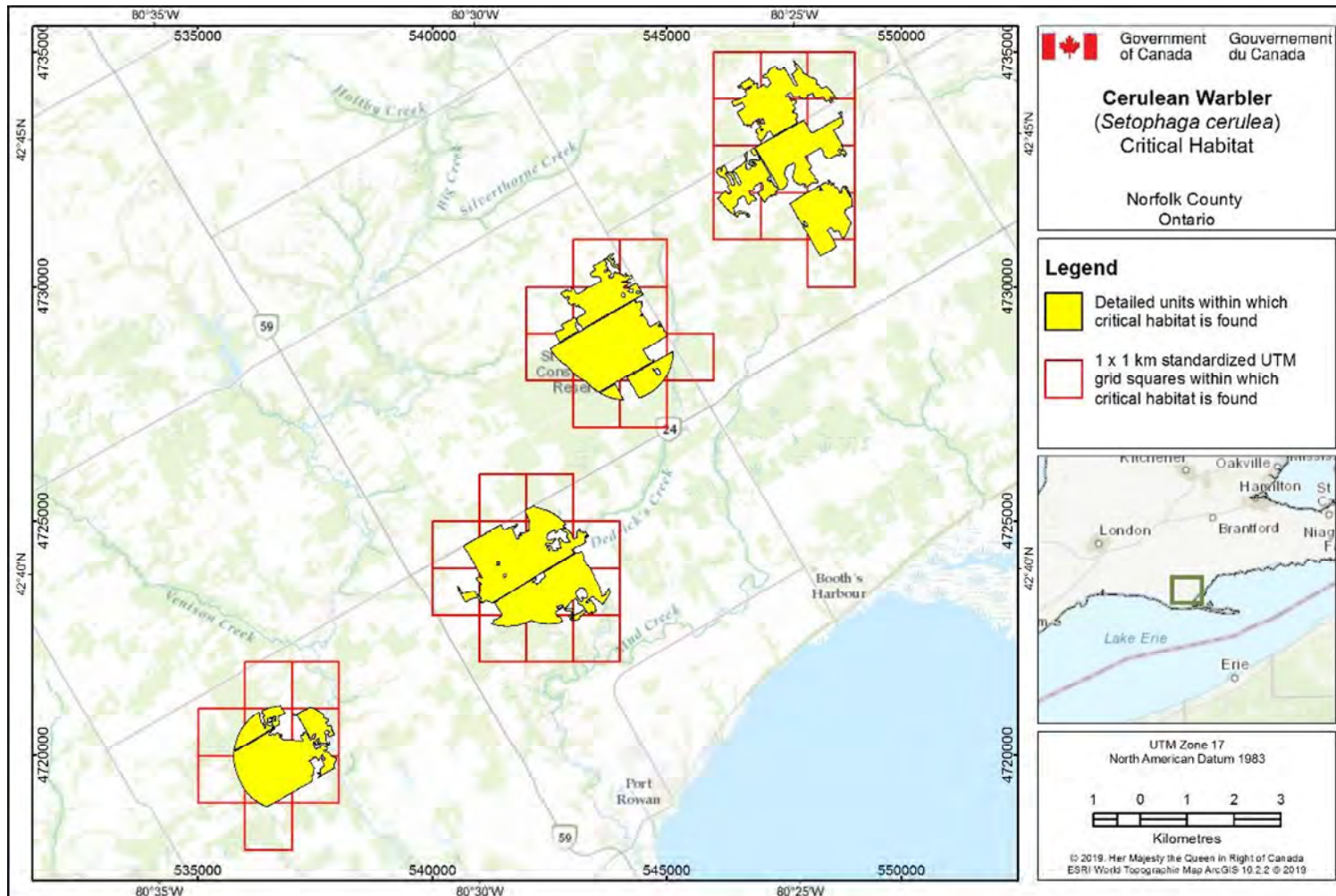
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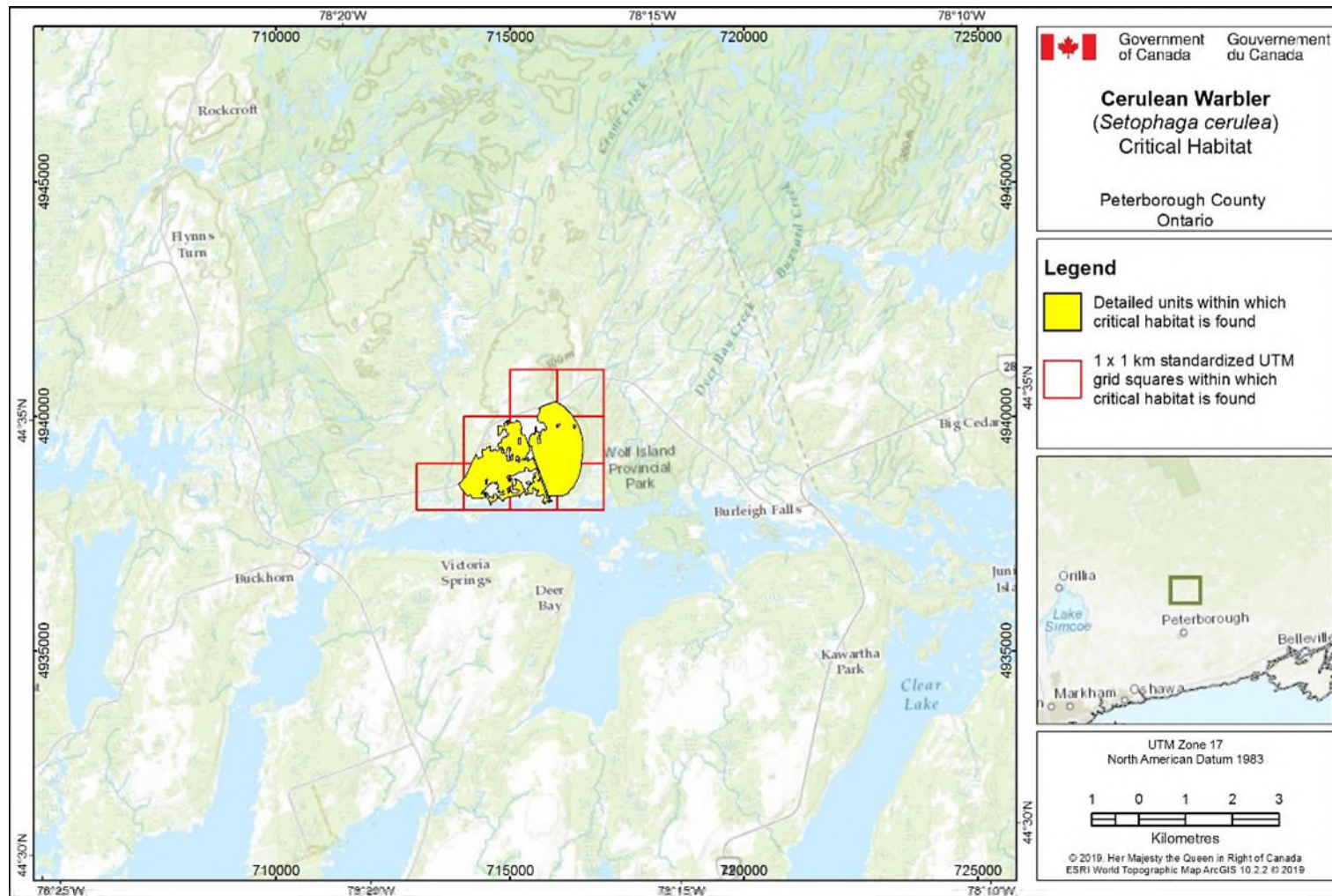
## Appendix A: Critical Habitat for the Cerulean Warbler



**Figure A-1. Critical habitat for the Cerulean Warbler in Bruce County, Ontario.** The area containing critical habitat for the Cerulean Warbler, as described in section 7.1, is represented by the yellow shaded unit. Within this area, critical habitat occurs where the biophysical attributes described in section 7.1.2 are found. The 1 km × 1 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

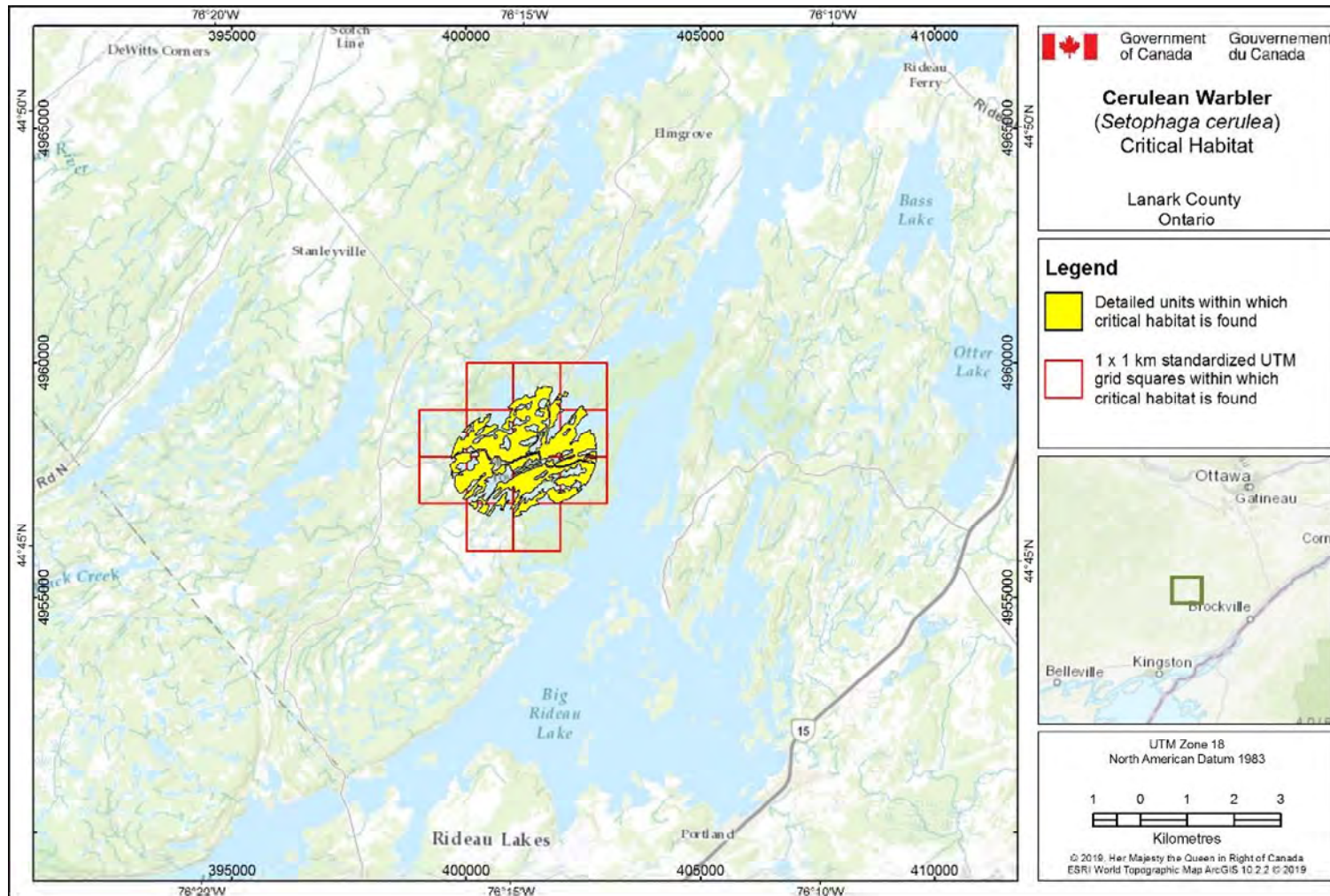


**Figure A-2. Critical habitat for the Cerulean Warbler in Norfolk County, Ontario.** The area containing critical habitat for the Cerulean Warbler, as described in section 7.1, is represented by the yellow shaded unit. Within this area, critical habitat occurs where the biophysical attributes described in section 7.1.2 are found. The 1 km × 1 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

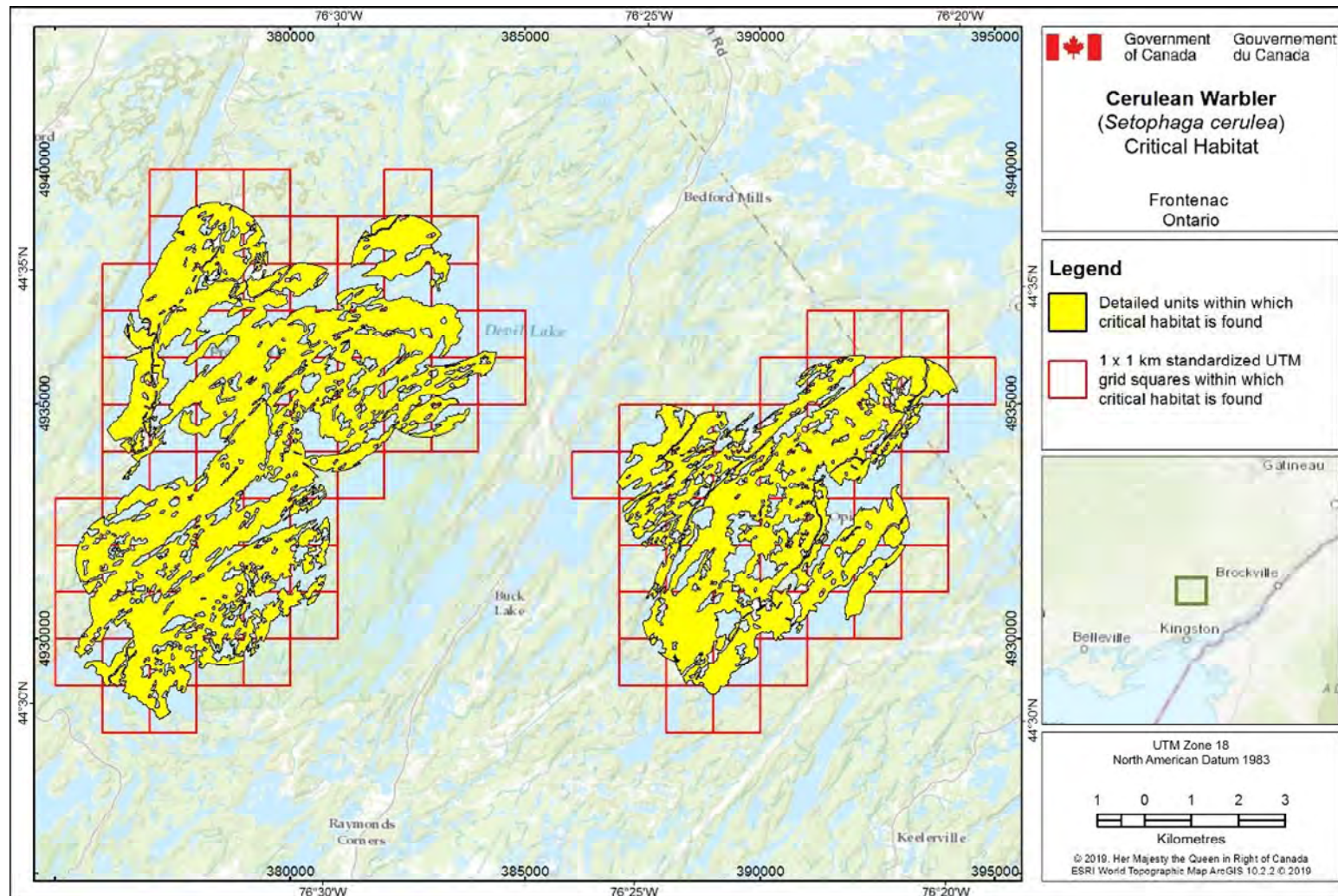


**Figure A-3. Critical habitat for the Cerulean Warbler in Peterborough County, Ontario.** The area containing critical habitat for the Cerulean Warbler, as described in section 7.1, is represented by the yellow shaded unit. Within this area, critical habitat occurs where the biophysical attributes described in section 7.1.2 are found. The 1 km × 1 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

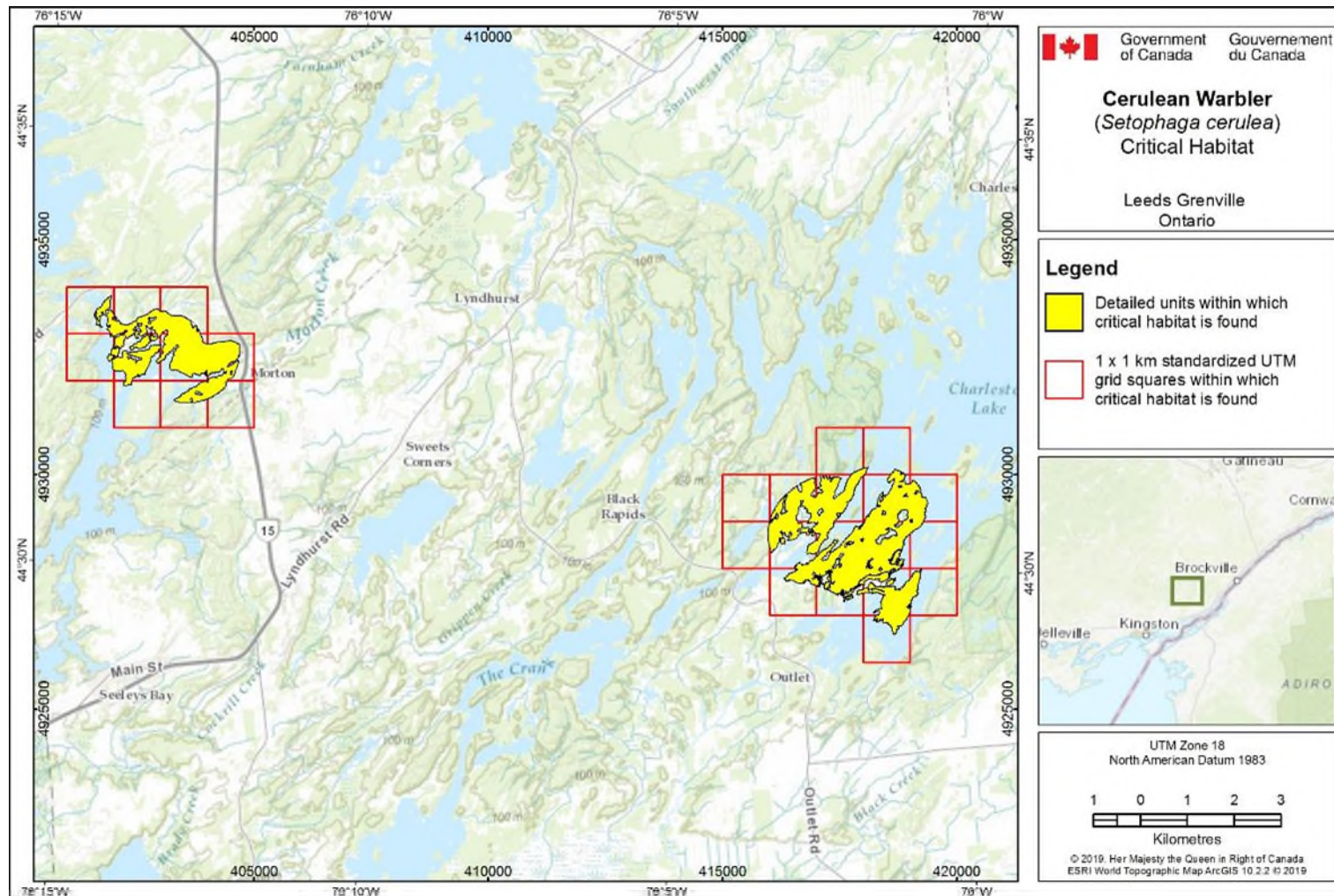




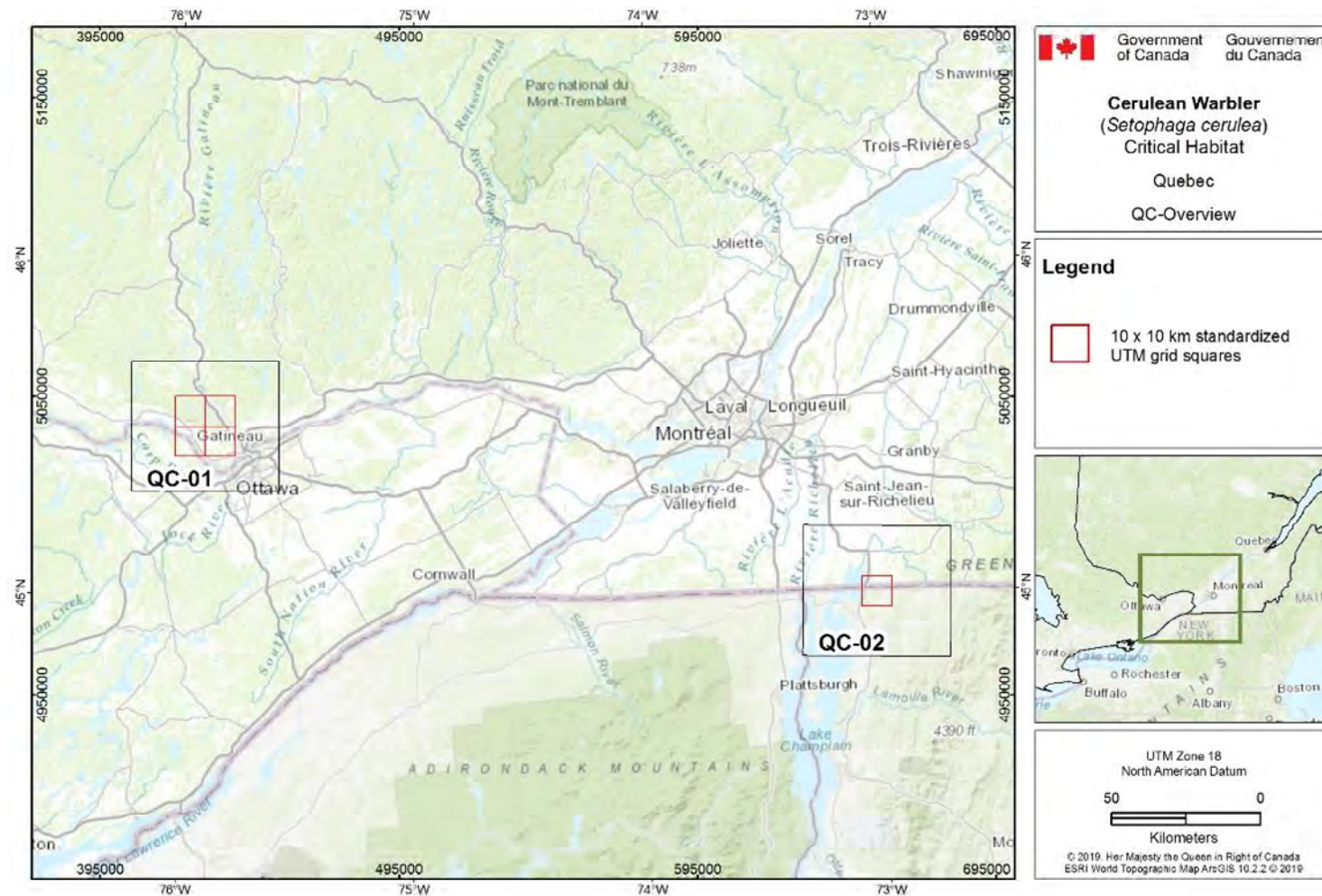
**Figure A-4. Critical habitat for the Cerulean Warbler in Lanark County, Ontario.** The area containing critical habitat for the Cerulean Warbler, as described in section 7.1, is represented by the yellow shaded unit. Within this area, critical habitat occurs where the biophysical attributes described in section 7.1.2 are found. The 1 km × 1 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.



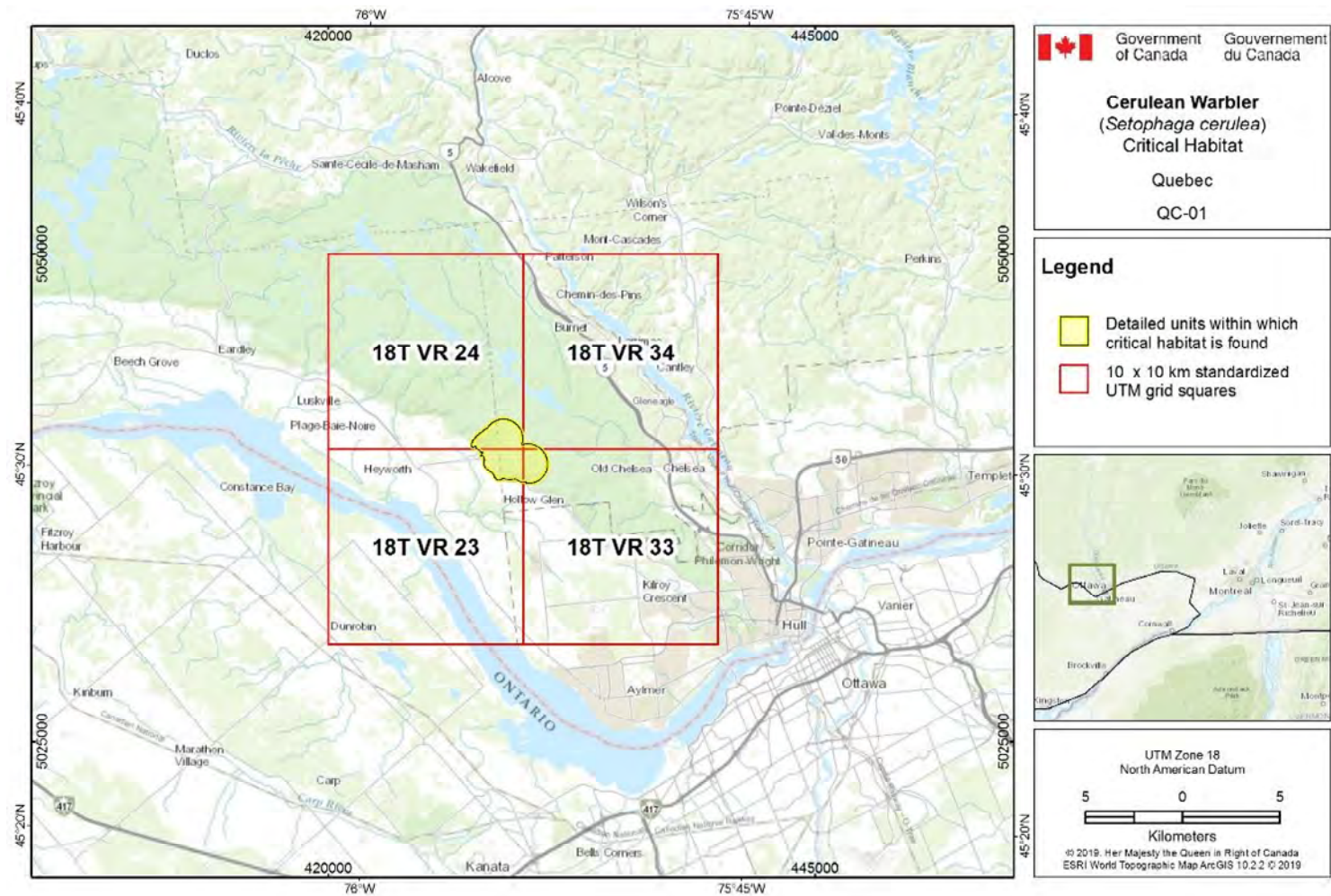
**Figure A-5. Critical habitat for the Cerulean Warbler in Frontenac, Ontario.** The area containing critical habitat for the Cerulean Warbler, as described in section 7.1, is represented by the yellow shaded unit. Within this area, critical habitat occurs where the biophysical attributes described in section 7.1.2 are found. The 1 km × 1 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.



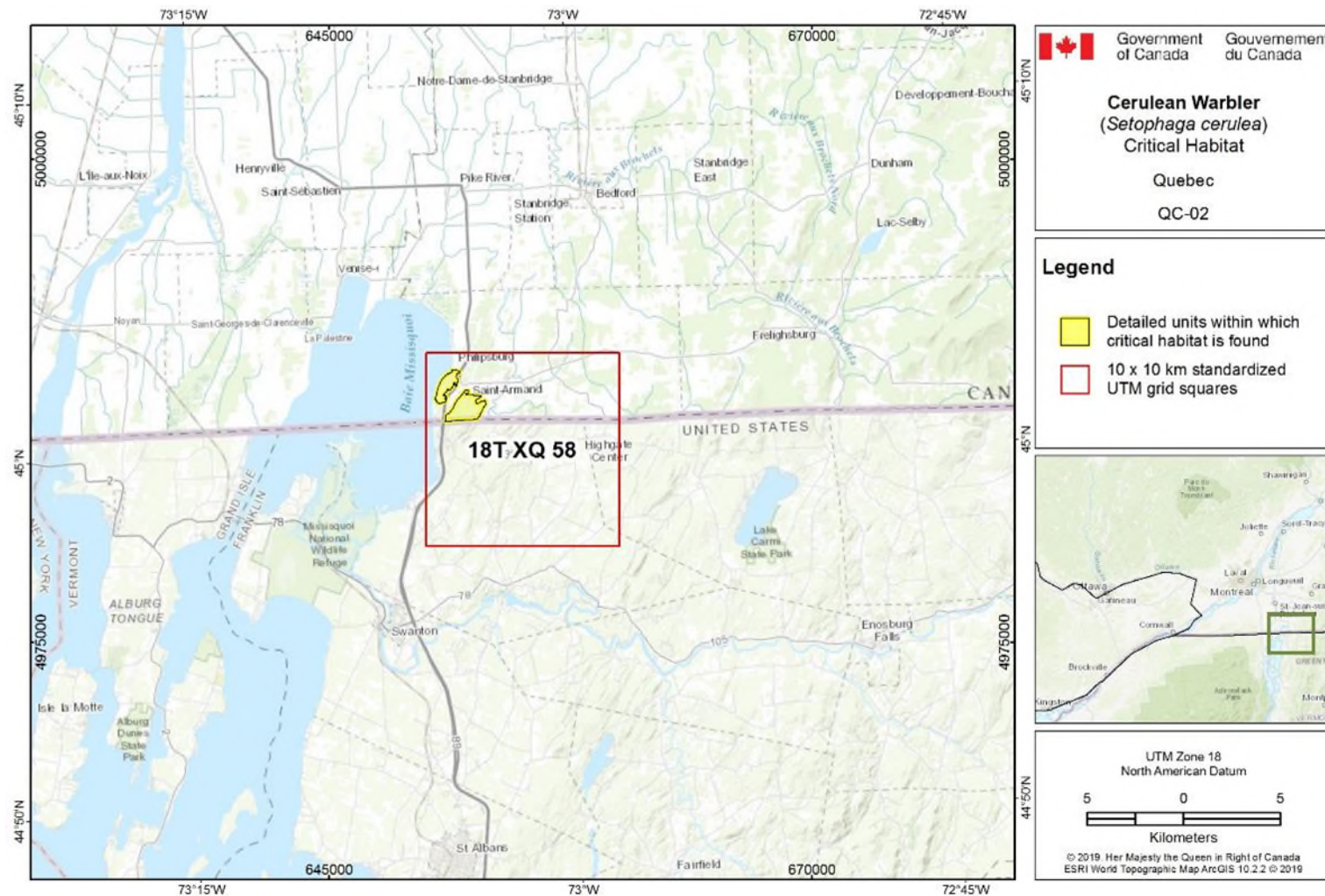
**Figure A-6. Critical habitat for the Cerulean Warbler in Leeds Grenville, Ontario.** The area containing critical habitat for the Cerulean Warbler, as described in section 7.1, is represented by the yellow shaded unit. Within this area, critical habitat occurs where the biophysical attributes described in section 7.1.2 are found. The 1 km × 1 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.



**Figure A-7. Critical habitat for the Cerulean Warbler in Quebec (overview).** The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.



**Figure A-8. Critical habitat for the Cerulean Warbler in Quebec (QC-01).** The area containing critical habitat for the Cerulean Warbler, as described in section 7.1, is represented by the yellow shaded unit. Within this area, critical habitat occurs where the biophysical attributes described in section 7.1.2 are found. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.



**Figure A-9. Critical habitat for the Cerulean Warbler in Quebec (QC-02).** The area containing critical habitat for the Cerulean Warbler, as described in section 7.1, is represented by the yellow shaded unit. Within this area, critical habitat occurs where the biophysical attributes described in section 7.1.2 are found. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

## Appendix B: Subnational Conservation Ranks of the Cerulean Warbler (*Setophaga cerulea*) in Canada and the United States

**Table A-1.** Subnational conservation ranks of the Cerulean Warbler (*Setophaga cerulea*)

Country (N Rank)	State or Province (S Rank)
United States (N4B)	Alabama (S1B), Arkansas (S3B), Connecticut (S3B), Delaware (S1B), District of Columbia (S2N), Florida (SNA), Georgia (S1), Illinois (S3), Indiana (S3B), Iowa (S2B,S3N), Kansas (S1B), Kentucky (S4S5B), Louisiana (S1B), Maryland (S3B), Massachusetts (S1B,S2M), Michigan (S3), Minnesota (S3B), Mississippi (S2B), Missouri (S2S3), Nebraska (S2), New Hampshire (S3B), New Jersey (S3B,S3N), New York (S3?B), North Carolina (S2B), Ohio (S4), Oklahoma (S2B), Pennsylvania (S4B), Rhode Island (S1B,S2N), South Carolina (S1?B), South Dakota (S1B), Tennessee (S3B), Texas (SHB,S3N), Vermont (S1S2B), Virginia (S3S4B), West Virginia (S2B), Wisconsin (S2S3B)
Canada (N3B, NUM)	Ontario (S3B), Quebec (S1B)

Source: NatureServe 2018

**Table A-2.** Definitions of National (N) and Subnational (S) Conservation Status Ranks (Master et al. 2012)

Rank	Definition
N1 S1	Critically Imperiled— At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.
N2 S2	Imperiled— At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
N3 S3	Vulnerable— At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
N4 S4	Apparently Secure— At a fairly low risk of extirpation in the jurisdiction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
N5 S5	Secure— At very low or no risk of extirpation in the jurisdiction due to a very extensive range, abundant populations or occurrences, with little to no concern from declines or threats.
N#N# S#S#	Range Rank— A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).

SH	Possibly Extirpated— Known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.
SNA	Not Applicable— A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.
SNR	Unranked— Conservation status not yet assessed.
NU SU	Unrankable— Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
B	Breeding
N	Non-breeding
M	Migrant



## Appendix C: Breeding Evidence<sup>26</sup>

### **Category: Possible Breeding**

#### **Code Description of behaviour**

- H Species observed in its breeding season in suitable nesting habitat.  
 S Singing male present, or breeding calls heard, in its breeding season in suitable nesting habitat.

### **Category: Probable Breeding**

#### **Code Description of behaviour**

- P Pair observed in their breeding season in suitable nesting habitat.  
 T Permanent territory presumed through registration of territorial song on at least 2 days, a week or more apart, at the same place.  
 D Courtship or display between a male and a female or 2 males, including courtship feeding or copulation.  
 V Visiting probable nest site.  
 A Agitated behaviour or anxiety calls of an adult.  
 B Brood patch on adult female or cloacal protuberance on adult male.  
 N Nest-building or excavation of nest hole.

### **Category: Confirmed Breeding**

#### **Code Description of behaviour**

- DD Distraction display or injury feigning.  
 NU Used nest or egg shell found (occupied or laid within the period of the study).  
 FY Recently fledged young or downy young, including young incapable of sustained flight.  
 AE Adults leaving or entering nest site in circumstances indicating occupied nest.  
 FS Adult carrying faecal sac.  
 CF Adult carrying food for young.  
 NE Nest containing eggs.  
 NY Nest with young seen or heard.

<sup>26</sup> Adapted from Cadman et al. 2007 and Robert et al. 2019.

## Appendix D: 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](#)<sup>27</sup>. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the [Federal Sustainable Development Strategy](#)'s<sup>28</sup> (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.

While implementation of this recovery strategy is expected to benefit the environment and native species that favour mature forest habitats such as the Cerulean Warbler, potentially adverse effects were also considered. These adverse effects relate to species whose specific requirements may differ from those of the Cerulean Warbler. For example, habitat management approaches that favour the Cerulean Warbler in Canada may not favour species that require open country habitats such as the Bobolink (*Dolichonyx oryzivorus*) or Eastern Meadowlark (*Sturnella magna*) or early successional habitats such as the Golden-winged Warbler (*Vermivora chrysoptera*). Even species that use mature forest habitat may have specific requirements that conflict with the specific needs of the Cerulean Warbler (e.g. Acadian Flycatcher may avoid the canopy gaps used by Cerulean Warbler).

Consequently, it is important that habitat management activities for the Cerulean Warbler be planned and implemented from an ecosystem perspective through the development, with input from responsible jurisdictions, stakeholders, Indigenous peoples, and landowners, of multi -species plans, ecosystem-based recovery programs, or area management plans that take into account the needs of multiple species, including other species at risk. Many of the stewardship and habitat improvement activities to benefit the Cerulean Warbler will be implemented through ecosystem-based conservation programs that have already taken into account the needs of other species at risk.

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<sup>27</sup> [www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html](http://www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html)

<sup>28</sup> [www.fsds-sfdd.ca/index.html#/en/goals/](http://www.fsds-sfdd.ca/index.html#/en/goals/)

**Table 5. Species expected to benefit from recovery techniques directed at Cerulean Warbler.**

<b>Common Name</b>	<b>Scientific Name</b>	<b>SARA Status</b>
Acadian Flycatcher	<i>Empidonax virescens</i>	Endangered
American Beech	<i>Fagus grandifolia</i>	
Barred Owl	<i>Strix varia</i>	
Downy Woodpecker	<i>Picoides pubescens</i>	
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	
Hairy Woodpecker	<i>Picoides villosus</i>	
House Wren	<i>Troglodytes aedon</i>	
Louisiana Waterthrush	<i>Parkesia motacilla</i>	Threatened
Northern Saw-whet Owl	<i>Aegolius acadicus</i>	
Prothonotary Warbler	<i>Protonotaria citrea</i>	Endangered
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>	
Southern Flying Squirrel	<i>Glaucomys volans</i>	
Tufted Titmouse	<i>Baeolophus bicolor</i>	
White-breasted Nuthatch	<i>Sitta carolinensis</i>	