PROPOSED

Species at Risk Act
Recovery Strategy Series
Adopted under Section 44 of SARA

Recovery Strategy for the Blue Racer (*Coluber constrictor foxii*) in Canada

Blue Racer

2017

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

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RECOVERY STRATEGY FOR THE BLUE RACER (*Coluber constrictor foxii*) IN CANADA

2017

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of Ontario has given permission to the Government of Canada to adopt the *Recovery Strategy for the Blue Racer (*Colouber constrictor foxii*) in Ontario* (Part 2) under Section 44 of the *Species at Risk Act* (SARA). Environment and Climate Change Canada has included a federal addition (Part 1) which completes the SARA requirements for this recovery strategy.

The federal recovery strategy for the Blue Racer in Canada consists of two parts:

Part 1 – Federal Addition to the *Recovery Strategy for the Blue Racer (*Coluber constrictor foxii*) in Ontario*, prepared by Environment and Climate Change Canada.

Part 2 – *Recovery Strategy for the Blue Racer (*Coluber constrictor foxii*) in Ontario*, prepared by R.J. Willson and G.M. Cunnington for the Ontario Ministry of Natural Resources and Forestry.

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Part 2 – *Recovery Strategy for the Blue Racer (*Coluber constrictor foxii*) in Ontario*, prepared by R.J. Willson and G.M. Cunnington for the Ontario Ministry of Natural Resources and Forestry.

Part 1 – Federal Addition to the *Recovery Strategy for the Blue Racer (*Coluber constrictor foxii*) in Ontario*, prepared by Environment and Climate Change Canada

Preface

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

The Minister of Environment and Climate Change is the competent minister under SARA for the Blue Racer and has prepared the federal component of this recovery strategy (Part 1), as per section 37 of SARA. SARA section 44 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for content (sub-sections 41(1) or (2)). The Ontario Ministry of Natural Resources (now the Ontario Ministry of Natural Resources and Forestry) led the development of the attached recovery strategy for the Blue Racer (Part 2) in cooperation with Environment and Climate Change Canada.

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, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Blue Racer 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 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[3] be described

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

[3] 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.

Acknowledgements

The initial draft of the federal addition was prepared by Jennie Pearce (Pearce and Associates Ecological Research), and was further developed by Kathy St. Laurent, Lauren Strybos, Justine Mannion, Krista Holmes (Environment and Climate Change Canada, Canadian Wildlife Service – Ontario) and Bruna Peloso (formerly Environment and Climate Change Canada, Canadian Wildlife Service – Ontario). Rachel deCatanzaro, Liz Sauer, Lesley Dunn (Environment and Climate Change Canada, Canadian Wildlife Service – Ontario), Veronique Lalande, Paul Johanson (Environment and Climate Change Canada, Canadian Wildlife Service - National Capital Region), Vivian Brownell, Joe Crowley, Anita Imrie and Jay Fitzsimmons (Ontario Ministry of Natural Resources and Forestry) reviewed and provided comments and advice during the development of this document.

Acknowledgement and thanks is given to all other parties that provided advice and input used to help inform the development of this recovery strategy including various Indigenous organizations and individual citizens, and stakeholders who provided input and/or participated in consultation meetings. Additionally, thanks are given to Rob Willson for providing the 2002 survey report and for advice in the development of this addition.

Additions and Modifications to the Adopted Document

The following sections have been included to address specific requirements of the federal *Species at Risk Act* (SARA) that are not addressed in the *Recovery Strategy for the Blue Racer (*Coluber constrictor foxii*) in Ontario* (Part 2 of this document, referred to henceforth as "the provincial recovery strategy") and/or to provide updated or additional information.

Environment and Climate Change Canada is adopting the provincial recovery strategy (Part 2), including section 2.0, Recovery; which outlines the approaches necessary to meet the population and distribution objective. Environment and Climate Change Canada has established its own population and distribution objective that is consistent with the recovery goal recommended in the provincial recovery strategy.

Under SARA, there are specific requirements and processes set out regarding the protection of critical habitat. Therefore, statements in the provincial recovery strategy referring to protection of the species' habitat may not directly correspond to federal requirements. Recovery measures dealing with the protection of habitat are adopted; however, whether these measures will result in protection of critical habitat under SARA will be assessed following publication of the final federal recovery strategy.

1. COSEWIC* Species Assessment Information

Date of Assessment: May 2012

Common Name (population): Blue Racer

Scientific Name: *Coluber constrictor foxii*

COSEWIC Status: Endangered

Reason for Designation: This large snake has an extremely restricted distribution and in Canada, occurs only on Pelee Island in southern Ontario. Despite efforts to protect dwindling habitat, it remains at low numbers. Threats include loss and fragmentation of habitat, increased road mortality and persecution.

Canadian Occurrence: Ontario

COSEWIC Status History: Designated Endangered in April 1991. Status re-examined and confirmed in May 2002 and May 2012.

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

2. Species Status Information

The Blue Racer (*Coluber constrictor foxii*) is a subspecies of the North American Racer (*Coluber constrictor*). There are 11 subspecies found in North America (Crother et al. 2001) with three occurring in Canada. The Blue Racer is the only subspecies of the North American Racer found in Ontario, where it is now only found on Pelee Island in Lake Erie although historically they were also recorded on the mainland in extreme southwestern Ontario.

The historical distribution of the Blue Racer in North America was in the Great Lakes region and ranges from extreme southwestern Ontario to central and southern Michigan, northeastern Ohio, eastern Iowa, southeastern Minnesota and to southern Illinois (Conant and Collins 1998; Willson and Cunnington 2012). The Blue Racer has a global conservation rank of G5T5 with a rounded status of T5, indicating the subspecies is globally Secure[4] (NatureServe 2014). The conservation rank of the Blue Racer in the United States and most states in which it is found has not been assessed; in Indiana the Blue Racer is ranked S4, Apparently Secure[5] (NatureServe 2014).

In Canada, the Blue Racer has a national and subnational (Ontario) rank of Critically Imperiled[6] (N1 and S1, respectively) (NatureServe 2014). It is listed as Endangered[7] on Schedule 1 of the federal SARA and is also listed as Endangered[8] under Ontario's *Endangered Species Act, 2007* (ESA).

The Blue Racer population that occurs in Canada is estimated to constitute less than 1% of the subspecies' global distribution, with an Index of Area of Occupancy[9] (IAO) of 16 km^2 (COSEWIC 2012).

3. 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 Blue Racer. 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

[4] Common, widespread and abundant
[5] 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.
[6] At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats or other factors
[7] A wildlife species facing imminent extirpation or extinction in Canada.
[8] A species that lives in the wild in Ontario but is facing imminent extinction or extirpation.
[9] Area of Occupancy: a biological measure of the occupied habitat within a wildlife species' range, determined by COSEWIC using an Index of Area of Occupancy (IAO).

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. In Canada, a single breeding population of the Blue Racer is present on Pelee Island, Ontario. COSEWIC (2012) estimated the population to be less than 250 adults and possibly declining, although no formal surveys have been undertaken since 2002. However, hatchlings and juveniles have been observed as recently as 2015 (Crowley pers. comm. 2015) indicating that the population has been reproducing. The size of the population makes it vulnerable to extinction from demographic and environmental stochasticity[10], catastrophic events and loss of genetic variability. The Pelee Island population is isolated from other Blue Racer populations and there is currently no effective immigration or emigration of individuals to adjacent mainland populations in the United States. Populations in Michigan, Iowa and Illinois are apparently secure and individuals from these populations would be adapted to local conditions in Ontario, and may provide opportunities for rescue effort[11].

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

   Unknown. Within the species' existing range in Canada (i.e., Pelee Island), suitable habitat exists, but is fragmented and may be further degraded by urban and agricultural development activities and increased road traffic (COSEWIC 2012). Availability of hibernation habitat is currently limited, and nesting sites, which are naturally rare, have become more limited on Pelee Island, thus forcing the species to use less optimal sites (Willson and Cunnington 2015). Although little information on population trends is available, informal surveys conducted between 2000 and 2009 indicate that the population may have declined, and suggest that habitat may be degraded (COSEWIC 2012). It may be possible to increase the amount of suitable habitat, and maintain sufficient habitat to support the species in Canada, through active management. The acquisition and active management of land by the Nature Conservancy of Canada (NCC) in 2009 and 2010 on Pelee Island has allowed for some natural habitat regeneration, as well as the establishment of new habitat features. Over time, the quality of these NCC-managed properties should continue to improve. In areas not currently utilized by the species, it is hoped that future emigration into these areas will

[10] Variation in population growth due to fluctuations in environment over time.
[11] Rescue effort refers to using individuals from stable Blue Racer populations in the United States to establish populations in areas within the species' former range in Canada, where the species no longer occurs.

occur (MacKinnon and Porchuk 2006), and monitoring of the habitats created by NCC for use by Blue Racers should be encouraged.

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

   Unknown. Habitat loss, degradation and fragmentation from activities associated with land use changes and increased development and vehicular mortality are the most significant threats to the Blue Racer. Threats to the Blue Racer are not well quantified or monitored on Pelee Island, but future threats could likely be mitigated although there may also be irreversible habitat loss and fragmentation. The development and implementation of Best Management Practices (e.g., maintenance of suitable vegetation types including lawns, construction of artificial hibernacula, creation of nesting and cover habitat) to restore and maintain Blue Racer habitat, and the securement of habitat through conservation easements or land purchases may mitigate the future loss and fragmentation of habitat (Nature Conservancy of Canada 2008; Mifsud 2014). The implementation of education and awareness programs that promote better understanding of species at risk-related legislation such as SARA and the ESA, as well as existing stewardship options for landowners may address the intentional persecution of snakes; while mitigation measures such as the creation of ecopassages and roadside fencing in combination with road signage may help to reduce road mortality. Additionally, Snake Fungal Disease (SFD) has been identified as a potential threat to the Blue Racer in this recovery strategy. It is not known what impact SFD may have on the species within Canada, and methods for controlling SFD have not yet been developed.

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

   Unknown. The priority for recovery of the Blue Racer is to maintain and, if feasible, increase the current abundance and distribution of the species within its existing range. Addressing threats to the species and its habitat is vital to achieving this objective. The severity of threats, methods to avoid or mitigate threats, and effectiveness of recovery techniques are poorly known at this time. However, it is anticipated that recovery activities such as protecting and connecting habitat through land purchases and conservation easements, managing vegetation succession through prescribed burns, and the creation of hibernation, nesting and shelter habitat will support recovery.

As the Blue Racer is at the northern extent of its North American distribution and has always had a naturally limited distribution in Canada, this species may continue to be vulnerable to human-caused and natural stressors despite efforts to recover the species.

4. Threats

As described in the provincial recovery strategy (Part 2, section 1.6), the loss, degradation and fragmentation of habitat on Pelee Island is both a historic and an ongoing threat to the Blue Racer (COSEWIC 2012); as is the increased traffic associated with new development projects, which increases road-related mortality of snakes. Intentional killing of snakes is not uncommon (Ashley et al. 2007), and there is evidence that Blue Racers have been intentionally killed on Pelee Island.

In addition to those threats identified in Part 2, evidence suggests that Wild Turkeys (*Meleagris gallopavo*), which were introduced to Pelee Island in 2002, may prey on juvenile Blue Racers (MacKinnon and Porchuk 2006; COSEWIC 2012).

Additionally, another potential threat that may affect the Blue Racer is Snake Fungal Disease (SFD) (*Ophidiomyces ophiodiicola*) (Sleeman 2013). This is an emerging fungal disease in wild snakes that causes severe skin lesions, leading to widespread morbidity and mortality (Sleeman 2013; Allender et al. 2015). SFD is currently known to affect seven species including the Northern Watersnake, as well as the Eastern Foxsnake (*Pantherophis gloydi*), Eastern Milksnake (*Lampropeltis triangulum*), and Massasauga (*Sistrurus catenatus*) (Sleeman 2013). SFD has been confirmed in Ontario, in an Eastern Foxsnake found in southwestern Ontario in 2015 (Crowley pers. comm. 2015). It has also been confirmed in nine states in the U.S., although it is considered likely to be even more widespread (Sleeman 2013).

The disease spreads directly through contact with infected snakes and indirectly via environmental exposure (i.e., contact with contaminated soil) (Sleeman 2013; Allender et al. 2015). In 2009, a Northern Watersnake with a fungal skin infection consistent with SFD was collected from an island in western Lake Erie, Ohio (Sleeman 2013). While the population-level effects of SFD remain unclear, it appears to spread easily and is often fatal, and there is concern it could have negative impacts on small snake populations of conservation concern (Sleeman 2013; Allender et al. 2015). For example, SFD is thought to have contributed to a 50% decline in a small Timber Rattlesnake (*Crotalus horridus*) population in New Hampshire in 2006 to 2007 (Clark et al. 2011). Climate change has the potential to further increase the risk of SFD to snake populations, as warming temperatures may lead to increased infection rates in hibernating snakes (Allender et al. 2015). Due to the small population and isolated range of the Blue Racer, both globally and in Canada, SFD may threaten population viability if it becomes established in the population.

5. Population and Distribution Objectives

The provincial *Recovery Strategy for the Blue Racer (*Coluber constrictor foxii*) in Ontario* recommends the following recovery goal:

- The recovery goal for the Blue Racer in Ontario is to (1) maintain, or if necessary increase population abundance to ensure long-term population persistence; (2) increase habitat quantity, quality and connectivity on Pelee Island; and (3) continue to assess the feasibility of repatriating the species to portions of its former range on the southern Ontario mainland.

Under SARA, a population and distribution objective for the species must be established. Consistent with the goal recommended in the Government of Ontario's Recovery Strategy, Environment and Climate Change Canada's population and distribution objective for the Blue Racer is to:

- Maintain and, if biologically and technically feasible, increase the species' current abundance and distribution in Canada.

Pelee Island is considered to contain a single population of less than 250 individuals (COSEWIC 2012). The best available estimates of population size are from mark-recapture data available for the years 1993-1995 and 2000-2002, estimating 307 adults (95% confidence interval[12] = 129-659) and 140.7 adults (95% confidence interval = 59.0-284.7), respectively (Willson and Cunnington 2015). Though differences in sampling design and study area between the two time periods preclude direct comparison of the estimates, informal surveys provide reasonable certainty that the number of adult snakes on Pelee Island has declined, and it is likely that their numbers remain below 250 (COSEWIC 2012). There remain two locations on Pelee Island where suitable habitat is known to still exist, but the presence of Blue Racer is yet to be confirmed, as the species has not been observed in over a decade despite repeated survey efforts. It is not known whether the current number of Blue Racers in the Ontario population will be sufficient to ensure long-term population persistence. Until further information is available on minimum viable population size, the priority for recovery of the Blue Racer is to maintain and, if feasible, increase the abundance and distribution of the species within its existing range in Canada.

Blue Racers have been restricted in Canada to Pelee Island for almost 30 years, and it is highly unlikely Blue Racers could naturally recolonize their historical range on the Ontario mainland without the intentional release of individuals from Pelee Island or the United States. Therefore, efforts to investigate the feasibility of repatriating the species to portions of its former range are important to the species survival in Canada and to increasing the species' distribution. Thus far, many repatriation efforts for snakes have

[12] The range around the population size estimate for Blue Racer, which if repeated would include the true estimate of population size 95% of the time.

been unsuccessful (Dodd and Seigel 1991; Fischer and Lindemayer 2000); though several studies suggest that the success of repatriation efforts is enhanced when the probable causes of decline or extirpation are understood or removed (Burke 1991; Reinert 1991; Fischer and Lindemayer 2000). Given the reasons for Blue Racer decline on the mainland are not fully understood, the focus of this recovery strategy is to increase suitable habitat and improve habitat connectivity on Pelee Island in order to maintain, and if feasible increase, the abundance and distribution of the existing population of the Blue Racer. However, while not part of the current federal objective, in adopting the *Recovery Strategy for the Blue Racer (*Coluber constrictor foxii*) in Ontario* (Part 2), Environment and Climate Change Canada supports continuing to assess the feasibility of repatriating the species to portions of its former range on the southern Ontario mainland. New information on the feasibility of repatriation will be evaluated as it becomes available.

Maintaining the existing population of the Blue Racer on Pelee Island will require controlling and mitigating threats to this species, especially those related to a loss of suitable habitat. Increasing suitable habitat and promoting connectivity between important habitats is essential to maintaining a viable Blue Racer population on Pelee Island. Provided other threats to Blue Racer individuals (e.g., housing and agricultural land development, road mortality, intentional persecution) are managed and mitigated, viable populations would be expected to persist over long time frames where sufficient suitable habitat exists, and the natural expansion of the existing population to different areas of Pelee Island may be encouraged through maintaining currently unoccupied adjacent suitable habitat.

6. Broad Strategies and General Approaches to Meet Objectives

Environment and Climate Change Canada is adopting the approaches identified in section 2.3 of the *Recovery Strategy for the Blue Racer (*Coluber constrictor foxii*) in Ontario* (Part 2) as the broad strategies and general approaches to meet the population and distribution objective; with the exception of Approaches 2.1 and 5.1. These two approaches have been modified, for the purposes of this recovery strategy, to read as follows:

2.1 Support the Ontario Ministry of Natural Resources and Forestry's efforts to develop a habitat regulation and/or habitat description for Blue Racer under Ontario's *Endangered Species Act, 2007*.

5.1 Support any potential efforts of the Ontario Ministry of Natural Resources and Forestry to determine feasibility of repatriation.

Environment and Climate Change Canada is also adding the following approach to respond to the emerging threat of SFD:

4.6 Investigate the threat of SFD to Blue Racer within Canada, including presence of the disease within the Canadian population; possible vectors of the disease; methods of disease control.

7. Critical Habitat

7.1 Identification of the Species' Critical Habitat

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 examples of activities that are likely to result in its destruction. Under SARA, critical habitat is "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species".

Identification of critical habitat is not a component of provincial recovery strategies under the Province of Ontario's ESA. Under the ESA, when a species becomes listed as endangered or threatened on the Species at Risk in Ontario List, it automatically receives general habitat protection. The Blue Racer currently receives general habitat protection under the ESA; however, a description of the general habitat has not yet been developed. In some cases, a habitat regulation may be developed that replaces the general habitat protection. A habitat regulation is a legal instrument that prescribes an area that will be protected[13] as the habitat of the species by the Province of Ontario. A habitat regulation has not been developed for Blue Racer under the ESA; however, the provincial recovery strategy (Part 2) contains a recommendation on the area for consideration in developing a habitat regulation. This federal recovery strategy identifies critical habitat for the Blue Racer in Canada to the extent possible, based on this recommendation and on the best available information as of June 2015. Additional critical habitat may be added in the future if new information supports the inclusion of areas beyond those currently identified.

The identification of critical habitat for Blue Racer is based on two criteria: habitat occupancy and habitat suitability.

7.1.1 Habitat Occupancy

The habitat occupancy criterion refers to areas of suitable habitat (defined in Section 7.1.2) where there is a reasonable degree of certainty of current use by the species.

[13] Under the federal *Species at Risk Act* (SARA), there are specific requirements and processes set out regarding the protection of critical habitat. Protection of critical habitat under SARA will be assessed following publication of the final federal recovery strategy.

Habitat is considered occupied when:

- At least one Blue Racer individual has been observed in any single year since 1990.

In Ontario, the remaining population of Blue Racers includes only a small number of individuals (COSEWIC 2012). The species is not well surveyed across its range, therefore a single observation may be indicative of a local population or important habitat features. This is appropriate for the Blue Racer which has a small geographic range and is facing considerable threats.

The twenty-five year timeframe (1990-2015) for the habitat occupancy criterion is reasonable due to the cryptic nature of the species and the limited number of systematic surveys. Most available records are from mark-recapture and radio telemetry[14] surveys conducted between 1993 and 1995 by Porchuk (1996), and provide some of the best information on known locations of nesting and hibernacula features. The Blue Racer exhibits fidelity to nesting and hibernacula features and these features are limited on Pelee Island (Willson and Cunnington 2015). In addition, application of a twenty-five year timeframe allows for the inclusion of two locations where habitat appears to be suitable, but for which the Blue Racer has not been observed for over a decade despite repeated survey efforts. Future survey efforts should confirm the status of the species and habitat use at these two locations.

Habitat occupancy is based on documented nesting or hibernacula locations, survey and telemetry data, and incidental observations of the Blue Racer (live or dead) in locations where key suitable habitat biophysical attributes defined below in Section 7.1.2 are present nearby. These observational data must have a spatial precision of <1km or provide enough detail to be associated with a specific suitable habitat feature(s) to be considered adequate to identify critical habitat.

7.1.2 Habitat Suitability

Habitat suitability refers to areas possessing a specific set of biophysical attributes that support individuals of the species to carry out essential life cycle activities (e.g., hibernation, mating, nesting, foraging, shelter) as well as their movements. Although there are no absolute barriers to movement on Pelee Island, it is important that all required habitat areas are linked or in reasonable proximity to one another so that snakes can move between them with ease. Suitable habitat for the Blue Racer can therefore be described as a mosaic of dry, open to semi-open habitat, in which specific biophysical attributes can be associated with essential life cycle activities. Within the area of suitable habitat, the biophysical attributes required by the Blue Racer will vary over space and time with the dynamic nature of ecosystems. In addition, particular

[14] A radio-telemetry survey involves monitoring the radio signals sent from an animal-attached device to track the animal's movements; telemetry is the process of transmitting the information through the atmosphere.

biophysical attributes will be of greater importance to snakes at different points in time (e.g., during different life processes, seasons or at various times of the year).

The biophysical attributes of critical habitat are detailed in Table 1.

Table 1. Detailed biophysical attributes of critical habitat for specific life cycle activities of the Blue Racer in Ontario.

Life Stage and/or Need	Biophysical Attributes	Reference
All life processes (Hibernation, Nesting, Shelter, Thermoregulation, Foraging, Mating, Movement)	• Forest edge habitat[15] with full (>60%) canopy cover adjacent to open or semi-open habitat. • Early to mid-successional vegetation communities that are dry (little moisture) with open (<25%) to semi-open (25-40%) canopy cover. • Habitat types may include, but are not limited to, the following examples: - Savannas; - Meadows; - Old fields; - Alvars; - Thickets; - Woodland; and, - Edges of hedgerows, riparian vegetation strips bordering canals, shallow ditches adjacent to roadways, and shoreline.	• Porchuk 1996; Porchuk and Prevett 1999; Carfagno and Weatherhead 2006; Willson and Cunnington 2015
Shelter	• Presence of features that facilitate shedding, thermoregulation, digestion and protection from predators. Features are typically located in areas with high exposure to sunlight and limited canopy cover, and may include, but are not limited to: - Living or dead vegetation on the ground or in trees, large flat rocks, piles or accumulations of rock and soil (naturally occurring). - Human refuse such as sheet metal and wooden boards (non-naturally occurring[16]).	• Porchuk 1996; Willson and Cunnington 2015

[15] The definition of edge habitat corresponds with the definition used in the habitat analyses of Porchuk (1996). Edge habitat is defined as occurring within five metres of the interface between the two adjoining communities (e.g., forest-field). For example, where a forest transitions to an open habitat, the edge community would extend five metres into the forest and five metres into the open habitat.
[16] Non-naturally occurring features are human-constructed or maintained structures with a primary purpose other than providing habitat for wildlife.

Nesting	• Features are typically located in areas exposed to sunlight most of the day, and on Pelee Island are often restricted to the shoreline areas. Features can include[17]: - Fallen decaying logs; - Large rocks; or - Mounds of decaying organic matter.	• Porchuk 1996; Willson and Cunnington 2015
Hibernation	• Structure that extends below the frost line and where adequate moisture exists (where snakes will not freeze or become dehydrated). • Typically located in limestone plains, where cracks and fissures in the bedrock provide access to underground cavities and caverns. • May also include piles or accumulations of rock and soil.	• Porchuk 1996; Willson and Cunnington 2015

Movement	• Contiguous edge habitat[18] that connects adjacent suitable habitat for all life processes.
	• Permeable[19] to the Blue Racer and not interrupted by barriers to movement. Barriers may include cliffs, dense urbanized developments, and bodies of water.
	• Edge habitat types may include, but are not limited to, the following:
	  • Hedgerow;
	  • Riparian vegetation strips bordering canals;
	  • Shallow ditches adjacent to roadways;
	  • Shoreline; and,
	  • Forest.
		• Porchuk 1996; Porchuk and Prevett 1999; Carfagno and Weatherhead 2006; Willson and Cunnington 2015

Given that there is no available information on the amount of habitat that is required for the Blue Racer to complete its life cycle activities within a home range, a precautionary approach is used to identify an extent of suitable habitat for the Blue Racer. This description of suitable habitat reflects the fact that certain biophysical attributes do not need to be immediately adjacent to each other, as long as they remain connected so that the individuals can easily move between them to meet all their biological needs and respond to or avoid disturbances as required. The distances determining the extent of suitable habitat are specific to the Blue Racer and based on the species' biological and behavioural requirements (see Part 2, section 1.4).

[17] Although use has been exhibited, non-naturally occurring nesting habitat such as sheet metal and wooden boards have not been included as biophysical attributes because the majority of eggs laid under these objects do not hatch due to extreme temperature and moisture fluctuations (Porchuk 1996; Porchuk 1998).
[18] The definition of edge habitat corresponds with the definition used in the habitat analyses of Porchuk (1996). Edge habitat is defined as occurring within five metres of the interface between the two adjoining communities (e.g., forest-field). For example, where a forest transitions to an open habitat, the edge community would extend five metres into the forest and five metres into the open habitat.
[19] A type of habitat that allows for the passage of animals.

Suitable habitat for the Blue Racer is described as:

- The extent of the biophysical attributes that are located within a radial distance of 2,300 m from a known record of Blue Racer.

This criterion will capture the vast majority of potential hibernation and nesting habitats, which are important considering few precise locations are known. In addition, where they are known, hibernacula and nest sites are also identified separately because of their close relationship with survival and recruitment of individuals. Hibernacula and nest site availability and selection are known factors limiting the Blue Racer and are likely to be especially important for population persistence given the rarity of these habitats, and the fidelity to and communal use of these sites (which may indicate a low availability of optimal sites). Therefore, suitable habitat for the Blue Racer also includes:

- The area within a 120 m radial distance from the entrance and/or exit of a naturally-occurring Blue Racer hibernacula feature (single site or complex); AND
- The area within a 30 m radial distance from a known naturally-occurring nest record of the Blue Racer.

Suitable habitat for the Blue Racer can be described using the Ecological Land Classification (ELC) framework for Ontario (from Lee et al. 1998)[20], which provides a standardized approach to the interpretation and delineation of dynamic ecosystem boundaries. The ELC approach classifies habitats not only by vegetation community but also considers hydrology[21] and topography[22], and as such encompasses the biophysical attributes of the habitat for Blue Racer. In addition, ELC terminology and methods are familiar to many land managers and conservation practitioners who have adopted this tool as the standard approach for habitat classification in Ontario, and has been used specifically on Pelee Island.

The biophysical attributes of Blue Racer suitable habitat are typically found in the following ELC Community Series designations: Open Alvar (ALO); Shrub Alvar (ALS); Treed Alvar (ALT); Open Tallgrass Prairie (TPO); Tallgrass Savanna (TPS); Tallgrass Woodland (TPW); Cultural Meadow (CUM); Cultural Thicket (CUT); Cultural Savanna (CUS); and Cultural Woodland (CUW). Due to their rarity, confirmed hibernacula and nesting will also be identified as critical habitat wherever they are located (they do not need to occur in ELC polygons of suitable habitat).

[20] ELC in Ontario is being revised to further distinguish between different types of cultural habitats (e.g., row crops, perennial cover crops, specialty crops, pasture) in addition to various native grassland ecotypes (H. Lee pers. comm. 2012). It is recommended that these new ELC ecotypes be incorporated when the next version of the classification scheme has been approved and/or becomes widely adopted.
[21] The movement, distribution, and quality of water.
[22] The arrangement of the natural and artificial physical features of an area.

Movement habitat is also not described using the ELC framework. Instead movement refers to any contiguous[23] edge habitat that connects adjacent suitable ELC habitat patches for hibernation, mating, nesting, shelter, and foraging, as well as known hibernacula and nesting sites. The search for these suitable habitat patches constitutes the majority of movements for snakes. Blue Racers on Pelee Island move substantial distances over the active season (Porchuk 1996). The distance used to set the suitable habitat boundary (i.e., 2,300 m radial distance from an observation) is the area that will capture over 90% of an individual's range, based on a data analysis of the Blue Racer's radio-tracked movements from known hibernacula on Pelee Island (Porchuk 1996; Willson and Porchuk unpub. data from Willson and Cunnington 2015). Connectivity between habitats that remain occupied and available to the Blue Racer is important as much of the habitat for the species has already been lost or fragmented within the landscape. Hedgerows, riparian vegetation strips adjacent to canals and roadways, shorelines, and forest connect many of the habitat patches, and Blue Racers readily use the edges of these habitat types for movement in addition to the edges of the ecological community series described above (Willson 2002; Porchuk 1996; Brooks and Porchuk 1997).

Many of the cracks and fissures visible on the surface through which Blue Racers gain access to underground cavities or caverns for hibernation, are connected underground and Blue Racers can move several metres horizontally through them (Porchuk 1996). Hibernation complexes up to 120 m in diameter have been documented in the limestone plain regions of Pelee Island (Porchuk and Willson unpub.data from Willson and Cunnington 2015), and including the area within 120 m of the entrance and/or exit of a hibernacula feature ensures that most of the complex will be protected.

The area within a 30 m radial distance around a nesting observation is important to maintain the microclimatic conditions (e.g., thermal, vegetative and light features) and serves as a staging area. Non-naturally occurring nesting habitat such as sheet metal and wooden boards have not been included as suitable nesting habitat because the majority of eggs laid under these objects do not hatch due to extreme temperature and moisture fluctuations (Porchuk 1996; Porchuk 1998).

Shelter habitat used by Blue Racers is typically composed of living or dead vegetation on the ground or in trees, large flat rocks, and piles or accumulations of rock and soil. However, the Blue Racer may also use non-naturally occurring features such as discarded sheet metal and car parts for shelter. Since Blue Racers exhibit fidelity to shelter habitat, these features are important components of the species' habitat. Where feasible, the non-naturally occurring features should be left in place to provide areas for cover, protection from predators, and thermoregulation when they occur in or immediately adjacent to critical habitat.

[23] Adjacent habitat patches and/or land cover that may or may not be of the same type but are permeable to the Blue Racer movement (no barriers).

Active agricultural fields in row crops or in crop rotation, including vineyards, do not possess the biophysical attributes required by Blue Racer and are not identified as critical habitat (including hibernacula) as they are poor quality habitats offering limited cover and use of these habitats can result in increased rates of mortality, and may become ecological traps[24]. In addition, roads pose a high mortality threat to Blue Racers, and while they may be crossed during the active season or during movement to and from hibernacula or nesting sites (Porchuk 1996; Brooks and Porchuk 1997; MacKinnon and Porchuk 2006), they do not provide habitat for the species and as such are not identified as critical habitat.

7.1.3 Application of the Blue Racer Critical Habitat Criteria

Critical habitat for the Blue Racer is identified as the extent of suitable habitat (section 7.1.2), where the habitat occupancy criterion is met (section 7.1.1). At occupied locations, critical habitat is defined as the ensemble of suitable habitat located within 2,300 m of a Blue Racer record (see Figure 1). Critical habitat will also include hibernacula and nesting features wherever they occur along with surrounding habitat within 120 m and 30 m of the feature, respectively. Application of the critical habitat criteria to the best available data identified critical habitat for the known extant population of the Blue Racer in Canada (Pelee Island), totaling up to 526 ha[25]. As more information becomes available, additional critical habitat may be added or may be further refined.

Due to the sensitivities of the species (i.e., to persecution), critical habitat for the Blue Racer is presented using 10 x 10 km Standardized Universal Transverse Mercator (UTM) grid squares (Figure 2, See also Table 2). The UTM grid squares presented in Figure 2 are part of a standardized grid system that indicates the general geographic areas containing critical habitat, which can be used for land use planning and/or environmental assessment purposes. In addition to providing these benefits, the 10 x 10 km Standardized UTM grid respects provincial data-sharing agreements in Ontario. Critical habitat within each grid square occurs where the description of habitat occupancy (section 7.1.1) and habitat suitability (section 7.1.2) are met. More detailed information on critical habitat to support protection of the species and its habitat may be requested on a need-to-know basis by contacting Environment and Climate Change Canada – Canadian Wildlife Service at ec.planificationduretablissement-recoveryplanning.ec@canada.ca.

[24] A low-quality habitat that animals choose over other available, better quality habitats.
[25] This area was identified using air photos, and field verifications may lead to some modifications in area and extent. The areas derived from a 120 m and 30 m radial distance around known hibernaculum and nesting sites, respectively, are included within this estimate.

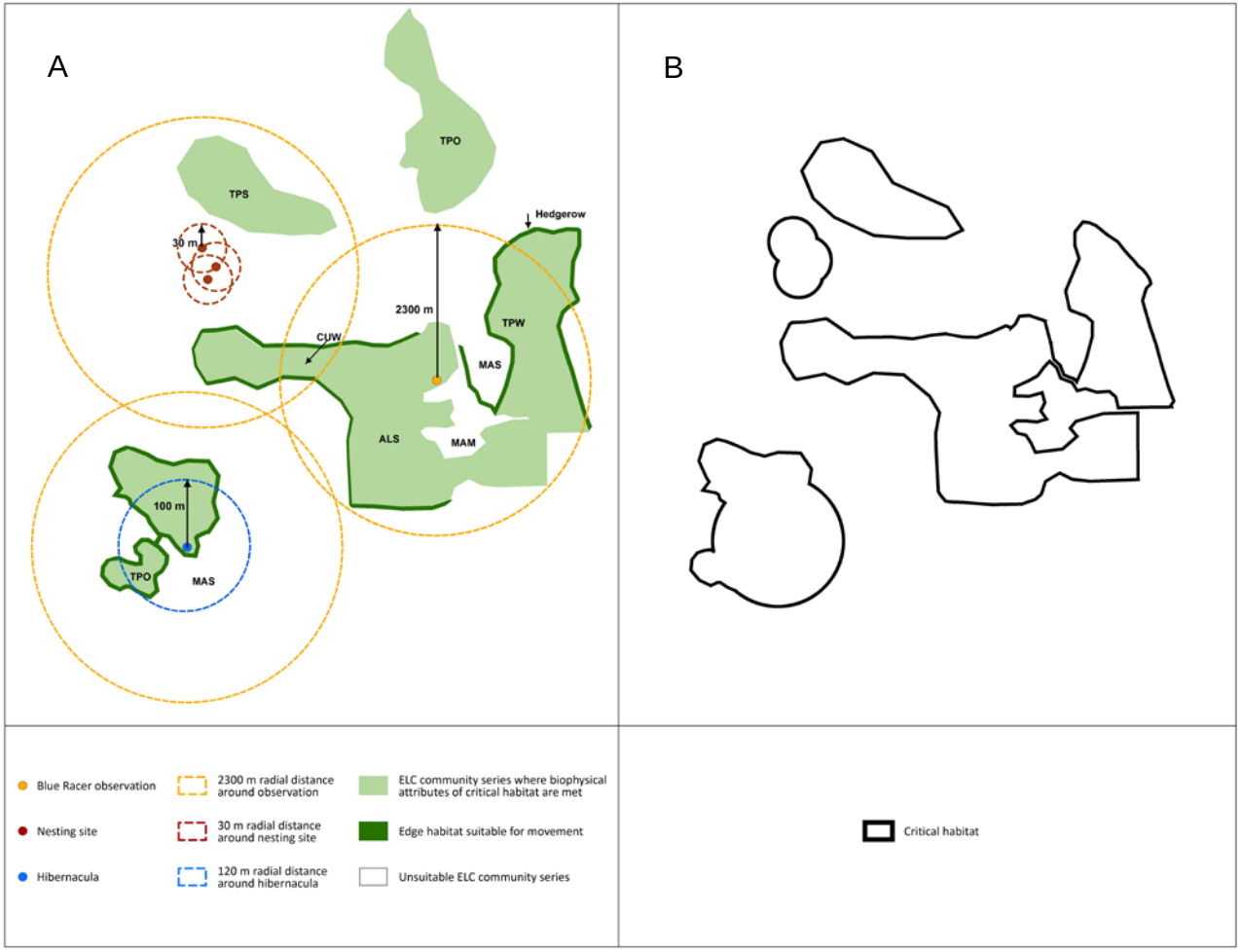

Figure 1. Schematic of Critical Habitat Criteria for the Blue Racer. (A) Critical habitat is identified for the Blue Racer as the extent of suitable habitat (section 7.1.2) where the habitat occupancy criterion is met. At occupied locations, critical habitat is defined as the ensemble of suitable habitat located within 2,300 m of a Blue Racer record. Critical habitat will also include hibernacula and nesting features wherever they occur along with surrounding habitat within 120 m and 30 m of the feature, respectively. Ecological Land Classification (ELC) acronyms used in the figure are: Shrub Alvar (ALS); Open Tallgrass Prairie (TPO); Tallgrass Savanna (TPS); Tallgrass Woodland (TPW); Cultural Woodland (CUW); Shallow Marsh(MAS); and Meadow Marsh (MAM). (B) Critical habitat includes the boundary of suitable habitat, hibernacula, and/or nesting site that meet the habitat occupancy criterion.

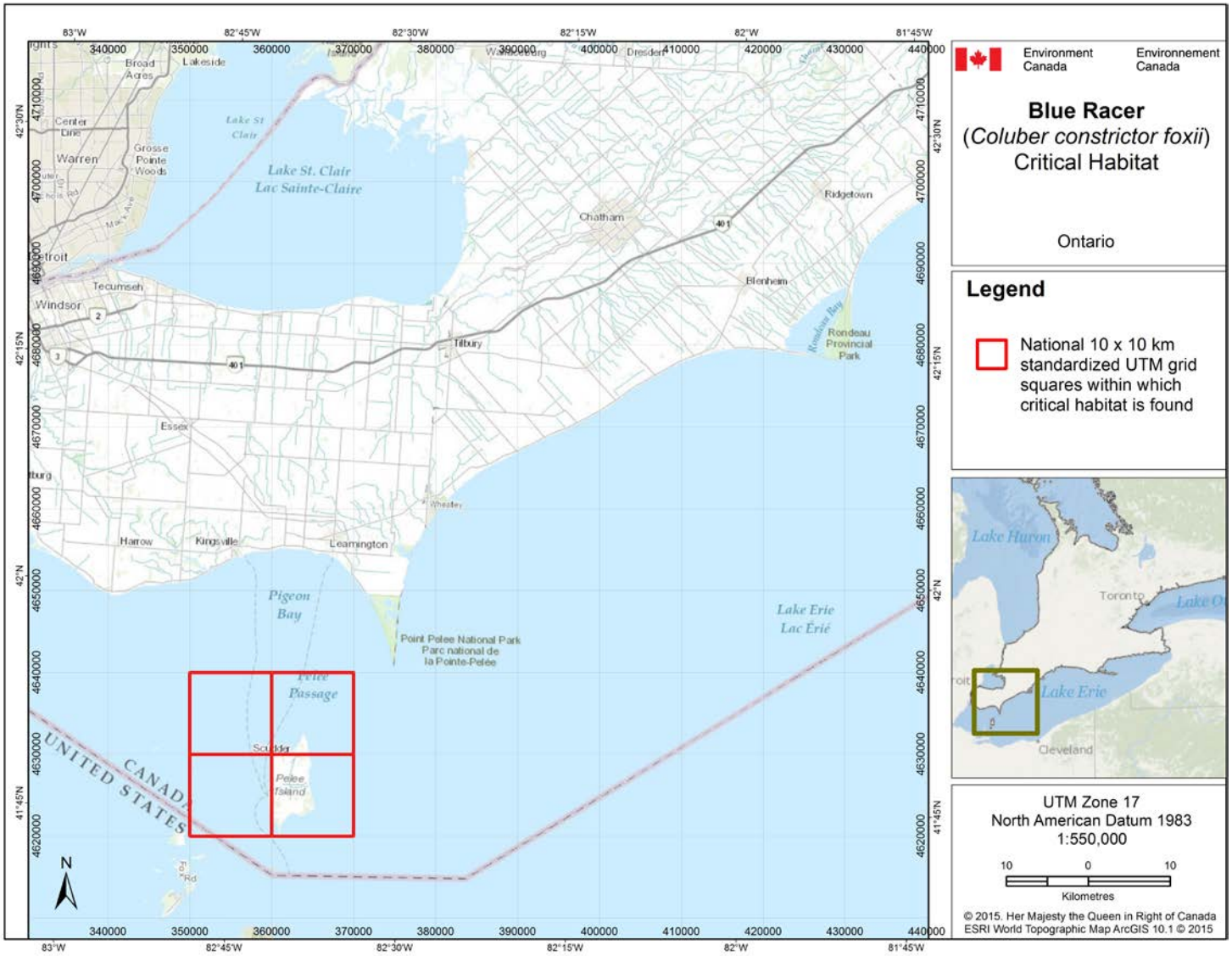

Figure 2. Grid squares that contain critical habitat for the Blue Racer in Canada. Critical habitat for the Blue Racer occurs within these 10 x 10 km UTM grid squares (red squares), where the description of habitat occupancy (section 7.1.1) and habitat suitability (section 7.1.2) are met.

Table 2. Grid squares that contain critical habitat for the Blue Racer in Canada. Critical Habitat for the Blue Racer occurs within these 10 x 10 km UTM grid squares where the description of habitat occupancy (section 7.1.1) and habitat suitability (section 7.1.2) are met.

Population	10 x 10 km Standardized UTM grid square ID[1]	Province/Territory	UTM Grid Square Coordinates[2]	
			Easting	Northing
Pelee Island	17TLG63	Ontario	360000	4630000
	17TLG53		350000	4630000
	17TLG62		360000	4620000
	17TLG52		350000	4620000
Total = 4 grid squares				

[1] Based on the standard UTM Military Grid Reference System (see http://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/maps/9789), where the first 2 digits and letter represent the UTM Zone, the following 2 letters indicate the 100 x 100 km Standardized UTM grid, followed by 2 digits to represent the 10 x 10 km Standardized UTM grid containing all or a portion of the critical habitat unit. This unique alphanumeric code is based on the methodology produced from the Breeding Bird Atlases of Canada (See www.bsc-eoc.org/ for more information on breeding bird atlases). To protect species sensitivities, UTM Standardized grid squares at the intersection of UTM zones are merged with their adjacent grid squares to ensure a 10 x 10 km grid square minimum.

[2] The listed coordinates are a cartographic representation of where critical habitat can be found, presented as the southwest corner of the 10 x 10 km Standardized UTM grid square that is the critical habitat unit. The coordinates are provided as a general location only.

7.2 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 was degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single activity or multiple activities at one point in time or from the cumulative effects of one or more activities over time. Activities described in Table 3 include those likely to cause destruction of critical habitat for the species; however, destructive activities are not limited to those listed.

Blue Racer habitat requires management to remain suitable, thus some of the activities necessary to maintain habitat may result in the temporary removal of critical habitat (e.g., mowing and/or burning of shrubs and other successional vegetation). However, these activities have the potential to contribute to the future availability of critical habitat (e.g., burning vegetation at locations can create/maintain more open areas needed by Blue Racers during certain life processes). Timing of such activities is important to ensure that critical habitat is not permanently damaged or destroyed, and is described below in Table 3. Timing restrictions will need to be discussed with the appropriate agencies (generally, the province of Ontario (Ontario Ministry of Natural Resources and Forestry) on non-federal lands, and Environment and Climate Change Canada on federal lands), on a case-by-case basis.

Table 3. Activities Likely to Result in the Destruction of Critical Habitat

Description of Activity	Description of Effect (biophysical attribute or other)	Location of the activity likely to destroy critical habitat			
		Within critical habitat			Outside critical habitat
		Foraging, nesting, and shelter habitat	Movement habitat	Hibernacula	
Development and conversion of suitable habitat to land uses that do not provide suitable habitat for this species (e.g., residential or commercial development, road building)	Site clearing, blasting and grading that alter cover result in the direct loss of suitable habitat characteristics (e.g., piles or accumulations of rock and soil, living or dead vegetation) which the species relies on for foraging, for nesting, for shelter and for overwintering. Blasting may also damage overwintering habitat outside the active quarry area by destroying or preventing access to underground hibernacula.	X	X	X	X
Destruction or alteration of natural structures providing nesting sites and/or hibernacula (e.g., use of off-road vehicles, farm machinery or lawn mowers)	The use of off-road vehicles, farm machinery or lawn mowers in critical nesting and/or hibernacula habitat may damage or destroy preferred nesting features and substrates (e.g., decayed downed woody debris); and/or may permanently damage or destroy, or may prevent access to, important hibernation sites.	X		X	
Activities that result in the net removal, disturbance or destruction of natural and non-naturally occurring cover habitat	Blue Racers may use natural and/or non-naturally occurring cover habitat for predator protection and shelter during various life stages (e.g., shedding and gestation). The removal, disturbance or destruction of such cover habitat may increase the snakes' susceptibility to predation and exposure and interfere with digestion, gestation and/or the recovery from an injury.	X	X	X	

	Naturally occurring cover habitat should not be removed at any time of the year to ensure the availability of cover habitat within and outside of the active season, and during subsequent active seasons. If the removal of non-natural cover habitat were to occur during the active season (April to approx. November) within the bounds of critical habitat, it is likely that snakes would be disturbed and critical cover habitat lost. Blue Racers show high site fidelity to cover objects within an active season and so its removal when in use may be detrimental. However, if the removal of non-natural cover habitat occurs outside the active season (approx. December to March), snakes may use alternate cover habitat (e.g., naturally occurring cover) in subsequent active seasons. It may be possible to replace the function served by human-influenced structures or features should they need to be removed or disturbed. This determination will need to be done on a case-by-case basis taking into consideration a number of factors including the species' biology, potential risk to the species, the availability of natural and anthropogenic habitat features in the surrounding area, and options for mitigation or replacement. Note: Removal of human refuse used as nesting habitat would not destroy critical habitat, because non-naturally-occurring objects do not provide an appropriate microclimate for successful egg development (e.g., low hatch rates). However, it must be ascertained that the object does not also provide cover habitat.				
Activities that result in significant reduction or clearing of natural and semi-natural features, including the removal of hedgerows, and/or living or dead ground vegetation	Removing hedgerows, and/or living or dead ground vegetation at any time of the year would result in the direct loss of habitat that the species relies on for foraging, mating, movement, nesting, and cover habitat. Removal of linear habitats provided by hedgerows would remove connectivity between larger habitat patches used by the species.	X	X		

Prescribed fire	Prescribed burns to control succession create habitat for the Blue Racer, but may also be harmful depending on timing. At the wrong time, prescribed burns may remove cover and prey species leaving snakes vulnerable to predation and without adequate energy reserves prior to and following hibernation. If this activity were to occur in September or October, within the bounds of critical habitat, it is likely that the effects on critical habitat would be direct.	X	X		

8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objective. Every five years, success of recovery strategy implementation will be measured against the following performance indicators:

- The abundance and distribution of the Blue Racer in Canada has been maintained, and if biologically and technically feasible, increased.

9. Statement on Action Plans

One or more action plans will be completed for Blue Racer by December 31, 2023.

10. 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*[26]. 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[27] (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.

This recovery strategy will clearly benefit the environment by promoting the recovery of the Blue Racer and by protecting and enhancing habitat for two other co-occurring Threatened snake species, the Eastern Fox Snake (*Elaphe gloydi*) and the Lake Erie Water Snake (*Nerodia sipedon insularum*).

The potential for the strategy to inadvertently lead to adverse effects on other species was considered. Other species at risk on Pelee Island include the Prothonotary Warbler (*Protonaria citrea*), Least Bittern (*Ixobrychus exilis*), Blanchard's Cricket Frog (*Acris*

[26] www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[27] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=CD30F295-1

blanchardi), Small-mouthed Salamander (*Ambystoma texanum*), Wild Hyacinth (*Camassia scilloides*), Chimney Swift (*Chaetura pelagica*), Eastern Prickly Pear (*Opuntia humifusa*), Grey Fox (*Urocyon cineroargenteus*), Kentucky Coffee-tree (*Gymnocladus dioicus*), Red Mulberry (*Morus rubra*), Acadian Flycatcher (*Empidonax virescens*), and the Eastern Spiny Softshell Turtle (*Apalone spinifera spinifera*). Recovery approaches for the Blue Racer are not anticipated to have adverse effects on these species that are predominantly associated with habitats not preferred by the Blue Racer. Actions to maintain open habitats for the Blue Racer may have an adverse effect on the Endangered Yellow-breasted Chat (*Icteria virens virens*) that is dependent on early successional habitat. To mitigate adverse effects on the Yellow-breasted Chat, the ecological risk of each activity must be individually assessed before undertaking them. For example, the location of prescribed burns can be controlled so that they do not eliminate active Yellow-breasted Chat habitat while creating future habitat for the species. Following this approach, mitigation strategies are available to meet the needs of both species at risk on Pelee Island.

The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects that cannot be avoided or mitigated. The reader should refer to the following sections of the document, in particular: habitat needs (Part 2, section 1.4), knowledge gaps (Part 2, section 1.7).

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Part 2 – *Recovery Strategy for the Blue Racer (*Coluber constrictor foxii*) in Ontario*, prepared by R.J. Willson and G.M. Cunnington for the Ontario Ministry of Natural Resources and Forestry

Photo: Joe Crowley

Blue Racer
(Coluber constrictor foxii) in Ontario

Ontario Recovery Strategy Series

Recovery strategy prepared under the *Endangered Species Act, 2007*

2015

Natural. Valued. Protected.

Ministry of Natural Resources and Forestry

Ontario

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 (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. There was a transition period of five years (until June 30, 2013) to develop recovery strategies for those species listed as endangered or threatened in the schedules of the ESA. 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 Natural Resources and Forestry Species at Risk webpage at:
www.ontario.ca/speciesatrisk

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DECLARATION

The recovery strategy for the Blue Racer 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 of the individuals who provided advice or contributed to its preparation, or the official positions of the organizations with which the individuals are associated.

The 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

Ontario Ministry of Natural Resources and Forestry
Environment Canada – Canadian Wildlife Service, Ontario

EXECUTIVE SUMMARY

Formerly found in extreme southwestern Ontario, the Blue Racer (*Coluber constrictor foxii*) is a snake that is now confined to Pelee Island. The Blue Racer is listed as endangered under Ontario's *Endangered Species Act, 2007* (ESA). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) declared the Blue Racer endangered in 1991 and this status was retained in status updates in 2002 and 2012. The Blue Racer is also identified as endangered under Schedule 1 of the *Species at Risk Act* (SARA).

The Blue Racer is one of Ontario's largest snakes. Relative to the other snake species that occur on Pelee Island the Blue Racer is uncommon. The primary threats to survival and recovery of the species on Pelee Island are habitat loss and degradation, vehicular mortality and intentional persecution.

The recovery goal for the Blue Racer in Ontario is (1) to maintain, or if necessary increase population abundance to ensure long-term population persistence; (2) increase habitat quantity, quality and connectivity on Pelee Island; and (3) continue to assess the feasibility of repatriating the species to portions of its former range on the southern Ontario mainland. The protection or recovery objectives are as follows.

1. Protect habitat and connections, and where possible, increase the quantity and quality of available habitat for Blue Racer on Pelee Island.
2. Promote protection of the species and its habitat through legislation, policies, stewardship initiatives and land use plans.
3. Reduce mortality by minimizing threats.
4. Address knowledge gaps and monitor Blue Racer population.
5. Continue to assess the feasibility of repatriating Blue Racers to a location on the southern Ontario mainland.

The three most important types of habitat for the Blue Racer, in order of importance, are (1) hibernation habitats, (2) nesting habitats and (3) shelter habitats. Although these three habitats are the most important for maintaining a viable population, other habitats used for foraging, mating and movement are necessary for population persistence. All of these types of habitat are necessary for individuals of the species to complete their life cycle and thus should be prescribed in a habitat regulation for Blue Racer.

Given the importance and sensitivity to disturbance of hibernation and nesting habitats, it is recommended that these features be recognized as having a high sensitivity to alteration. Additionally, shelter habitats that are used by two or more Blue Racers (i.e., are communal) should be recognized as having a high sensitivity to alteration. Blue Racers show fidelity to all of these types of habitat, particularly areas used for hibernation.

Additional recommendations pertaining to hibernation habitat to be considered in a habitat regulation are as follows.

- Hibernation habitat should be protected until it is demonstrated that the feature can no longer function in this capacity.

- The area within 120 m of an identified hibernation feature (single site or complex) should be regulated as habitat and recognized as having a high sensitivity to alteration.

Additional recommendations pertaining to nesting and shelter habitat to be considered in a habitat regulation are as follows.

- A naturally occurring nesting habitat or communal shelter habitat (i.e., used by two or more Blue Racers) that has been used at any time in the previous three years should be protected.
- A non-naturally occurring nesting habitat or communal shelter habitat (i.e., used by two or more Blue Racers) should be protected from the time its use was documented until the following November 30.
- The area within 30 m of the boundary of the nesting feature should be regulated as habitat and recognized as having a high sensitivity to alteration.

Foraging and mating habitats should be recognized as having a moderate sensitivity to alteration. Relative to hibernation, nesting and shelter habitats, the spatial extent of foraging, mating and movement habitats is considerably larger. Foraging and mating habitats are best defined at the level of ecological community (e.g., savanna, woodland) and these areas will be several hectares in size.

It is recommended that the following ecological community types on Pelee Island be regulated as foraging and mating habitats when they occur within 2,300 m of a reliable Blue Racer observation:

- alvars (treed, shrub and open types);
- thicket;
- savanna;
- woodland; and
- edge (includes hedgerows and riparian vegetation strips bordering canals).

It is evident that there are not well-defined movement corridors for Blue Racer. Given the considerable spatial extent of the areas that would be regulated as hibernation, nesting, shelter, foraging and mating habitat as per the recommendations above, it is recommended that no additional areas be regulated as movement habitat.

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1. BACKGROUND INFORMATION

1.1 Species Assessment and Classification

COMMON NAME: Blue Racer
SCIENTIFIC NAME: *Coluber constrictor foxii*
SARO List Classification: Endangered
SARO List History: Endangered (2004)
COSEWIC Assessment History: Endangered (2012, 2002, 1991)
SARA Schedule 1: Endangered (January 12, 2005)
CONSERVATION STATUS RANKINGS: GRANK: G5 NRANK: N1 SRANK: S1

The glossary provides definitions for technical terms, including the abbreviations above.

1.2 Species Description and Biology

Species Description
The Blue Racer (*Coluber constrictor foxii)* is one of Ontario's largest snakes, reaching lengths of 90 cm to 152 cm snout-to-vent length (SVL; Conant and Collins 1998). The largest documented specimen captured on Pelee Island was 138 cm SVL (Porchuk and Willson unpub. data). Blue Racers often have creamy white ventral scales, dull grey to brilliant blue lateral scales and pale brown to dark grey dorsums (Porchuk 1996). They also have characteristic black masks, relatively large eyes and often have brownish-orange rostral scales (snouts). Unlike adults, hatchlings and yearlings (first full active season) have dorsal blotches that fade completely by the third year; however, juvenile patterning is still visible on the ventral scales until late in the snake's third season (Porchuk unpub. data).

Species Biology
The Blue Racer is an egg-laying snake and average clutch size on Pelee Island for seven females was 14.7 ± 2.53 (standard deviation; Porchuk 1996). Females can reproduce annually (Rosen 1991, Carfagno and Weatherhead 2006), but biennial cycles have also been documented (Porchuk 1996). Males can mature physiologically at 11 months (Rosen 1991) but do not have the opportunity to mate until their second full year. Similarly, females may mature at 24 months (Rosen 1991) but are not able to reproduce until the following year (Porchuk 1996). On Pelee Island, mating occurs in

May. Females lay eggs in late June through early July and eggs hatch from mid-August to late-September (Porchuk 1996).

Blue Racers hibernate underground for five to seven months each year (Porchuk 1996, Brooks et al. 2000, Willson 2002). Most adult Blue Racers hibernate communally and occasionally hibernacula are shared with Eastern Foxsnake (*Pantherophis gloydi*), Lake Erie Watersnake (*Nerodia sipedon insularum*) and Eastern Gartersnake (*Thamnophis sirtalis sirtalis*) (Porchuk 1996). Monitoring of known communal hibernacula on Pelee Island suggests that individual Blue Racers do not begin to use the communal sites where adults hibernate until their third year (Porchuk and Willson unpub. data).

Blue Racers are active during the day and are active foragers (Fitch 1963). Adults engage in both terrestrial and arboreal foraging (Porchuk 1996). Young snakes may consume crickets and other insects, whereas adults feed primarily on rodents, birds and snakes (Fitch 1963, Ernst and Ernst 2003, Porchuk 1996, Porchuk unpub. data).

Probable natural predators of adult Blue Racers on Pelee Island include the larger birds of prey (e.g., Red-tailed Hawk, *Buteo jamaicensis*; Northern Harrier, *Circus cyaneus*; Great-horned Owl, *Bubo virginianus*) and mammals such as Raccoon (*Procyon lotor*), Foxes (*Vulpes vulpes* and *Urocyon cinereoargenteus*), and Coyote (*Canis latrans*) (COSEWIC 2002, Ernst and Ernst 2003). Dogs (*Canis familiaris*) and feral house cats (*Felis cattus*) are known to kill and/or harass juvenile Blue Racers (COSEWIC 2002) and it is likely that adult Blue Racers are also occasionally killed by these animals given that even large, venomous snakes are preyed upon regularly by cats (see Whitaker and Shine 2000). The eggs and young are likely vulnerable to a wider variety of avian and mammalian predators. Wild Turkeys (*Meleagris gallopavo*) were re-introduced to Pelee Island in the winter of 2002 and as an opportunistic feeder, may prey upon juvenile Blue Racers (MacKinnon 2005).

Blue Racers seem to be relatively intolerant of high levels of human activity, and for most of the active season they remain in areas of low human density (Porchuk 1996). Evidence to substantiate this comes largely from radiotelemetry data from both Blue Racers (Porchuk 1996) and Eastern Foxsnakes (Willson 2000a) that inhabited the same general areas on Pelee Island (although studies were not conducted concurrently). For instance, Eastern Foxsnakes were often found under front porches, in barns/garages and in the foundations of houses, whereas most Blue Racers were observed in areas with less human activity (Porchuk and Willson unpub. data).

Similar to other active foraging snakes studied (e.g., Rouse et al. 2011), Blue Racers on Pelee Island were documented to move substantial distances over the active season (Porchuk 1996). Twenty-two female Blue Racers moved an average of 241.3 ± 14.5 (standard error) metres per day when they were documented moving on a particular day (on many days snakes do not move) and 12 male Blue Racers moved an average of 250.3 ± 18.5 (standard error) metres per day when they were documented moving on a particular day (Porchuk 1996).

The hibernaculum is crucial to the survival of snakes inhabiting temperate latitudes (Prior and Weatherhead 1996) and Blue Racers show a high degree of fidelity to these sites (Porchuk 1996). Therefore, distance-based metrics that incorporate the hibernaculum will be the measures of spatial dispersion most relevant to conservation efforts (COSEWIC 2008, Rouse et al. 2011). Maximum Distance found from Hibernacula (MDH) values calculated for 25 Blue Racers (14 females; 11 males) radiotracked by Porchuk (1996) are as follows: mean MDH = 1,391.6 ± 616.63 (standard deviation) m, median MDH = 1,145.0 m, 90 percent quantile = 2,276.8 m, range = 467.0–2,714.0 m (Willson and Porchuk unpub. data).

Distances from hibernacula to other important habitats such as nest sites also have high conservation value. The maximum straight-line distance between a female's hibernaculum and nest site documented by Porchuk (1996) was 2,600 m.

1.3 Distribution, Abundance and Population Trends

Distribution

The historical distribution of the Blue Racer in North America ranges from extreme southwestern Ontario to central and southern Michigan, northeastern Ohio, eastern Iowa, southeastern Minnesota and to southern Illinois (Conant and Collins 1998; Figure 1). Ohio, Indiana, Illinois, Michigan, Wisconsin and Iowa are the only states with extant populations of Blue Racer (Harding 1997). In Canada, Blue Racers are now found only on Pelee Island (Figure 2). The most reliable historical records of Blue Racer on the Ontario mainland are from Point Pelee National Park (Essex County) and the Grand Bend/Pinery Provincial Park area (Lambton and Huron Counties). The last possible but unconfirmed report of a Blue Racer from the Ontario mainland was along the Ausable River in 1983 (Kamstra 1991). In the early 1990s, searches and appeals were extended for information or sightings in the vicinity of Pinery Provincial Park; however, no sightings were reported. See Rowell (2012) for a thorough summary of historical Blue Racer records from the Ontario mainland.

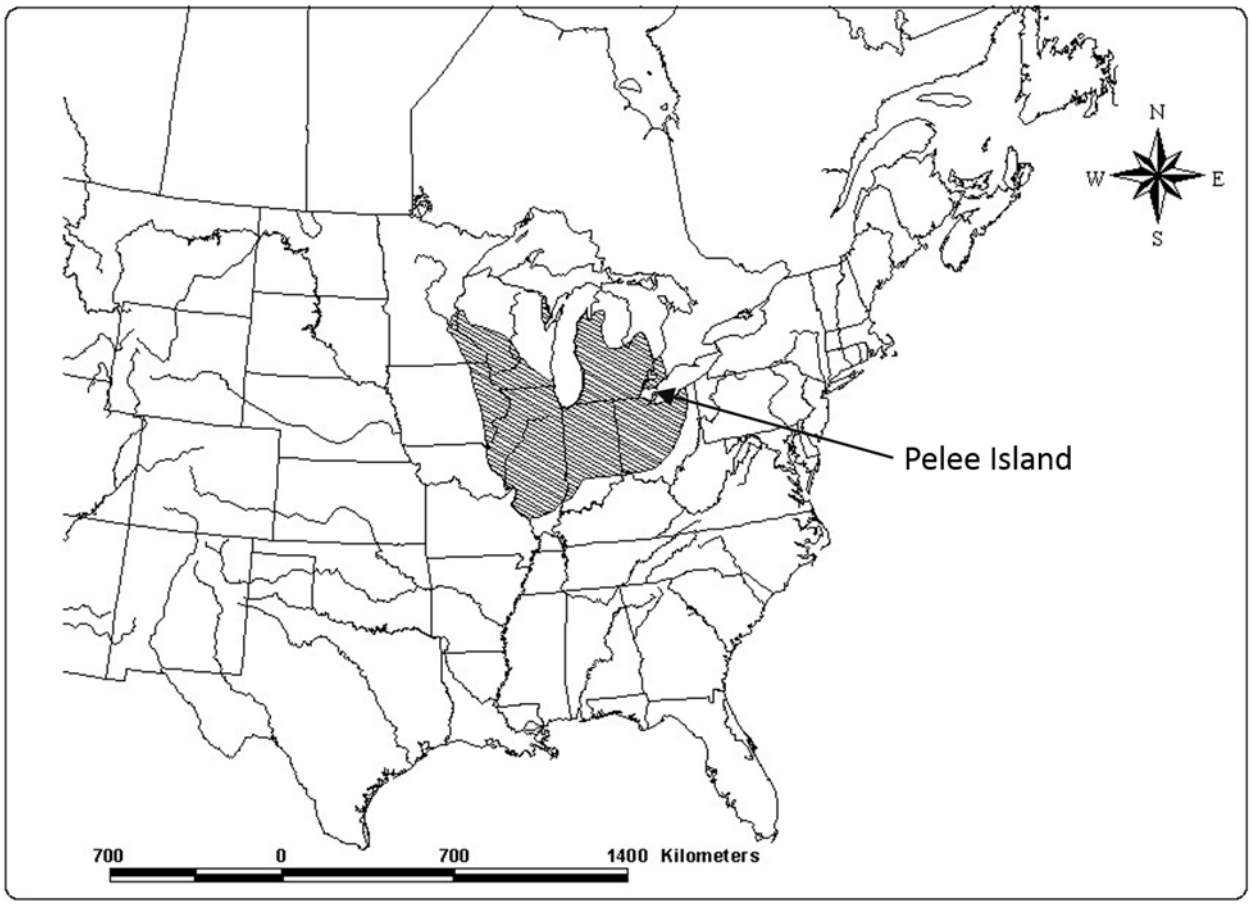

Figure 1. North American distribution of Blue Racer.

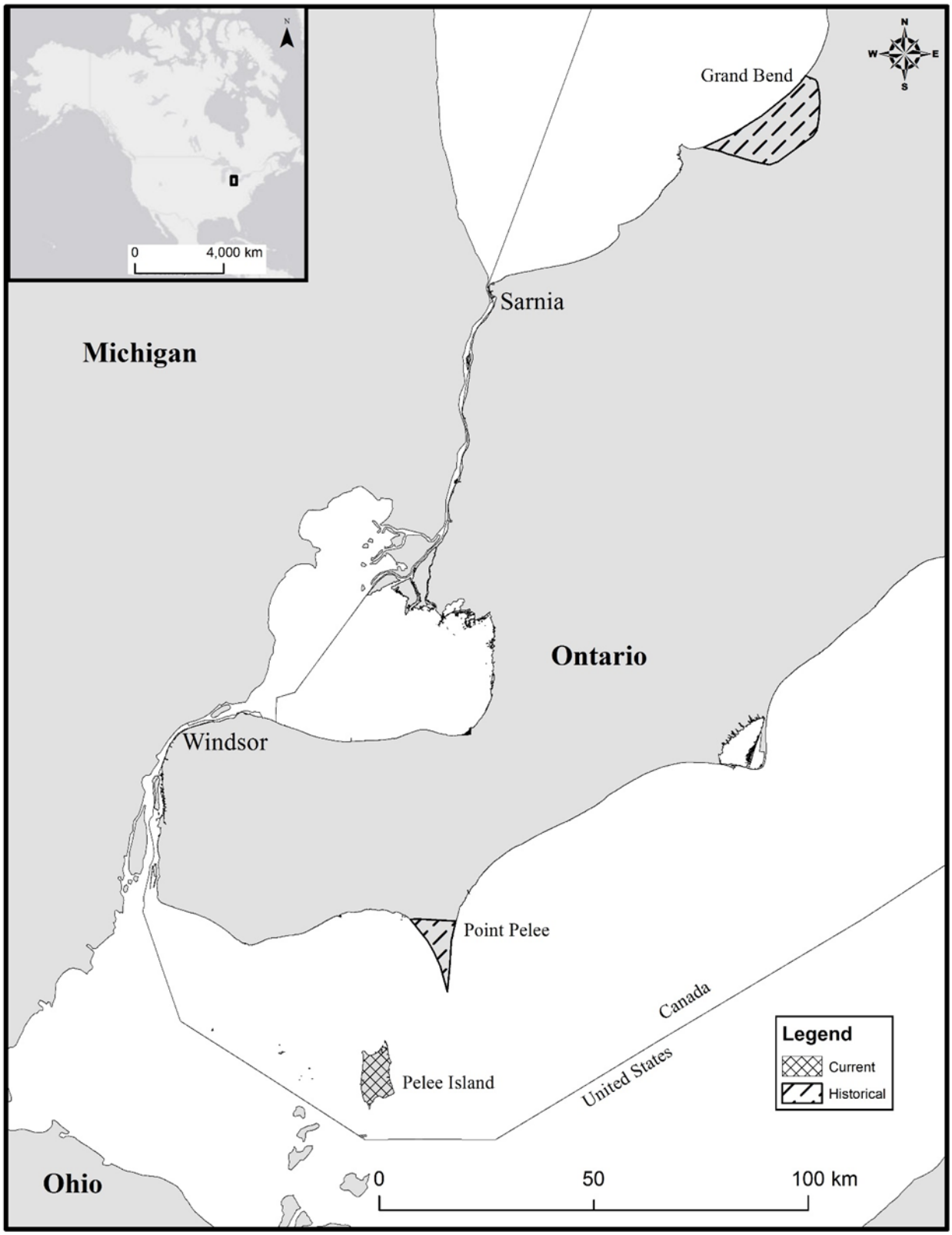

Figure 2. Current and historical distribution of Blue Racer in Ontario.

Abundance and Population Trends

To estimate the size of the Pelee Island Blue Racer population, a three-year mark-recapture and radiotelemetry study was conducted from 1993 to 1995. The resultant mark-recapture data were incorporated into a Jolly-Seber population model and generated a population size estimate of 307 adults (95% confidence interval = 129–659; Porchuk 1996) for 1994. Further mark-recapture sampling of the Pelee Island Blue Racer population was conducted over the three-year period 2000 to 2002 (Willson 2002). Over the three years of the survey, 1,584 person hours were spent searching four study sites.

In total, 222 Blue Racers were encountered, of which 166 were captured (75% capture rate). The persistence of Blue Racers within three focal areas identified in earlier studies was confirmed and the species continued to be absent from a fourth historically-inhabited site. The number of Blue Racers encountered at each study site differed substantially and corroborated site-specific abundance levels documented in earlier studies.

Jolly Seber mark-recapture analyses generated a population size estimate for the three study sites combined of 140.7 ± 73.47 (95% confidence interval = 59.0–284.7) adult Blue Racers (Willson 2002). Comparisons between the population estimates generated from the two study periods (1993–1995 and 2000–2002) are not possible because the earlier study's sampling methodology was less systematic (e.g., sampling effort was not restricted to quantifiable locations or times) and the most recent survey was geographically restricted to specific properties (Willson 2002). Because of the systematic design of the most recent survey, comparisons with future sampling periods should be possible.

As of 2005, six Blue Racers had been located outside of the area of occupancy shown in COSEWIC (2002) and two of these individuals were hatchlings (Willson and Porchuk unpub. data). Three of the six Blue Racer observations (1997, 2004) were at the Red Cedar Savanna south of East-West Road and just east of the Pelee Island Winery Pavilion. These observations indicate that the area is used by Blue Racers, at least during the late summer when adults often disperse large distances from their hibernacula (Porchuk 1996). It is also possible, however, that some of these individuals are using hibernation sites west of the area of occupancy that have yet to be documented.

1.4 Habitat Needs

At a landscape scale, Blue Racers on Pelee Island predominantly use dry, open to semi-open areas (i.e., minimal canopy closure), as well as the edges of these and other ecological community types such as woodlands and forests (Porchuk 1996). The preference for edge habitat documented for this species by Porchuk (1996) was also observed by Carfagno and Weatherhead (2006) in Illinois. Additionally, both Porchuk

(1996) and Carfagno and Weatherhead (2006) documented a preference of racers for early to mid-successional vegetation communities (i.e., areas with low to intermediate canopy closure). Porchuk (1996) defined edge as occurring within five metres of the interface between the two adjoining communities (e.g., forest-woodland, marsh-thicket). For example, where a forest transitions to a farm field, the edge habitat would extend five metres into the forest and five metres into the farm field. Hedgerows and the majority of the riparian vegetation strips bordering canals were considered edge under this definition.

On Pelee Island, the ecological communities that are open or semi-open and correspond with the Ecological Land Classification (ELC) of Lee et al. (1998) are as follows: alvar, thicket, savanna and woodland (when tree cover is at the lower end of the range for this community). It should be recognized that the habitat classifications and descriptions used in Porchuk (1996) predated the ELC for southern Ontario and thus the habitat descriptions more closely align with those of Kamstra et al. (1995). Additionally, areas recognized as high quality habitat for snakes are not always easily described by the ELC (Willson unpub. data).

For the majority of snakes inhabiting temperate-zone climates, thermoregulation is an important driver of habitat selection (e.g., Blouin-Demers and Weatherhead 2001). As such it is not surprising that Blue Racers on Pelee Island used habitats with less canopy closure in the spring than during the summer when they also were documented in areas with higher canopy closure (e.g., woodlands and forests; Porchuk 1996). Similar shifts in habitat use were also documented for racers (*Coluber constrictor)* in Illinois (Carfagno and Weatherhead 2006). In addition to being documented in forests during the summer, Blue Racers likely also move through forests to reach preferred habitats (Porchuk 1996). Indeed, given the limited spatial extent of forest communities (> 60% tree cover) on Pelee Island, and the high movement capacity and tendency of Blue Racers documented by Porchuk (1996), it is unlikely that there are any forested areas on the island that individual Blue Racers could not move through (Willson unpub. data).

For egg-laying snakes inhabiting northern latitudes, the three most important types of habitat in order of importance are (1) hibernation habitats, (2) nesting (egg-laying) habitats and (3) shelter habitats (e.g., features that facilitate ecdysis (shedding or moulting of skin), digestion and protection from predators) (COSEWIC 2008). Although these three habitats are the most important for maintaining a viable population, other habitats used for foraging, mating and movement are also necessary for population persistence.

Hibernation Habitat

On Pelee Island, several hibernation complexes are located within the limestone plain regions (Porchuk 1996). Within these limestone plains there are areas where cracks and fissures in the bedrock provide access to underground cavities or caverns. Blue Racers enter these cavities in the fall and emerge in the spring (Porchuk 1998). Radiotelemetry and mark-recapture data showed that while underground in many of these hibernation areas, snakes could move several metres horizontally; thus, many of the cracks visible on the surface are connected underground (Porchuk 1996). Some of

the hibernation complexes approach 120 m in diameter (Porchuk and Willson unpub. data). In addition to the hibernation areas in the bedrock, Blue Racers have also been documented hibernating in piles or accumulations of rock and soil (Porchuk 1996). Blue Racers exhibited high fidelity to hibernation habitats (Porchuk 1996).

Nesting Habitat

Eggs are laid in fallen decaying logs, under large rocks and in mounds of decaying organic matter (Porchuk and Brooks 1995, Porchuk 1996). Eggs are also laid under discarded pieces of sheet metal, boards and other human refuse. However, the majority of the eggs laid under these objects do not hatch (Porchuk 1996, Porchuk 1998). The majority of nests are located in areas exposed to sunlight most of the day (i.e., high exposure to solar radiation because of limited canopy cover; Porchuk 1996). Intra- and interspecific (with Eastern Foxsnake) communal nesting has been documented on Pelee Island (Porchuk and Brooks 1995, Porchuk 1996).

Shelter Habitat

This type of habitat is used by Blue Racers during periods when they need to maintain their body temperature within a preferred range for several days while being protected from predators. For example, snakes shed or moult their skin up to four times per year. During this process (ecdysis), which on average lasts 5 to 10 days under natural conditions, individual snakes usually become sedentary (R. Willson, unpub. data). Becoming sedentary and seeking shelter habitat during this period is driven both by the need to maintain preferred body temperatures (higher body temperatures accelerate body processes) and to reduce the risk of predation during the phase of the ecdysis when vision is impaired. Additionally, this type of habitat is used when a snake is digesting recently ingested prey (larger prey items requiring longer periods). Other situations when Blue Racers may use a shelter habitat include after an injury and females may use preferred sites at some stage of gestation prior to nesting. While using this type of habitat, Blue Racers may be visible during certain times of the day (i.e., basking) or, depending on the time of year and the ambient temperatures, they may be hidden the majority of the time (Porchuk 1996).

Shelter habitat is typically composed of living or dead vegetation on the ground or in trees, large flat rocks, piles or accumulations of rock and soil, discarded sheet metal and car parts (Porchuk 1996, Willson 2002). These features can be naturally occurring or established by human activity. Similar to hibernation and nesting habitats, Blue Racers exhibit fidelity to shelter habitat (e.g., some rocks and brush piles are used repeatedly by individuals over a single active season or over the course of several years) (Porchuk and Willson unpub. data). Additionally, the majority of shelter habitats are located in areas exposed to sunlight most of the day (i.e., high exposure to solar radiation because of limited canopy cover; Porchuk 1996; Porchuk and Willson unpub. data).

Foraging, Mating and Movement Habitat

These types of habitat are less sensitive to disturbance than the hibernation, nesting and shelter habitats, and they are more difficult to define and delineate. Nevertheless, Blue Racers require access to suitable foraging and mating habitat to complete

important life processes. Foraging and mating activities occur most often, although not exclusively, in alvar, thicket, savanna, woodland and edge communities (Porchuk 1996, Brooks and Porchuk 1997). For example, Porchuk (1996) observed 50 percent (14 of 28) of courtships and the lone copulation on the edges of fields, canals, hedgerows and roads and 28.5 percent (8 of 28) of courtships in savanna and open field.

Ensuring connectivity between the different types of habitat is essential to maintaining a viable Blue Racer population on Pelee Island. When the space use of the Blue Racer population is examined as a whole and over the entire active season, it is evident that there are not well-defined movement corridors. For example, although most individual Blue Racers tend to follow hedgerows between vegetated patches, individual snakes were documented moving through fields with crops (e.g., soybean winter wheat and corn; Porchuk 1996). Currently there are no absolute barriers to movement.

1.5 Limiting Factors

Population Size and Distribution
Relative to the other snake species that occur on Pelee Island, the Blue Racer is uncommon. The size of the Pelee Island Blue Racer population may render it vulnerable to extinction from demographic and environmental stochasticity, catastrophic events and loss of genetic variability (Caughley 1994, Burkey 1995). Isolated from other Blue Racer populations, there can be no effective immigration of individuals to Pelee Island or emigration of individuals to other island or mainland sites (i.e., a natural range expansion beyond the island's boundaries is highly unlikely; Porchuk 1998).

Availability of Hibernation Habitat
Brooks and Porchuk (1997) suggest that the lack of appropriate hibernation habitat is likely one of the major factors limiting the distribution of Blue Racers on Pelee Island. Similar to other Ontario snake species that have been examined to date (Prior et al. 2001, Lawson 2005, Rouse 2006), Blue Racers exhibit high fidelity to specific hibernation sites and consequently would have difficulty finding a new hibernaculum if these habitats are destroyed.

Availability of Nesting Habitat
The reproductive success of Pelee Island Blue Racers may be limited by the availability of suitable nesting habitat. Female Blue Racers favour decaying logs as nesting sites (Porchuk 1996), which on Pelee Island are often restricted to shoreline areas. Because of the specific physical characteristics of these sites (i.e., narrow range of temperature and moisture levels, protection from predators), they are naturally rare. As shoreline habitat becomes increasingly altered for human use, these sites will become more limited and females may be forced to oviposit in less than optimal sites (Porchuk 1998). Observations of nest success or failure on Pelee Island suggest that suboptimal nests (e.g., under human refuse) may reduce population recruitment rates (Porchuk and Brooks 1995).

1.6 Threats to Survival and Recovery

Habitat Loss and Degradation

Loss of habitat quantity and quality continues to be a threat to the Blue Racer population on Pelee Island. Whether there has been a net loss of habitat since the previous recovery strategy was drafted in 2005 has not been determined. However, there are undoubtedly areas where Blue Racers used to be observed regularly but now appear to be unsuitable based on both the advanced succession of the vegetation community and lack of observations of the species (J. Hathaway pers. comm. 2013). Whereas certain types of habitat loss are obvious (e.g., hedgerow removal and conversion to agriculture), other types of land use change are more subtle (e.g., succession of vegetation communities, removal of non-native grasses). Advanced succession of vegetation communities has been recognized as a factor that could reduce the quantity and quality of Blue Racer habitat since at least 1991 (Kamstra 1991). Another factor that makes it difficult to assess whether habitat loss has occurred since 2005 is that there are areas being removed from agricultural production as part of changes in land ownership and use, thus some of these areas will become potential habitat for Blue Racer.

Anthropogenic refuse such as sheet metal, abandoned cars and farm equipment are discarded throughout the island and are frequently used by Blue Racers for shelter and occasionally nesting (Porchuk 1998). Refuse providing shelter is considered beneficial to Blue Racers; however, eggs laid under exposed sheet metal are doomed to failure because of extreme temperature and moisture fluctuations (Porchuk 1996). Of nine Blue Racer clutches laid under sheet metal and wooden boards, only one clutch remained viable until hatching occurred.

Although it has yet to be quantified, the impacts of blasting on subterranean structures such as hibernacula may have adverse effects on habitat.

Vehicular Mortality

Vehicular mortality has always been considered a key threat to the Blue Racer population on Pelee Island (Kamstra 1991, Porchuk 1998, Willson and Rouse 2001). There are often peaks in road mortality levels over the course of an active season. For example, mature males may move more extensively during the mating season and females often move substantial distances to find suitable nesting habitat (Porchuk 1996). Additionally, hatchling Blue Racers are often found dead on Pelee Island's roads during late August and September, particularly along East Shore Road where hatchlings move inland from shoreline nest sites (Porchuk 1996). Adult Blue Racers often cross roads relatively quickly compared to the other large snakes on the island; thus, this species is most at risk of being killed on the roads when traffic volume and driving speeds are high (Porchuk and Willson unpub. data). Roadkill surveys were conducted for all snake species from 1993 to 1995 (Brooks and Porchuk 1997), 1998 to 1999 (Brooks et al. 2000) and during the springs of 2000 to 2002 (Willson 2002). During the most intensive survey, a total of 78 Blue Racers (33 adults, 45 subadults) were found road-killed from 1993 to 1995 (Brooks and Porchuk 1997). It is unknown whether

mortality at these levels would have long-term population consequences similar to that determined by Row et al. (2007) for Gray Ratsnakes (*Pantherophis spiloides*) in eastern Ontario; however, given the isolation of the Blue Racer population, it seems very likely that vehicle-induced mortality on roads is a significant threat to survival and recovery (Willson and Rouse 2001).

Direct mortality due to farm machinery has also been documented (Porchuk 1996) and four adult Blue Racers were found killed by lawn mowers between 1993 and 1995 (Brooks and Porchuk 1997). Off-road vehicles also pose a threat to Blue Racers, particularly in shoreline areas where hatchlings and eggs can be killed or destroyed while still within nesting habitats (Porchuk 1998).

Intentional Persecution
Snakes regularly elicit reactions of fear or hostility from the general public, and as a result, intentional killing of snakes is not uncommon (Ashley et al. 2007). At least three Blue Racers were shot by pheasant hunters during the study by Porchuk (1996) and three Eastern Foxsnakes were also intentionally killed by humans during the same study period (Porchuk 1998).

1.7 Knowledge Gaps

Habitats Created as Part of Conservation Efforts
Hibernation, nesting and shelter habitats have been created on Pelee Island to increase the quantity and quality of habitat for Blue Racer (Willson and Porchuk 2001; J. Hathaway pers. comm. 2013). At the time the habitats were created it was understood that it may be many years before Blue Racers begin to use the features as habitat (Willson and Porchuk 2001). However, the majority of the created habitats have not been assessed for use by Blue Racer and this information would help inform efforts to enhance habitat for the species.

It is unknown what structural or chemical cues Blue Racers are using to select hibernation, nesting or shelter habitats. This information would help inform efforts to enhance habitat for the species.

Minimum Viable Population and Survey Requirements
The Blue Racer has been extensively studied on Pelee Island and much is known about the biological requirements for adult Blue Racers (e.g., space use, key habitat requirements, prey, predators). However, the amount of suitable Blue Racer habitat required to sustain a viable population is unknown. In theory, population modelling could provide estimates of the minimum viable population (MVP) size, the extent to which mortality needs to be reduced to increase survivorship and recruitment, as well as other population parameters. A typical expression of MVP is the smallest isolated population having a 99 percent probability of survival over the next 100 years despite the influences of environmental, demographic and genetic variability and natural catastrophes (Shaffer 1981).

The most effective and implementable program for monitoring the Blue Racer population has not been determined.

Understanding of Potential Threats

Studies have not been conducted to examine the impact of fertilizer and pesticide use on Pelee Island snakes, thus the effects of such chemicals remain unclear. Residues of toxic compounds were found in three Blue Racers from Pelee Island (organochlorine < 1 ppm wet weight, 6.85–24.1 ppm PCB, and 0.03–0.41 ppm of mercury) but were at such low levels that they did not elicit severe toxic chemical contamination (Campbell and Perrin 1991). It is unknown whether there are acute effects of chemical applications on Blue Racers (e.g., when a snake forages in a freshly sprayed field) or if there is a risk of bioaccumulation of toxins.

Wild Turkeys were introduced to Pelee Island in 2002. It is unknown whether this generalist predator may be having an adverse effect on the Blue Racer population (e.g., by preying upon juvenile Blue Racers).

Finally, the drivers of extirpation of Blue Racers from the Ontario mainland are unknown.

1.8 Recovery Actions Completed or Underway

Habitat Protection and Management

- The provincial *Endangered Species Act, 2007* (Government of Ontario 2007) came into force in 2008. Habitat protection is provided for Blue Racer under Section 10 of the act.
- As of 2012, the following properties were known to contain Blue Racer habitat and were owned by organizations that have natural heritage protection as one of their primary objectives:
    - Lighthouse Point Provincial Nature Reserve (Ontario Ministry of Natural Resources and Forestry; OMNRF);
    - Fish Point Provincial Nature Reserve (OMNRF);
    - Stone Road Alvar Conservation Area (Essex Region Conservation Authority);
    - Stone Road Alvar Nature Reserve (Ontario Nature);
    - Shaughnessy Cohen Memorial Savanna (see Nature Conservancy of Canada (NCC) 2008);
    - Florian Diamante Nature Reserve (NCC 2008);
    - Stone Road Alvar (NCC 2008); and
    - Middle Point Woods (NCC 2008).

  Blue Racers have been documented at all of these areas with the exception of Fish Point Provincial Nature Reserve (Willson 2002). Management at these properties has varied over time according to the objectives of the responsible agencies.

- The owners of some additional lands with Blue Racer habitat or potential Blue Racer habitat have entered into conservation easements with the NCC.
- Landowners whose properties contained Blue Racer habitat (with certain size restrictions) are eligible to apply to participate in the Conservation Land Tax Incentive Program (CLTIP). This program offers 100 percent tax relief to landowners for the portion of their property that was considered to be endangered species habitat. Blue Racer habitat was mapped for CLTIP purposes in 1998 using provincial habitat mapping guidelines (OMNR 1998). The CLTIP mapping incorporated historical as well as recent mark-recapture and radiotelemetry data collected from 1992–1998 (Willson and Rouse 2001).

Habitat Restoration and Creation

Numerous habitat recovery actions have been initiated over the past 30 years on Pelee Island by several organizations for the Blue Racer specifically, and for Pelee Island's natural heritage areas in general.

- The Wilds of Pelee Island completed several site-specific life science inventories, wildlife and plant monitoring studies and a restoration plan for marginal agricultural lands (ca. 20 ha) adjacent to the existing natural area known as the Pelee Island Winery's Red Cedar Savanna. Restoration of these agricultural lands to an ecological community with a higher habitat value for Blue Racer was one of the project objectives.
- Hibernation habitat was created using methodology adapted from Zappalorti and Reinert (1994). Four artificial hibernation sites were created in 1996 (of which two remain) on private properties around Pelee Island (Porchuk 1998). One of these sites demonstrated certain over-wintering success in 2001 with Eastern Gartersnake and an Eastern Foxsnake (Porchuk unpub. data). An additional four hibernation sites were constructed in 2000 and 2001 at three different sites (Willson and Porchuk 2001). It is anticipated that these sites will eventually provide long-term, secure over-wintering areas for the Blue Racer, Eastern Foxsnake and possibly Lake Erie Watersnake; however, surveys have not been completed to assess success.
- Nesting habitat was first created in 1997 by placing artificially hollowed cottonwood logs in areas where they were likely to be encountered by female Blue Racers (Porchuk 1998). Based on the findings of Willson (2000a), 15 nesting piles constructed of herbaceous and woody vegetation were created between 2000 and 2005 at several locations on the island in an effort to increase the amount of suitable nesting habitat for Blue Racers and other egg-laying snakes.
- Shelter habitat was created by placing large, flat, limestone rocks in open-canopy locations in 2000 and 2001. These features were created to provide enhanced thermoregulatory opportunities for snakes while limiting predation risks (Willson and Porchuk 2001). Eleven of these habitats were constructed at several locations on the island.
- The NCC has been actively modifying several different ecological communities (e.g., alvar, woodland) within the properties that they manage on Pelee Island since at least 1998 when they purchased the Shaughnessy Cohen Memorial

Savanna (Porchuk 2000, NCC 2008). Areas of farmland that have been taken out of production will begin to increase in habitat value to Blue Racers, particularly in the early stages of succession prior to dense shrub growth (MacKinnon 2005).

Public Outreach

- In 1989, wildlife-crossing signs were erected along roads on Pelee Island specifically warning motorists to be aware of snakes crossing the roads. These signs were almost immediately removed or vandalized (Porchuk 1998).
- A natural heritage video was created in 1995 by several government and non-government conservation agencies, including the Pelee Island Heritage Centre, and was played in the passenger lounge on every ferry connecting Pelee Island with the Ontario mainland for several years; however, it has not been updated and is no longer played (Porchuk 1998). Copies of the video were also made available for sale. The informative nature of this video may have helped reduce road mortality and direct persecution by educating tourists.
- In 1995, a pamphlet was designed by the Pelee Island Heritage Centre, Essex Region Conservation Authority, Ontario Nature and the Ontario Heritage Foundation, and was made available on the ferry and at the Heritage Centre. The pamphlet provided information on several rare and endangered flora and fauna on Pelee Island including the Blue Racer. Information on how tourists and residents could help to conserve rare species was included. This pamphlet is currently out of print (MacKinnon 2005).
- In addition to the natural heritage video and pamphlet, The Pelee Island Heritage Centre also sold conservation T-shirts as a public outreach initiative.
- From 1993 to 1995, numerous articles, seminars and youth outreach initiatives regarding the Blue Racer were organized by the University of Guelph research team.
- In an effort to show that the preservation of endangered species can be beneficial to the community and local economy, the Wilds of Pelee Island held an Endangered Species Festival on the island in 2001, 2002 and in 2003. It is estimated that $16,000 was generated for the Pelee Island economy during the festival, thus demonstrating that conserving endangered species and their habitats could benefit the island economy through eco-tourism. In 2003, the festival was combined with the 8th Annual Meeting of the Canadian Amphibian and Reptile Conservation Network bringing in over 220 people from Ontario, and other regions of Canada and the United States (MacKinnon 2005).
- In 2003, the Wilds of Pelee Island published a 72-page, colour guide entitled *Pelee Island Human and Natural History: Guide to a Unique Island Community*. Photos and text concerning the Blue Racer and other species at risk were featured in the publication.

Research and Monitoring

Table 1 summarizes the studies completed up to 2002 that were focused on Blue Racers on Pelee Island.

Since 2002, J. Hathaway has led expeditions, tour groups and habitat restoration outings to the island in May of most years. Because reptiles and amphibians are a highlight of the tours he leads and he was part of the spring survey team (Willson 2002), Blue Racer observations were recorded in areas known to be inhabited by the species (J. Hathaway pers. comm. 2013). In the spring of 2013 researchers from Central Michigan University captured Blue Racers to collect genetic material (J. Crowley pers. comm. 2013).

Table 1. Significant investigations or reports of the distribution, ecology and behaviour of Blue Racers on Pelee Island, 1970–2002.

Years(s)	Researcher(s) and Reference(s)	Nature of Investigation (Objectives)	Methods	Field Work Dates	Notable Records or Results
1976	Campbell (1976)	determine status of Blue Racer on Pelee Island	intensive searching, road cruising	2–12 May, 30 May to 4 Jun, 9–13 Jun, 16–19 Jul, 24–27 Sept	4 Blue Racers captured & 5 observed; in addition to this study, Campbell had been intermittently conducting field work on Pelee Island since 1970; May 1971: female Blue Racer found near old cistern at Fish Point (last reported Blue Racer from this location)
1978	Ecologistics LTD (1979)	determine whether proposed pit sites (3 & 4) on Browns Rd are significant habitat for racers	intensive searching, & set out shelter boards (shingles)	Jun to Nov 284.25 person-hours	confirmed that Blue Racers were extremely difficult to locate during summer months as no Blue Racers were encountered
1984	Oldham (1984)	document presence of Blue Racers in the Mill Pt Area	intensive searching	6 intermittent trips (21.5 days) from 5 Apr to 24 Sept	5 Blue Racers captured, 1 Blue Racer found dead on road adjacent to Mill Pt area; author also plotted 61 reliable Blue Racer encounters from 1969–1984; 46 records provided by C. Campbell)
1985	Oldham (1985)	document presence of Blue Racers in the Mill Pt Area	intensive searching	8–14 May 40 person-hours	failed to find Blue Racers at Mill Pt; however, 3 individuals encountered elsewhere
1991	Campbell & Perrin (1991)	recommend national status based on all available information	literature & data review	NA	endangered status recommended; COSEWIC formally designates Blue Racer Endangered in Canada

Years(s)	Researcher(s) and Reference(s)	Nature of Investigation (Objectives)	Methods	Field Work Dates	Notable Records or Results
1991	Kamstra (1991)	formulate Blue Racer recovery plan for Ontario	literature & data review	NA	given the difficulty of locating Blue Racers via regular searching, author recommends shelter board, road survey & radiotelemetry studies
1992	Blue Racer Recovery Team (Prevett 1994, summarized in Willson 2000b)	determine feasibility of radiotelemetry study	intensive searching, mark-recapture	2 May, 21 Sep, 4 Oct	2 May: 16 individuals captured indicating radiotelemetry study possible
1992	Kraus (1992)	document road mortality, set out & monitor shelter boards	road survey & set out shelter boards	2 May to 15 Jul (intermittent)	2 Blue Racers found dead on the road
1993 1994 1995	Guelph Team led by Porchuk & Brooks (Porchuk 1996, Brooks and Porchuk 1997)	document distribution, ecology & behaviour	intensive searching, mark-recapture, radiotelemetry, road survey	20 Apr to16 Oct 31 Mar to 22 Oct 14 Apr to 27 Sep	detailed spatial, ecological & behavioural data obtained, essential habitats identified
1996	Porchuk (unpub. data, summarized in Willson 2000b)	determine effectiveness of erecting hibernacula traps & continue mark-recapture	mark-recapture, hibernacula traps	19 Apr to 30 May	individual Blue Racers show significant fidelity to hibernacula
1997 1998 1999	Guelph Team led by Willson & Brooks (Brooks et al. 2000)	continue monitoring Blue Racer population at Browns Rd savanna	mark-recapture, hibernacula traps, road survey	1 Apr to 5 Jun 1 Apr to 13 Sep 1 Apr to 1 Jun	long term recapture data from individuals dating back to 1992
1999	Porchuk (1998)	formulate official RENEW recovery plan	literature & data review	NA	proactive recovery actions necessary to ensure persistence of Blue Racers on Pelee Island
2000 2001 2002	Spring Survey Team led by Willson (2000b, 2001, 2002)	conduct systematic survey to document population trend & size	intensive searching along standardized transects & within defined areas mark-recapture	15 Apr to 11 May 13 Apr to 12 May 14 Apr to 15 May	systematic survey techniques can produce capture rates suitable for population estimation

2. RECOVERY

2.1 Recovery Goal

The recovery goal for the Blue Racer in Ontario is to (1) maintain, or if necessary increase population abundance to ensure long-term population persistence; (2) increase habitat quantity, quality and connectivity on Pelee Island; and (3) continue to assess the feasibility of repatriating the species to portions of its former range on the southern Ontario mainland.

2.2 Protection and Recovery Objectives

Table 2. Protection and recovery objectives

No.	Protection or Recovery Objective
1	Protect habitat and connections, and where possible, increase the quantity and quality of available habitat for Blue Racer on Pelee Island.
2	Promote protection of the species and its habitat through legislation, policies, stewardship initiatives and land use plans.
3	Reduce mortality by minimizing threats.
4	Address knowledge gaps and monitor Blue Racer population.
5	Continue to assess the feasibility of repatriating Blue Racers to a location on the southern Ontario mainland.

2.3 Approaches to Recovery

Table 3. Approaches to recovery of the Blue Racer in Ontario.

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
1. Protect habitat and connections, and where possible, increase the quantity and quality of available habitat for Blue Racer on Pelee Island				
Critical	Ongoing	Protection Management	**1.1** Increase amount of habitat available for Blue Racer. – Continue to support and promote NCC's implementation of its Western Lake Erie Islands Natural Area Conservation Plan. – Contribute to NCC's planning and habitat management objectives to promote actions that will increase the amount of high quality habitat for Blue Racer. – Continue to support the protection of other important lands for Blue Racer on Pelee Island (e.g., lands owned and/or managed by Ontario Nature, Essex Region Conservation Authority and OMNRF).	• Threats: habitat loss and degradation, intentional persecution, vehicular mortality

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Critical	Ongoing	Protection Management	**1.2** Assess quantity and quality of existing and potential Blue Racer habitat. – Review and refine mapping for protected and non-protected habitat in light of ongoing changes to the structure of vegetation communities (e.g., successional changes) as well as changes in land use and ownership.	• Threats: habitat loss and degradation
Necessary	Long-term	Management Stewardship	**1.3** Develop and implement best management practices for restoring and maintaining Blue Racer habitat. – Implement best management practices at key protected sites (e.g., maintenance of a mosaic of vegetation types such as grassland, savanna, edge) and encourage adoption at private sites. – Construct artificial hibernation, nesting and shelter habitats. – Provide technical support and assistance to landowners and land managers in restoring sections of their land for Blue Racer.	• Threat: habitat loss and degradation
2. Promote protection of the species and its habitat through legislation, policies, stewardship initiatives and land use plans				
Critical	Ongoing	Protection Management	**2.1** Develop a habitat regulation and/or habitat description for Blue Racer under the *Endangered Species Act, 2007*.	• Threats: habitat loss and degradation, vehicular mortality

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Critical	Short-term	Communications Education and Outreach	**2.2** Develop Best Management Practices for minimizing negative impacts on species. – Provide advice to private and public land managers on mitigation techniques to minimize negative impacts of management practices and development activities on Blue Racers and their habitat (e.g., timing of prescribed burns and vegetation mowing). – When possible, combine best management practices for the Blue Racer with those for the endangered Lake Erie Watersnake (*Nerodia sipedon insularum*), the endangered Eastern Foxsnake (*Pantherophis gloydi*) and other species at risk on Pelee Island.	• Threats: habitat loss and degradation, vehicular mortality
Necessary	Long-term	Stewardship	**2.3** Implement an awareness plan to inform landowners about the Conservation Land Tax Incentive Program and the stewardship fund and how they could benefit from protecting and restoring habitat for Blue Racer and other species at risk.	• Threats: habitat loss and degradation
Necessary	Ongoing	Communications Education and Outreach Stewardship	**2.4** Produce Stewardship Publications. – Publish stewardship efforts in local newsletters, hold guided tours at restoration sites and quantify the positive spin-offs of recovery participation	• Threats: habitat loss and degradation

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	Long-term	Communications Education and Outreach	**2.5** Produce Fact Sheets. – Publish a series of fact sheets on the life history requirements of the Blue Racer – Create a better understanding of what features are important to the species on Pelee Island.	• Threats: habitat loss and degradation, intentional persecution
Necessary	Long-term	Communications Education and Outreach	**2.6** Produce Educational Guides. – Create a guide for public on safely living with species at risk to encourage safe practices with respect to driving, mowing lawns, off road vehicle usage, industrial machinery activity, water sport concerns and building-structure dangers (e.g. inadvertent death traps, window kills for birds). – Produce Educational Materials for Children and Youth.	• Threats: vehicular mortality, intentional persecution
3. Reduce mortality by minimizing threats				
Beneficial	Ongoing	Communications Education and Outreach	**3.1** Increase Landowner Communications. – Publicize locally the need for cautious driving for island wildlife by posting signs and information bill-boards, particularly in areas of high Blue Racer crossing/basking on roads.	• Threats: intentional persecution, vehicular mortality

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Beneficial	Ongoing	Communications Education and Outreach	**3.2** Support the Pelee Island Heritage Centre and other island-based conservation and stewardship organizations to do the following. – Promote and protect the uniqueness of Pelee Island's species, including snakes. – Promote travelling on the island with bikes and using island taxi services. – Foster pride among island residents in rare species and habitats in their community.	• Threats: intentional persecution, vehicular mortality
4. Address knowledge gaps and monitor Blue Racer population				
Necessary	Ongoing	Monitoring and Assessment	**4.1** Determine whether any of the hibernation, nesting or shelter habitats that have been created are being used by Blue Racers. – Assess use or non-use of these created habitats.	• Threats: habitat loss and degradation • Knowledge Gap: habitats created as part of conservation efforts
Necessary	Long-term	Research	**4.2** Research the structural and chemical components of hibernation and nest sites to determine how these habitats can be created in ways that maximize the likelihood that they will be used by Blue Racers.	• Threats: habitat loss and degradation • Knowledge gap: habitats created as part of conservation efforts

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	Ongoing	Monitoring and Assessment	**4.3** Conduct Population Monitoring. – Determine the most effective and implementable program to monitor the Blue Racer population taking into account Pelee Island's unique circumstances. – Implement monitoring program.	• Knowledge Gap: minimum viable population, survey requirements
Necessary	Ongoing	Monitoring and Assessment	**4.4** Determine whether Wild Turkeys are having adverse effects on the Blue Racer population.	• Knowledge Gap: understanding potential threats
Necessary	Ongoing	Monitoring and Assessment	**4.5** Determine if acute effects of chemical applications (i.e., when a snake forages in a freshly sprayed field) or bioaccumulation of toxins pose a risk to Blue Racers.	• Knowledge Gap: understanding potential threats
5. Continue to assess the feasibility of repatriating Blue Racers to a location on the southern Ontario mainland				
Beneficial	Long-term	Research Management	**5.1** Determine Feasibility of Repatriation. – Assess future possible repatriation site(s) for the potential to support viable Blue Racer populations. – Assess threats for potential mainland sites and determine whether they could be mitigated. – Assess socio-economic implications of repatriation. – Investigate the genetics of potential donor populations. – Develop and implement a detailed repatriation plan if objective is deemed necessary or critical.	• Threat: habitat loss and degradation • Knowledge Gap: understanding potential threats

Narrative to Support Approaches to Recovery

Objective 6: Continue to assess the feasibility of repatriating Blue Racers to a location on the southern Ontario mainland
Given the extirpation of the Blue Racer from the Ontario mainland, it is not possible for a natural population to re-establish itself in the absence of active management. Repatriation is the intentional release of individuals of a species to an area formerly occupied by that species but from which it has been extirpated (Reinert 1991, Fischer and Lindenmayer 2000). Previous studies with other snake species suggest that many repatriation efforts are unsuccessful or have unknown results where the measure of success is the establishment of a viable, self-sustaining population (Dodd and Seigel 1991, Fischer and Lindenmayer 2000). Prior to repatriation efforts, Burke (1991) and Reinert (1991) recommend that probable causes of decline be determined (rather than assumed) so that they can be mitigated prior to repatriation efforts (Dodd and Seigel 1991, Caughley 1994, Fischer and Lindenmayer 2000). The establishment of a long-term monitoring program to ascertain success and assure the publication of both positive and negative results is strongly recommended (Burke 1991, Dodd and Seigel 1991, Reinert 1991, Fischer and Lindenmayer 2000).

Any mainland area considered for repatriation must be thoroughly investigated for the presence of key variables that could contribute to Blue Racer survival (e.g., specific habitat requirements, prey availability, threats). Additionally, a substantial commitment of resources is required for the long-term monitoring of any introduced Blue Racer population to evaluate the success of repatriation efforts. Under current funding formulas for species at risk projects, such a commitment to long-term (ca. 10 year) project is highly unlikely. Considering the amount of resources and expertise required for repatriation, and the limited resources currently available for recovery, resources would be better spent on recovery actions with a higher probability of success. Protection of the existing population on Pelee Island and habitat improvements involve less risk and are likely more viable alternatives to repatriation (Reinert 1991). M'Closkey and Hecnar (1996) completed an analysis of the repatriation potential of Blue Racer to four locations on the Ontario mainland. They concluded that although the area around Pinery Provincial Park had the most potential as a repatriation site, conservation efforts should focus on the existing population on Pelee Island.

2.4 Area for Consideration in Developing a Habitat Regulation

Under the ESA 2007, a recovery strategy must include a recommendation to the Minister of Natural Resources 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 by the authors will be one of many sources considered by the Minister when developing the habitat regulation for this species.

The three most important types of habitat for the Blue Racer, in order of importance, are (1) hibernation habitats, (2) nesting habitats and (3) shelter habitats (e.g., features that facilitate ecdysis, digestion and protection from predators) (Porchuk and Willson unpub. data). Although these three habitats are the most important for maintaining a viable population, other habitats used for foraging, mating and movement are necessary for population persistence (Porchuk 1996, 1998). All of these types of habitat are necessary for individuals of the species to complete their life cycle and thus should be prescribed in a habitat regulation for Blue Racer.

Given the importance and sensitivity to disturbance of hibernation and nesting habitats, it is recommended that these features be recognized as having a high sensitivity to alteration. Additionally, shelter habitats that are used by two or more Blue Racers (i.e., are communal) should be recognized as having a high sensitivity to alteration. Blue Racers show fidelity to all of these types of habitat, particularly areas used for hibernation (Porchuk 1996, Porchuk and Willson unpub. data).

Hibernation Habitat

Additional recommendations pertaining to hibernation habitat to be considered in a habitat regulation are as follows.

- Hibernation habitat should be protected until it is demonstrated that the feature can no longer function in this capacity.
- The area within 120 m of an identified hibernation feature (single site or complex) should be regulated as habitat and recognized as having a high sensitivity to alteration.

Rationale

Assessments of the suitability of an area to function as hibernation habitat could entail long-term monitoring of a site for use by Blue Racers or an evaluation of a site's physical condition (e.g., a structurally unstable site could weather or change until access to the interior cavities is no longer possible). The area within 120 m of an identified hibernation feature should be regulated as habitat to ensure that any undocumented holes in the substrate that could be used to access the below-ground feature are protected. Studies on Pelee Island by B. Porchuk and R. Willson (unpub. data) documented hibernation complexes up to 120 m in diameter; thus regulating the area within 120 m of the hibernation feature would ensure that the majority of complexes are protected.

Nesting and Communal Shelter Habitats

Additional recommendations pertaining to nesting and shelter habitat to be considered in a habitat regulation are as follows.

- A naturally occurring nesting habitat or communal shelter habitat (i.e., used by two or more Blue Racers) that has been used at any time in the previous three years should be protected.
- A non-naturally occurring nesting habitat or communal shelter habitat (i.e., used by two or more Blue Racers) should be protected from the time its use was documented until the following November 30.

- The area within 30 m of the boundary of the nesting feature should be regulated as habitat and recognized as having a high sensitivity to alteration.

Rationale
It is recommended that a distance of 30 m from the boundary of a nesting feature be protected in a regulation to ensure that the thermal properties of the habitat are maintained. Because nesting habitats often occur along the edges of treed areas, particularly along the east shore (Porchuk 1996), protecting habitat within this distance should ensure that there are no trees felled that could alter the solar radiation reaching the nesting feature.

Foraging and Mating Habitats
Foraging and mating habitats should be recognized as having a moderate sensitivity to alteration. Relative to hibernation, nesting and shelter habitats, the spatial extent of foraging, mating and movement habitats is considerably larger. For example, a nesting feature situated in a fallen and partially decomposed section of tree could be one by two metres. In contrast, foraging and mating habitats are best defined at the level of ecological community (e.g., savanna, woodland) and these areas tend to be several hectares in size.

It is recommended that the following ecological community types on Pelee Island be regulated as foraging and mating habitats when they occur within 2,300 m of a reliable Blue Racer observation:

- alvars (treed, shrub and open types);
- thicket;
- savanna;
- woodland; and
- edge (includes hedgerows and riparian vegetation strips bordering canals).

With the exception of edge, the ecological community types listed above are meant to correspond with the ecological land classifications of Lee et al. (1998). These classifications were adopted by NCC (2008) in their management guidelines for Pelee Island alvars. To correspond with the definition used in the habitat analyses of Porchuk (1996), edge is defined as occurring within five metres of the interface between the two adjoining communities (e.g., forest-woodland, marsh-thicket). For example, where a forest transitions to a farm field, the edge community would extend five metres into the forest and five metres into the farm field. Hedgerows and the majority of the riparian vegetation strips bordering canals will by this definition be considered edge.

Rationale
Foraging and mating activities occur most often, although not exclusively, in these ecological community types (Porchuk 1996, Brooks and Porchuk 1997).

The distance of 2,300 m is recommended because it is approximately the 90 percent quantile of the Maximum Distance from Hibernacula (MDH) values calculated for 25 Blue Racers (14 females; 11 males) radiotracked by Porchuk (1996). Actual value

computed is 2,276.8 m. Computation of these values from the 1993–1995 telemetry was completed by R. Willson in 2013 using ArcGIS 10.2 and JMP 10 following Rouse et al. (2011). Based on the dataset analyzed, using an MDH of 2,300 m would encompass the activities of 23 of the 25 Blue Racers (92%). Using the 90 percent quantile with this dataset removed the top two MDH values and thus is an effective way to encompass the majority of the population's space use while removing the highest MDH values.

Because hibernation habitat is crucial to the survival of snakes inhabiting temperate latitudes, and Blue Racers show a high degree of fidelity to these sites, distance-based metrics that incorporate this habitat feature are the measures of spatial dispersion most relevant to conservation efforts (COSEWIC 2008, Rouse et al. 2011).

Movement Habitat

When the space use of the Blue Racer population is examined as a whole and over the entire active season, it is evident that there are not well-defined movement corridors. For example, although most individual Blue Racers tend to follow hedgerows between vegetated patches, other individuals can and will move right through an agricultural field when the crop provides adequate cover. Given the considerable spatial extent of the areas that would be regulated as hibernation, nesting, shelter, foraging and mating habitat as per the recommendations above, it is recommended that no additional areas be regulated as movement habitat.

GLOSSARY

Alvars: Defined in Ontario's Ecological Land Classification system as having a soil depth of less than 15 cm and tree cover less than 60 percent (Lee et al. 1998).

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. 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

Dorsum: The upper surface of an appendage or body part. Often referred to as the back (opposite of ventral).

Ecdysis: The regular molting or shedding of an outer covering layer (e.g., of skin).

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

Heterogeneity: Variety or diversity often associated with a lack of uniformity.

Hibernaculum: A shelter occupied during the winter by a dormant animal.

Lateral: Of or relating to the side.

Repatriation: Returning a species to an area that it formerly occupied.

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

Stochasticity (demographic): Random variation in demographic variables, such as birth rates and death rates, sex ratio and dispersal, for which some individuals in a population are negatively affected but not others.

Stochasticity (environmental): Random variation in physical environmental variables, such as temperature, water flow, and rainfall, which affect all individuals in a population to a similar degree.

Species at risk in Ontario list: This list was first published in 2004 as a policy and became a regulation in 2008.

Succession: The sequence of vegetation communities that develops from the initial stages of establishment by plants until a stable mature community has formed.

Ventral: The anterior or lower surface of an animal opposite the back (opposite of dorsum).

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