RECOVERY PLAN FOR THE *EASTERN RIBBONSNAKE (THAMNOPHIS SAURITUS)* IN NOVA SCOTIA

A recovery plan adopted by the Nova Scotia Department of Lands and Forestry

2020 - 2025

FINAL

Recommended citation:

Nova Scotia Department of Lands and Forestry. 2020. Recovery Plan for the Eastern Ribbonsnake (*Thamnophis sauritus*) in Nova Scotia [Final]. *Nova Scotia Endangered Species Act Recovery Plan Series*.

Cover illustration: Eastern ribbonsnake. Photo credit: Jeffie McNeil

Adoption of a Recovery Plan per Section 15(9) of the Endangered Species Act

Species:

Eastern Ribbonsnake (*Thamnophis sauritus*)

Reference:

Parks Canada Agency (PCA). 2012. Recovery Strategy for the Eastern Ribbonsnake (*Thamnophis sauritus*), Atlantic Population in Canada. Species at Risk Act Recovery Strategy Series. Parks Canada Agency, Ottawa.

Whereas a Species at Risk Act Recovery Strategy has been prepared for this species by Environment Canada, and that plan has been reviewed by members of the applicable Nova Scotia Recovery Team and determined to fulfil the requirements of Section 15(9) of the Endangered Species Act as they pertain to Nova Scotia, the above-named recovery plan shall be adopted in lieu of a Nova Scotia Recovery Plan subject to the following:

Date of Adoption: 20 May 2020

Expiry/renewal Date: 20 May 2025

Conditions:

1. Adoption of this recovery plan will be reviewed 5 years from the Date of Adoption.

2. Only elements of this plan that are relevant to Nova Scotia and are in accordance with the Endangered Species Act (Nova Scotia) shall be used. This includes the following sections of the reports:

   Parks Canada Agency (2012): 1. Background (1.2 to 1.4; 1.6 to 1.8), 2. Threats 3. Actions already completed or underway, 4. Knowledge gaps, 5. Recovery, 6. Critical habitat, 7. Performance measures, References.

3. The Nova Scotia Amphibians and Reptiles Recovery Team explicitly endorsed the adoption of critical habitat as described in this Recovery strategy and Action plan in lieu of core habitat and that core habitat be described as laid out in

Section 6 of PCA (2012).

4. Should any additional requirements be identified, the Nova Scotia Department of Lands and Forestry may prepare an addendum to this plan under the Endangered Species Act.

Approved:

Date:

20 May 2020

Appendix A:

Parks Canada Agency (PCA). 2012. Recovery Strategy for the Eastern Ribbonsnake (*Thamnophis sauritus*), Atlantic Population in Canada. Species at Risk Act Recovery Strategy Series. Parks Canada Agency, Ottawa.

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Eastern Ribbonsnake (*Thamnophis sauritus*), Atlantic Population in Canada

Eastern Ribbonsnake

2012

Parks Canada Parcs Canada

Canada

Recommended citation:

Parks Canada Agency, 2012. Recovery Strategy for the Eastern Ribbonsnake (*Thamnophis sauritus*), Atlantic Population in Canada. Species at Risk Act Recovery Strategy Series. Parks Canada Agency, Ottawa. x + 46 pp.

Additional copies:

Additional copies can be downloaded from the SARA Public Registry (http://www.sararegistry.gc.ca/)

Cover illustration: Eastern ribbonsnake at Grafton Lake, Nova Scotia © Tom Herman.

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Programme de rétablissement de la couleuvre mince de l'Est (*Thamnophis sauritus*), Population de l'Atlantique, au Canada.

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DECLARATION

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. The *Species at Risk Act* (S.C. 2002, c.29) (SARA) requires that federal competent ministers prepare recovery strategies for listed Extirpated, Endangered and Threatened species.

The Minister of the Environment presents this document as the recovery strategy for the eastern ribbonsnake, Atlantic population, as required under SARA. It has been prepared in cooperation with the jurisdictions responsible for the species, as described in the Preface. The Minister invites other jurisdictions and organizations that may be involved in recovering the species to use this recovery strategy as advice to guide their actions.

The goals, objectives and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new findings and revised objectives.

This recovery strategy will be the basis for one or more action plans that will provide further details regarding measures to be taken to support protection and recovery of the species. Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the actions identified in this strategy. In the spirit of the *Accord for the Protection of Species at Risk*, all Canadians are invited to join in supporting and implementing this strategy for the benefit of the species and of Canadian society as a whole. The Minister of the Environment will report on progress within five years.

CONTRIBUTORS

This strategy was prepared by Jennifer McNeil, in collaboration with the Eastern Ribbonsnake Recovery Team, and includes a special contribution from the Native Council of Nova Scotia (section 1.5).

RECOVERY TEAM MEMBERS

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ACKNOWLEDGEMENTS

The editors wish to recognize that recovery team members continually contribute to the science and communications for the recovery of the eastern ribbonsnake. They have also spent much time defining the strategic direction for this recovery strategy. The editors and members of the Recovery Team also wish to acknowledge the contributions of Brennan Caverhill, Simon Gadbois, Troy Frech, Tara Imlay, Jose Lefebvre, Delphine Mousse, JoAnne Phillips, Jesse Saroli, Josie Todd, Rachel Thibodeau, Brad Toms and the many other students, field assistants, interns and volunteers who helped with ribbonsnake projects. Their field work and participation in recovery team meetings is much appreciated. The assistance of Abbey Camaclang and Samara Eaton in finalizing this recovery strategy is also acknowledged. Finally, the editors and Recovery Team would like to thank the many volunteers who have reported sightings of ribbonsnakes and who have participated in research activities. We would also like to acknowledge the larger information base that lead to this recovery strategy, including Mi'kmaq perspectives, some of which are posted on www.speciesatrisk.ca.

STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

In accordance with *The Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals (2004)*, a strategic environmental assessment (SEA) is conducted on all *Species at Risk Act* recovery strategies. The purpose of the SEA is to

incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally-sound decision making.

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 their intended benefits. Environmental effects, including impacts to non-target species and the environment, were considered during recovery planning. The SEA is incorporated directly into the strategy and also summarized below.

Recovery objectives will focus primarily on addressing knowledge gaps (Section 4 of the recovery strategy). The need for further research into demography, habitat requirements, threats, and population trends was identified. This information will benefit eastern ribbonsnake (*Thamnophis sauritus*) recovery in Nova Scotia, and may also aid conservation of other ribbonsnake populations, including those in southern Ontario and southwestern Quebec. Increased knowledge and protection of habitat (Section 1.8 of the recovery strategy) will also benefit other species at risk (e.g., Blanding's turtle [*Emydoidea blandingii*] and Redroot [*Lachnanthes caroliana*]). To minimize overlap and maximize recovery efforts, recovery of eastern ribbonsnake will be coordinated with the recovery efforts for Blanding's turtle and Atlantic Coastal Plain Flora. The recovery strategy also proposes collaboration with Fisheries and Oceans Canada (DFO) and Nova Scotia Fisheries and Aquaculture to monitor exotic and introduced fish (e.g., smallmouth bass [*Micropterus dolomieui*] and chain pickerel [*Esox niger*]). This will benefit competing native fish species (e.g., trout [*Salvelinus* sp.]) as well as trophic dynamics, including amphibian abundance. Actions aimed at stewardship and education may also benefit other snake species, in addition to commonly associated vegetation and other terrestrial and aquatic organisms. The potential impacts to other species as a result of eastern ribbonsnake management are provided in Section 6.6 of the recovery strategy. This recovery strategy will have several positive effects on other species and the environment, and no important negative effects are anticipated.

RESIDENCE

SARA defines residence as: *a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating* [Subsection 2(1)].

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the *SARA* public registry: http://www.sararegistry.gc.ca/plans/residence_e.cfm.

PREFACE

This Recovery Strategy addresses the recovery of the eastern ribbonsnake (Atlantic population). In Canada, the species ranges in southern Ontario, southwestern Quebec and southwest Nova Scotia. The Atlantic population occurs only in Nova Scotia.

Section 37 of *SARA* requires the competent minister to prepare recovery strategies for listed extirpated, endangered, or threatened species, and Section 47 states that one or more action plans based on the recovery strategy must be prepared. This strategy complies with federal legislative requirements under *SARA* and largely meets the requirements for recovery planning under the *Nova Scotia Endangered Species Act* (S.N.S. 1998, c.11) (*NS ESA*) (Section 15).

The Parks Canada Agency led the development of this recovery strategy in collaboration with the Eastern Ribbonsnake Recovery Team and the Province of Nova Scotia. This recovery strategy was developed in cooperation or consultation with numerous additional individuals and agencies, including Acadia University, Dalhousie University, L'sitkuk Department of Environment, environmental non-government organizations, industry stakeholders, Aboriginal groups, and private landowners.

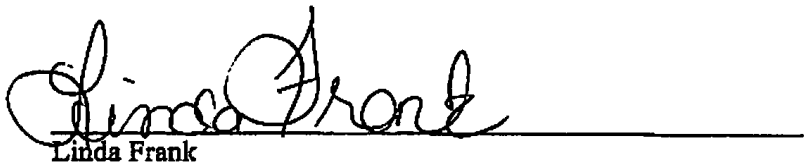
RECOMMENDATION AND APPROVAL STATEMENT

The Parks Canada Agency led the development of this federal recovery strategy, working together with the other competent minister(s) for this species under the Species at Risk Act. The Chief Executive Officer, upon recommendation of the relevant Park Superintendent(s) and Field Unit Superintendent(s), hereby approves this document indicating that Species at Risk Act requirements related to recovery strategy development (sections 37-42) have been fulfilled in accordance with the Act.

Recommended by:

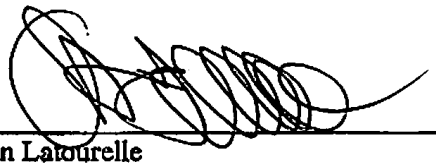
Harry Delong
Superintendent, Kejimkujik National Park and National Historic Site

Recommended by:



Linda Frank
Field Unit Superintendent, Mainland Nova Scotia Field Unit

Approved by:



Alan Latourelle
Chief Executive Officer, Parks Canada Agency

All competent ministers have approved posting of this recovery strategy on the Species at Risk Public Registry.

EXECUTIVE SUMMARY

The eastern ribbonsnake (*Thamnophis sauritus*) is a small, slender, semi-aquatic snake typically found in slow flowing wetlands with abundant aquatic and terrestrial vegetation. Like several other species in the province, eastern ribbonsnakes occur near the northern limit of their range in Nova Scotia and are isolated from the species' main range. Within the province, eastern ribbonsnakes appear to have a limited distribution in the southwest interior and are only known to occur in scattered wetlands of three watersheds. The isolation, restricted distribution, and apparently small population size have resulted in the listing of the Atlantic population as Threatened under both the federal *Species At Risk Act* (S.C. 2002, c.29) and the *Nova Scotia Endangered Species Act* (S.N.S. 1998, c.11).

Since the formation of the Recovery Team in 2003, a number of projects have endeavoured to fill knowledge gaps and encourage public involvement through outreach and stewardship initiatives. However, efforts to obtain long-term data have been hampered by the lack of reliable marking and tracking techniques. Despite the existing knowledge gaps, a number of potential threats have been identified. To assess these threats and to identify the scale(s) at which recovery should be initiated, more information is needed on the population structure, habitat requirements, life history traits, limiting factors, and range extent of eastern ribbonsnakes in Nova Scotia.

Critical habitat has also been identified based on known currently occupied *locations* (e.g. the entire lake, fen or bog, or selected portions of a river or stream) with at least one recent, confirmed ribbonsnake sighting. Critical habitat will encompass all wetlands found within the *location* as well as the terrestrial and aquatic zones that extend 100 m around each wetland. Due to uncertainties surrounding the extent of terrestrial habitat use by ribbonsnakes, only a partial identification of critical habitat is possible at this time. Other critical habitats may be identified in the future following additional surveys and studies on overwintering habitat use, overland movements and population viability.

At the present time, recovery of the population is considered feasible. The long-term recovery goal is to ensure a self-sustaining population with a 95% probability of persistence across its range. In the absence of a quantitative population recovery target, the two intermediate goals have been identified: 1) maintain populations of eastern ribbonsnake at known locations; and 2) gain a sufficient understanding of distribution, demography, population structure, and habitat associations in order to conduct a realistic assessment of population viability. A number of recovery objectives have been set to achieve these goals; these objectives are described in this strategy along with a list of recommended strategies and approaches. At this time, it is believed that the recovery approaches outlined will have a beneficial impact on non-target species, ecological processes, and the environment. Where habitats overlap, efforts will be made to coordinate the recovery efforts aimed at other species at risk to avoid potential conflict and ensure that actions are mutually beneficial.

One or more actions plans will be completed by December, 2014.

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1. BACKGROUND

1.1 Species assessment information from COSEWIC[1]

Common name (population): Eastern ribbonsnake (Atlantic population)

Scientific Name: *Thamnophis sauritus*

Status: Threatened

Last examination and change: 2002

Canadian occurrence: In Canada, the eastern ribbonsnake occurs in Ontario, Quebec and Nova Scotia. The Atlantic population occurs only in Nova Scotia.

Reasons for designation: This ribbonsnake population is a small, isolated postglacial relict confined to a small area in Nova Scotia. As such, it is unique and susceptible to demographic and environmental fluctuations. In addition, shoreline development poses a threat (COSEWIC 2002).

Status history: Designated Threatened in May 2002. Assessment based on a new status report.

1.2 Name and classification

The eastern ribbonsnake (*Thamnophis sauritus*) has four recognized subspecies: the eastern or common ribbonsnake (*T. s. sauritus*), the peninsula ribbonsnake (*T.s. sackinii*), the blue-striped ribbonsnake (*T.s. nitae*) and the northern ribbonsnake (*T.s. septentrionalis*). Of these, only the northern ribbonsnake, occurs in Canada (Smith 2002). Throughout this document the species will be referred to as eastern ribbonsnake or simply ribbonsnake, and to avoid confusion, use of sub-specific names will be avoided. Throughout this strategy it will be explicitly stated if knowledge presented is specific to the Nova Scotia population or was obtained elsewhere in the species' range, as populations may exhibit local and regional adaptations and display differences in habitat use and behaviour that will affect species recovery.

[1] COSEWIC - Committee on the Status of Endangered Wildlife in Canada

1.3 Species description

The eastern ribbonsnake (*Thamnophis sauritus*) is a small, slender, semi-aquatic snake. Like all snakes in Nova Scotia, it is not poisonous and completely harmless to people. Total adult length for the species throughout its range varies from 46 cm to 86.2 cm (Smith 2002). In Nova Scotia, the recorded maximum length is 75.8 cm, but most are considerably smaller (NS ribbonsnake database). The tail is long, accounting for almost one third of the total length (Gilhen 1984).

Figure 1. Distinctive yellow stripes on a ribbonsnake in Nova Scotia.

Eastern ribbonsnakes can be recognized by the three bright yellow stripes that run along the length of their dark body: one on each side and one along the back (Figure 1). The side stripes occur on the third and fourth scale rows up from the ventral (belly) scales, which are creamy white. In Nova Scotia populations, a caramel-brown stripe separates the side stripes and the ventral scales (Figure 2, Gilhen 1984). The head is small and slender, and there is a small vertical white line in front of the eye (Logier 1967).

Eastern ribbonsnakes can be confused with eastern garter snakes (*Thamnophis sirtalis*), which also have three stripes along their bodies. However, the side stripes on garter snakes occur on the second and third scale rows, and there is no caramel-brown stripe below them (Gilhen 1984). In Nova Scotia, garter snake stripes tend to be less distinct than those of ribbonsnakes. Additionally, garter snakes lack the vertical white line in front of the eye and are typically thicker bodied and larger than ribbonsnakes.

Figure 2. Ribbonsnake in Nova Scotia showing the caramel-brown stripe below the side stripe.

1.4 Distribution

1.4.1 Global and Canadian range

The eastern ribbonsnake occurs east of the Mississippi River from Florida to southern Canada (Rossman 1970). In Canada, the ribbonsnake occurs in southern Ontario, southwestern Quebec, and Nova Scotia (Smith 2002). Ribbonsnakes in Nova Scotia are isolated from the species' main range and have been listed separately by COSEWIC (2002) as the "Atlantic population."

Although the eastern ribbonsnake is considered globally secure (G5, NatureServe 2006) and is not listed under the United States *Endangered Species Act*, it is listed at some level of risk in 10 of the 28 (2 S1, 3 S2, 5 S3) states and districts in which it occurs (NatureServe 2006).

Figure 3. Global range of the eastern ribbonsnake (*Thamnophis sauritus*). Adapted from Smith 2002 and Conant and Collins 1991.

1.4.2 Nova Scotia range

The "Atlantic population" of ribbonsnakes appears to be limited to the southwestern interior of Nova Scotia (Figure 4). Confirmed sightings remain confined to three watersheds: the Mersey, Medway, and LaHave Rivers (NS ribbonsnake database 2010). Within these watersheds, several individual concentrations of ribbonsnakes have been identified; the extent of movement between these sites is currently unknown.

The eastern ribbonsnake belongs to a suite of species at risk in southwest Nova Scotia that are geographically separated from their main ranges. Many of these species, including the eastern ribbonsnake, are believed to be climatic relicts that became isolated in Nova Scotia at the end of a warmer period 5000 years ago (Smith 2002).

Isolated populations may be significant, particularly if they occur at the edge of the species' range, as is the case of the Nova Scotia eastern ribbonsnake population, because they may have diverged genetically from populations in the main range and may display local adaptations (Lesica and Allendorf 1995). The degree of genetic variability of ribbonsnakes in Nova Scotia remains unknown. There is no signal pattern of genetic variation yet detected within other isolated populations in Nova Scotia. Some species have diverged significantly from the main range and maintain high levels of genetic variation (Mockford *et al.* 1999) while others show little variation within Nova Scotia or between the province and the main range (Cody 2002).

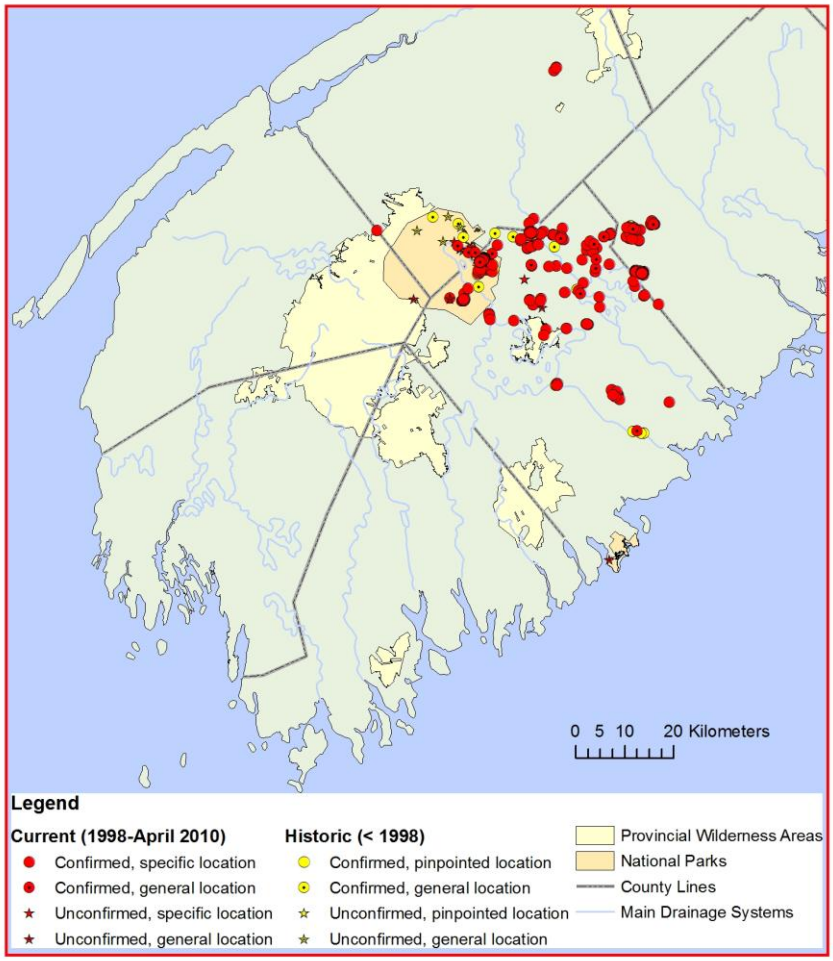

Figure 4: Currently known distribution of the eastern ribbonsnake in Nova Scotia (April 15, 2010).

1.5 Traditional knowledge and recovery

As a preamble to this section, there are two important considerations. First, this recovery strategy, as a requirement of SARA, adheres to the directives set out in that legislation. Second, Section 1.5 is a special contribution by the Native Council of Nova Scotia, through consultation, and is offered to provide insight on Aboriginal perspectives on the recovery of the Eastern ribbonsnake. A broader treatise, prepared by the Native Council of Nova Scotia on this subject area, can be obtained by request from the Ribbonsnake Recovery Team.

Eastern ribbonsnake habitat falls within Kespukwitk, one of the seven traditional districts of Mi'kma'ki. For this reason, it is important that the involvement of the Mi'kmaq living on and sharing the land, is actively sought and encouraged. It is this continuum of Mi'kmaq throughout Kespukwitk, who through their sages, talks, and walks, will begin to reveal aspects of the Eastern ribbonsnake. Mi'kmaq can make important contributions to the recovery of ribbonsnakes through traditional teachings, revealing the importance of traditional practices, and sharing an Aboriginal eco-centric world view. Mi'kmaq customary use of biodiversity embodies the Mi'kmaq principle of netukulimk; a way of harvesting resources without jeopardizing the integrity, diversity, or productivity of our natural environment (Native Council of Nova Scotia 1994). A more inclusive approach to ecosystem based management may be particularly useful for eastern ribbonsnake recovery and also to other rare and at risk species that are tied to similar habitats in the watersheds of southern Nova Scotia. This recovery strategy cannot hope to ever capture the total knowledge of the Mi'kmaq. Recovery planning can be augmented over time as involvement with the Mi'kmaq grows.

1.5.1 Aboriginal Traditional Knowledge

In order to integrate Aboriginal Traditional Knowledge (ATK) with other types of knowledge, it is important for recovery planners to understand how the Mi'kmaq world view may differ from other Aboriginal and scientific world views. Mi'kmaq traditional knowledge is not necessarily written, peer-reviewed, or published. ATK is a living knowledge, captured in oral language and culture, and which is highly specific to place and time – it is the *ki* of *Mi'kma'ki*. In sharing ATK, Mi'kmaq will often end by saying *tan teli kji'jitu* (as I know it to be), recognizing that the knowledge is living. In other words, the knowledge shaped from the land, e.g. about the eastern ribbonsnake, carried forward, and shared will differ between those experiencing that place at different times. It may change because of another action or because of another's perspective.

There are several petroglyphs of snakes in the Kejimkujik area (Figure 5, Robertson 1973), one of the few places these are known to occur. The abundance of snake petroglyphs, as well as known legends and dances regarding snakes, may indicate that ribbonsnakes were once more plentiful than currently known, or that they were of cultural significance. For example, there are legends that speak of snakes as bad omens if crossed.

It is known that Mi'kmaq people hold specific knowledge of ribbonsnake biology and habitat but that information has not yet been accessed. For example, ATK may be able to inform changes that have occurred in ribbonsnakes' range and provide insight as to whether changes in distribution may be related to changes in habitat.

Figure 5, Example of a snake petroglyph from the Kejimkujik area (Keji Slide Library)

1.5.2 Commitment to include the Mi'kmaq and consider traditional knowledge

This Recovery Strategy seeks to recognize and include Mi'kmaq in the recovery of the Eastern ribbonsnake and its habitat.

- First, by recognizing the significance that the Mi'kmaq People have shared a long history with the ribbonsnake in Kespukwitk.
- Second, by inviting Mi'kmaq individuals and communities to sit with others, as peers, to discuss, draft, and implement recovery strategies and action plans.
- Third, by recognizing and acknowledging that it is important to gather and understand the collective knowledge of the Mi'kmaq about ribbonsnakes and their habitats.
- Fourth, by recognizing the need to include Mi'kmaw worldviews to ensure the value of netukulimk for the long term sustainability of Kespukwitk.
- Finally, by recognizing the valuable contribution of the Mi'kmaq and their traditional knowledge as an important step towards reconciling Aboriginal and scientific world views.

1.6 Population size and trends

The size of the population of eastern ribbonsnakes in Nova Scotia is not known, and data is lacking on abundance, distribution, and population trends. The current range appears to be limited to the southwest interior of the province, with confirmed sightings encompassing only three watersheds and approximately 2500 km^2 (Figure 4). While ribbonsnakes have been found

at a number of places within this range (Table 7), only a few sites are known to currently have high concentrations (Table 1). It is possible that these concentrations may be highly ephemeral and dependent on specific habitat conditions. Ribbonsnakes have apparently disappeared from one site (Colpton Pond), which in the 1980's contained the highest density of ribbonsnakes recorded in Nova Scotia (40+ snakes found in a single day). The habitat at this site has changed dramatically and the population may have either decreased and/or migrated to adjacent habitats. While ribbonsnakes are still known to occur in nearby habitats, such dense concentrations have not been recorded since.

The most reliable data on population size comes from a single site at Grafton Lake. While quantitative data are lacking, it is believed that ribbonsnakes at this site increased in numbers after the removal of a dam on the lake in the mid 1990's, which exposed the original lakeshore. A small area within this site has been the subject of an intensive mark-recapture study since 2004. Initial abundance calculations in 2004 estimated that there were approximately 100 individuals in the 4 ha study site (McNeil 2005). A reduction in the number of captures per unit effort in 2005 and 2006 suggests that this population may be declining; however, there is uncertainty in the reliability of these estimates. The marking technique (primarily scale clipping) was not as permanent as hoped and was prone to identification errors. The habitat at this site is also changing rapidly as the shoreline vegetation regenerates following dam removal. This could affect both snake abundance and the detectability of ribbonsnakes within the habitat. In addition, the population within the study site is not closed and the rate of immigration from and emigration to adjacent habitats is not known.

Table 1. Sites with 50 or more recent, confirmed sightings of ribbonsnakes in Nova Scotia (1997-2010).

Area	**Total # of sightings**	**Sightings per total search effort**	**Year discovered**	**Other species at risk**	**Land ownership**	**Current habitat protection?**	**Research/ recovery efforts underway**
Grafton Lake	1454	1313 sightings/ 3096.1 hrs	1955	Blanding's turtle	Federal crown (National Park)	Yes	Volunteer surveys; intensive annual research; hibernacula location
Cobrielle Brook	100	93 sightings/ 173.1 hrs	1998		Federal crown (National Park)	Yes	Surveys
Barren Meadow/ Keddy Brook	88	49 sightings/ 141.5 hrs	2004	Blanding's turtle	Private and provincial crown	No (1 NSNT property in progress)	Surveys; landowner contact; NSNT collaboration
Molega Lake /Hog Lake	419	360 sightings/ 830.6 hrs	1976	Redroot	Private (primarily cottage owners)	Partial (one land NSNT)	Landowner contact; Surveys; NSNT collaboration
McGowan /Deans Lake	99	52 sightings/ 146.8 hrs	1999	Blanding's turtle	Provincial crown; private (industry, individual landowners)	Provincial crown Integrated Resource Management Plan	Landowner contact; Surveys

1.7 Biological needs, ecological role, and limiting factors

1.7.1 Thermal biology

Ribbonsnakes must rely on heat from their surroundings to regulate their body temperatures. The need to maintain appropriate temperatures affects their behaviour and habitat use (Carpenter 1956, Rossman *et al.* 1996). Eastern ribbonsnakes in Michigan were found to be most active when their cloacal temperatures were between 20 and 30 degrees Celsius (Carpenter 1956). In cool weather, ribbonsnakes often bask in order to gain sufficient heat for movement and digestion (Carpenter 1952, Rossman *et al.* 1996) and they may be able to restrict blood flow to the tail to maintain a higher body core temperature (Amiel and Wassersug 2010). Because ribbonsnakes give birth to live young, maintaining appropriate temperatures may be particularly important to females while their young are developing (Charland and Gregory 1995, Rossman *et al.* 1996). In Nova Scotia, mean body temperatures of gravid female ribbonsnakes (i.e., those with developing young) implanted with temperature-sensitive radio transmitters during summer ranged from 25.3ºC to 31.98ºC (Bell 2003). Ribbonsnakes must also avoid overheating and may enter water, climb bushes, or take refuge under vegetation, rocks, or logs to cool off (Carpenter 1952, Carpenter 1956, Tinkle 1957). During the fall, ribbonsnakes move into their hibernacula, which must provide an environment that prevents both freezing and dehydration (Carpenter 1953, Costanzo 1989).

In Nova Scotia, ribbonsnakes occur near the northern limit of their range and may be constrained to the warmer southwest part of the province by temperature and climatic trends (Bleakney 1951).

1.7.2 Growth, maturity and reproduction

Ribbonsnakes are typically less than 25 cm in total length when born. Size and age at maturity in Nova Scotia are not known, but in Michigan, female eastern ribbonsnakes reach maturity in their second year of growth (Carpenter 1952) and most other species in the genus *Thamnophis* reach maturity during their second or third year of growth (Rossman *et al*. 1996). Reproductive frequency in Nova Scotia is also unknown. In general, female *Thamnophis* produce one litter per year, although they may skip years, particularly in northern populations (Rossman *et al*. 1996). Carpenter (1952) found approximately 60 percent of the female ribbonsnakes in a Michigan population reproduced in a single year.

In Nova Scotia, mating has been observed in spring, just after emergence from the hibernacula (NS ribbonsnake database 2010). Spring mating is consistent with more southern populations of eastern ribbonsnakes (Ernst and Barbour 1989). However, aggregations of adults observed in September suggest that mating may also occur in fall (NS ribbonsnake database 2010).

Carpenter (1952) found that the greatest feeding in eastern ribbonsnakes in Michigan occurred from June through October, with feeding activity continuing until they move to their hibernacula (Carpenter 1952). In Nova Scotia, ribbonsnake with food bulges have been observed from April 9 to November 4 (NS ribbonsnake database 2010). Most shed skins are found from June through September, suggesting that this is the period of greatest growth.

1.7.3 Ecological role

Throughout their range, adult ribbonsnakes feed primarily on amphibians and small fish (Bell *et al.*, 2007, Brown 1979, Carpenter 1952). Diet in young ribbonsnakes is largely unknown, although a small ribbonsnake in Nova Scotia regurgitated an earthworm on 21 May 2006 (NS ribbonsnake database 2010). Additionally, in August 2006, a newborn ribbonsnake from the Nova Scotia population ate two earthworms while in captivity (Josie Todd, pers. comm.).

Ribbonsnakes have many potential predators (e.g., raccoons, hawks, other snakes and fish), but the rate of predation is unknown. Ribbonsnakes likely rely heavily on blending in with their environment (crypsis) and hiding under cover to avoid detection by predators (Scribner and Weatherhead 1995).

1.8 Habitat needs

1.8.1 General habitat

Ribbonsnakes are highly associated with wetlands, and most sightings in Nova Scotia occur within 5 m of water (NS ribbonsnake database 2010). They are typically found in slow flowing wetlands with abundant aquatic and terrestrial vegetation, including fens, along meadow streams, and in lake coves and shorelines. Many of these areas contain shallow pools and side channels. Ribbonsnakes have been found in a variety of vegetation, including sphagnum moss; grasses, sedges, and rushes; and emergent and shoreline shrubs. The occurrence and densities of ribbonsnakes in an area may be affected by disturbance regimes and stages of habitat succession, but the role of these factors is not yet understood. For instance, beaver activity occurs at many sites containing ribbonsnakes, and may play an important function in maintaining appropriate habitat.

Six important elements of life history are currently recognized for which habitat must be described: overwintering, basking, cover, gestation and birthing, feeding and shedding, and mating. At this time, most knowledge of specific sites in Nova Scotia comes from the intensive study sites at Grafton Lake and Molega Lake (Table 2).

Table 2. Known ribbonsnake habitat in Nova Scotia.

Seasonal activity (function)	**Site description**	**Timing**
Overwintering (allow survival through the winter)	• One known hibernacula in mixed forest 150m from nearest wetland; other forested hibernacula areas suspected based on late fall or early spring sightings • Also suspected in the upper floodplain under ground in areas of fractured slate overlain with moss and under a gravel walkway near the water's edge. Sites may be partially or fully submerged.	Oct. to Apr.
Basking (gain sufficient heat units for movement, digestion and gestation)	• Early spring/ late fall: Near suspected overwintering sites • Summer: Adjacent to feeding sites • Sunny locations associated with moss, floating sphagnum mats, matted sedge or grass clumps, rocks, logs, mudflats, leaf litter, dams and causeways	~Mar. to Nov.
Cover (avoid predators and prevent overheating)	• Includes moss, grasses and sedges, floating sphagnum mats, emergent vegetation, stumps, rock crevices, shrubs and small trees • Have been found under landscape fabric and hay bales at one site	~Mar to Nov.
Feeding/ shedding	• Mostly near small pools, streams and offshoot channels. • Shed skins have been found on sphagnum mats, mud flats, grasses and sedges and in or under bushes and small trees	Apr. to Nov.
Gestation and birthing	• Birthing areas unknown but small concentrations of neonates have been found in wetlands, usually near water • Gravid females have been found in wetlands, on roads and causeways and under landscape fabric and hay bales.	Birth – Aug and Sept
Mating	• Observed adjacent to hibernacula in wooded area within 1 week following emergence in spring 2010 • Concentrations of adults in vegetation adjacent to water in September suggest possible fall mating	March-April and possibly fall

2. THREATS

2.1 Classification of known and potential threats

Like other aspects of eastern ribbonsnake biology, threats are not well understood. Known and potential threats have been identified in Table 3 and ranked according to the level of concern in each threat category. The occurrence, frequency, certainty, and severity of most of these threats remain unknown and there may be additional threats to ribbonsnake populations that have not yet been identified. The assessment of threat information presented in Table 3 is based on documented research (see References Cited) or expert opinions from members of the Eastern Ribbonsnake Recovery Team.

Table 3. Classification of known and suspected threats to eastern ribbonsnake recovery in Nova Scotia.

General Threat	Specific Threat	Potential Stress	Extent	Occurrence	Frequency	Causal Certainty	Severity	Level of Concern
			Threat Information[+]					
A. THREAT CATEGORY: Changes in ecological dynamics or natural processes								
1. Lack of information	Inaction or inappropriate action (inability to recognize threats; delayed implementation of recovery actions; initiation of actions with unexpected detrimental effects)	↑ mortality; Degradation of habitat	WS	C	NA	H	U	H
2. Small, isolated concentrations of snakes within the NS range	Small population effects (inbreeding; genetic drift; increased susceptibility to stochastic events) due to isolation of populations resulting from human influences	↑ mortality; ↓ fecundity	U	U	U	L	U	H
3. Cottage and residential development	Alteration of natural disturbance regimes and functional processes	Alteration of movement patterns; Alteration of genetic structure	U	U	U	L	U	M
B. THREAT CATEGORY: Habitat loss or degradation								
1. Dam construction or removal (human or beaver) *	Alteration of water level and seasonal water flow regimes; long-term cumulative habitat loss	Change in habitat availability; Winter mortality; Change in prey availability; Local extinction	L	C	U	L	U	H
2. Cottage and residential development	Habitat degradation, fragmentation, and loss; alteration of water level and seasonal water flow regimes; alteration of shorelines; long-term cumulative habitat loss	↓ Habitat availability; ↑ mortality; ↓ movement between concentrations; local extinction	WS	C	R	M	U	H
3. Road density and new road construction	Habitat fragmentation; long-term cumulative habitat loss	↑ mortality; isolation of concentrations;	WS	C	U	U	U	H
4. Climate change*	Alteration of water level and seasonal water flow regimes	Change in habitat availability	WS	A	C	L	U	M
5. Forest harvesting practices (i.e., clear cutting, harvesting in the riparian zone, rotation times)	Alteration of water level and seasonal water flow; decrease in water quality; habitat degradation, fragmentation, and loss; long-term cumulative habitat loss; potential disruption of overwintering sites	↓ habitat availability; ↑ mortality; ↓ movement between concentrations	WS	C	U	L	U	M
6. Agricultural practices (i.e., tilling, crop production, cranberry growing)	Alteration of water level and seasonal water flow; decrease in water quality; habitat degradation, fragmentation, and loss; long-term cumulative habitat loss	↓ habitat availability; ↑ mortality; ↓ movement between concentrations	WS	U	U	L	U	M
7. Infilling/ draining wetlands	Habitat degradation, fragmentation, and loss; long-term cumulative habitat loss; loss of wetland function	↑ mortality; ↓ habitat availability; local extinction	L	C	M	M	H	H

General Threat	Specific Threat	Potential Stress	Extent	Occurrence	Frequency	Causal Certainty	Severity	Level of Concern
8. Peat mining	Habitat degradation, fragmentation, and loss; long-term cumulative habitat loss	↑ mortality; ↓ habitat availability; local extinction	L	A	U	M	U	L
C. THREAT CATEGORY: Accidental mortality								
1. On and off road vehicles	Vehicular mortality; increased encounters with people	↑ mortality	WS	C	C	M	U	H
2. Cottage, residential and road development	Vehicular mortality; increased encounters with people; increased predation by pets	↑ mortality	WS	C	U	M	U	H
3. Agricultural and forestry equipment	Vehicular mortality	↑ mortality	L	C	U	L	U	L
D. THREAT CATEGORY: Disturbance and persecution								
1. Negative perception of snakes	Intentional killing by humans resulting from hatred or fear of snakes	↑ mortality	U	U	U	L	U	M
2. Cottage, residential and road development	Increased encounters with people, pets and machinery; disturbance to snakes and habitat features	↑ mortality; ↓ fecundity	WS	U	U	L	U	M
E. THREAT CATEGORY: Exotic or invasive species								
1. Exotic predatory fish	Introduction of small mouth bass and chain pickerel; changes to ecosystem function	↑ mortality; ↑ competition for prey; altered prey composition	U	C	U	L	U	H
F. THREAT CATEGORY: Climate change								
1. Climate change*	Shifts in seasonal temperatures (reduction of heat units for development of young; increased winter mortality); alteration of water level and seasonal water flow	Change in fecundity Change in prey availability Winter mortality*	WS	A	C	L	U	M
G. THREAT CATEGORY: Natural Processes or activities								
1. Human activities and development	Increase in natural predator populations	↑ mortality	U	U	U	L	U	L
H. THREAT CATEGORY: Pollution								
1. Pesticide use (i.e., landscaping, crop and agricultural production, forestry)	Direct and long-term exposure	↑ mortality; ↓ prey availability; ↓ fecundity	U	C	U	L	U	L
2. Air pollution	Accelerated effect of methylated mercury impacting the food chain	↑ mortality; ↓ prey availability	U	C	U	L	U	L

* These factors in particular could have a positive or negative effect on ribbonsnake populations.

+ **Extent:** WS = widespread; L = localized; U= unknown / **Occurrence:** C = current; A = anticipated; U = unknown / **Frequency:** C= continuous; R = recurrent; U = unknown; NA = not applicable / **Causal Certainty:** H = high; M = medium; L = low / **Severity**: U = unknown; H = High / **Level of Concern:** H= high; M= medium; L=low

2.2 Description of "specific" threats

The following descriptions highlight the "specific" threats as outlined in Table 3, emphasizing key points and providing additional information on the threats. As there is little published literature outlining threats to ribbonsnakes, most information presented here deals with potential threats and effects, as assessed by the Recovery Team.

While the threats below and in the table are listed separately, an important concern is the long-term cumulative effect of a variety of threats on the eastern ribbonsnake population. As human development increases, the overall impact of activities on the habitat becomes more serious at both the small and larger scales. At the landscape scale, incremental losses and multiple threats often complicate recovery efforts and confound understanding of population trends (Jensen *et al.* 1993).

Lack of information for decision making

The COSEWIC status report identified lack of information as the greatest current threat to ribbonsnake recovery (Smith 2002). Little is reported on eastern ribbonsnake ecology or threats anywhere in its range. What is reported elsewhere is not necessarily applicable to the Nova Scotia population. Up until now, there has not been an inclusion of Aboriginal Traditional Knowledge and community knowledge in recovery. At this point, it is not known what factors limit eastern ribbonsnakes in the province (geographically or demographically), how healthy the population is, or what level of population fluctuations are normal. This could prevent recovery managers from recognizing population decline or identifying significant threats. In fact, it is not known if the effect of many of the potential threats listed below will be positive or negative (especially water level and climate change). Lack of information could also result in delay of recovery actions because of uncertainty of potential detrimental effects, or risk of initiating actions that may have unanticipated negative effect(s).

Small population effects

The Nova Scotia eastern ribbonsnake population is geographically isolated from the species' main range, which prevents any possibility of in-migration or a natural rescue effect. Although the full extent of the range within Nova Scotia remains unknown, it does appear to be restricted to a small number of watersheds in the southwest region of the province. This places the snakes at risk of small population effects such as inbreeding and genetic drift, and increases the population's susceptibility to stochastic events. These risks are further exacerbated if the Nova Scotia population actually consists of numerous isolated sub-populations with little or no movement between them.

Alteration of water level and seasonal water flow

Alterations to water level and seasonal water flow are anticipated to be among the most significant threats to ribbonsnake habitat. Hydrological changes can result from many activities, including installing or removing human-made dams, removing beaver dams, forest harvesting practices, agricultural practices, infilling of wetlands, altering shorelines and climate change. Even a small change in flooding regimes could result in vegetation succession in previously wet meadows, or in preventing vegetation from establishing. While these changes to the terrestrial

and aquatic habitat could affect all aspects of ribbonsnake life history, the impacts on feeding and overwintering sites are of particular concern.

Effects from either stabilizing or destabilizing water levels could be positive or negative for ribbonsnakes. We do not yet have sufficient understanding to be able to predict the type or scale of impact resulting from particular activities. Two of the sites containing the highest known densities in the province (Grafton Lake and Cobrielle Brook) have had human-made dams removed within the last decade. The destabilizing impact of natural beaver dam cycles may also be important for the local ribbonsnake population.

Habitat degradation, fragmentation, and loss

Habitat degradation, fragmentation, and loss can occur from many activities, including cottage and residential development, road construction, agricultural practices and forest harvesting practices, and infilling wetlands. Cottage development is of particular concern as it could result in alteration of shorelines, destruction of habitat, and fragmentation. Expansion of the road network could also result in fragmentation as well as direct mortality from vehicles and increased encounters with people and pets. In turn, fragmentation could result in isolation of individual concentrations or increased risk to individuals as they travel between concentrations or between seasonal habitats.

Changes to water quality (e.g., pollution, eutrophication, siltation) may also pose a threat to ribbonsnakes, particularly those that affect prey abundance. Based on limited data, adult ribbonsnakes in Nova Scotia appear to prey primarily on amphibians and small fish (Bell *et al.* 2007, NS ribbonsnake database 2010); the diet of neonate ribbonsnakes, however, is largely unknown. The extent to which prey availability limits population numbers, as well as the degree of dependence of ribbonsnakes on specific prey items, are also still unknown.

Vehicular mortality

Vehicular mortality is one of the few direct sources of mortality that has been documented in Nova Scotia. This includes mortality from both automobiles and all terrain vehicles. It could also include farm or forestry equipment and lawn mowers, although these are probably a lesser threat at the present time. Vehicular mortality may be particularly significant if snakes must cross roads to travel between overwintering and summering sites, or if they are drawn to roads to bask. Since 2004, nine incidences of vehicular mortality have been recorded in Nova Scotia (8 on roads, 1 on an ATV trail). Most of these reports have been incidental and not the result of targeted road surveys, and predators are likely to pick up any road kill snakes very quickly. The true incidence of vehicular mortality is likely to be considerably higher. This is particularly disturbing given the relatively low volume of traffic in the area. As development increases, vehicular mortality is also expected to increase.

Introduction of exotic predatory fish

The introduction of exotic predatory fish into areas containing ribbonsnakes is of particular concern. As a result of introductions, the ranges of both smallmouth bass and chain pickerel have been expanding in Nova Scotia, including the southwestern region of the province. These species can alter trophic dynamics, which could negatively impact ribbonsnakes through either direct predation or competition. Predatory fish have been shown to dramatically reduce populations of

small fish and affect amphibian abundance (Vander Zanden *et al.* 2004, Jackson 2002). Both of these exotic fish species are more tolerant of higher water temperatures than many of the native fish, thus increasing their potential effect on ribbonsnake prey populations (Vander Zanden *et al.* 2004).

Shifts in seasonal temperatures associated with climate change

Climate change may affect ribbonsnakes in Nova Scotia, and the impact may vary according to the different aspects of their life history. It is not known whether the overall effect on ribbonsnake populations, if any, will be positive, negative, or neutral. Having said this, if the effects are negative they could be very significant.

In addition to affecting water level, prey abundance, and habitat as described above, climate change may also directly impact ribbonsnake physiology. Ribbonsnakes in Nova Scotia occur near the northern limit of the species range (Bleakney 1951). Each year they spend 4-6 months in overwintering sites and have only 6-7 active months to feed and reproduce. While it might appear that an increase in annual temperatures will benefit this southern species, this may not necessarily be the case. Changes in seasonal temperature and precipitation conditions may affect growth and development of young, particularly if it results in cooler, wetter weather during the active season.

Winterkill can be a significant source of mortality for other species of *Thamnophis* (Shine and Mason 2004). The significance of winterkill has not been documented in ribbonsnakes, although one dead eastern ribbonsnake was found at the top of a hibernaculum in Michigan (Carpenter 1953). Snakes are at risk of freezing and dehydration over the winter and may be dependent on specific conditions inside the hibernacula. Altered winter climates may directly impact the severity of winterkill.

Increased predation associated with human activities

Snakes are at risk of predation from both natural predators and domestic pets. Predation by domestic pets has been documented in Nova Scotia (one documented cat kill and several other anecdotal reports) and is expected to increase as cottage, residential, and road development increase. Natural predators and predation rates remain unknown and until these are determined, it is difficult to identify potential anthropogenic effects on these predators and their subsequent effect on ribbonsnake predation.

Intentional killing and disturbance resulting from increased encounters between humans and snakes

Many people fear or dislike snakes and some people will kill any that they see, particularly if the snakes are found near or in their homes. While intentional killing has been a significant threat in other snake species at risk (Eastern Massasauga Recovery Team 2002), and may be the cause of death of one ribbonsnake found with extensive wounds in Nova Scotia in 2007, it is believed that the overall risk is relatively low for Nova Scotia ribbonsnakes at present. People rarely venture into wetlands where ribbonsnakes are typically found, and even when they do, these snakes are cryptic and difficult to catch. Because ribbonsnakes are strongly associated with wetlands, they are not as commonly encountered on lawns or in houses as some other species in Nova Scotia. However, with increasing development near wetlands, encounters by people will become more

common and the threat may increase. It is not known how effective education will be in mitigating this threat.

3. ACTIONS ALREADY COMPLETED OR UNDERWAY

In 2003, the Eastern Ribbonsnake Recovery Team was formed, and several of the recovery actions outlined in the strategy have been underway since that time. Work to date has focused primarily on filling knowledge gaps and encouraging public involvement with the species through outreach and stewardship initiatives.

Extensive surveys to expand knowledge of the range of ribbonsnakes in Nova Scotia have been underway since 2004. The majority of surveys to date have been limited to the Mersey and Medway watersheds, focusing on sites with historical or reported sightings; large areas of potential habitat, particularly to the west of the known range, remain largely unexplored. These surveys have expanded the known range in the province to a third watershed (LaHave) and have confirmed a number of new sites within the known range. They have also resulted in the confirmation of relatively high densities (>20 sightings) at five sites (Table 1). Data on area searched, date, effort, and weather conditions are collected during each survey to refine survey protocols for greater efficiency. In coordination and collaboration with the Blanding's Turtle Recovery Team, many of the wetlands previously surveyed for the presence of ribbonsnakes have been characterized; the data will ultimately be used to try to develop models that may help predict where ribbonsnakes occur.

Researchers have been conducting intensive mark-recapture surveys in a defined area on Grafton Lake since 2004 and Molega Lake since 2007 to identify seasonal habitat use and to begin collecting long-term data on abundance, survivorship, and individual site fidelity. The first overwintering site in terrestrial habitats away from the wetland was located in November 2009 and confirmed in March 2010.

While researchers have been able to document some seasonal movement patterns, efforts to date have been hampered by a lack of a reliable long-term marking technique (especially for young snakes) and a method to track snakes. Since 2004, snakes at this site have been marked by ventral scale clipping; however, using the current techniques, these marks often wear off within a single season. Beginning in 2006, some snakes were marked by PIT tagging; long-term success of this technique will be assessed in the coming years. Attempts externally attach transmitters to adults were largely unsuccessful, with transmitters only remaining on the snake up to four days (Imlay 2009). Fluorescent powder was also used to track ribbonsnakes and was found to be useful in documenting movement paths up to 16m long but not in re-locating ribbonsnakes (Imlay 2009). In 2009 a study was initiated to examine the feasibility of using trained dogs to locate ribbonsnakes by scent. Results from the pilot year of the study were promising, showing that dogs are useful in locating ribbonsnakes and helping to track escaped snakes (Gadbois et al 2009). The study will continue in 2010.

No genetic analysis had been published on eastern ribbonsnakes anywhere in their range prior to 2004, when Harwood (2005) initiated a study to develop microsatellite primers and to conduct an initial analysis of population structure in Nova Scotia. No genetic structure was found in the

initial analysis; however, both sample sizes (n=44) and number of loci (n=2) evaluated were small, and Harwood (2005) recommended the continued collection of DNA samples and the development of additional primers. A follow-up study in 2007 suggested that there is detectible structure within the Nova Scotia population, with evidence of low to moderate restriction in gene flow among concentrations (McLaughlin 2008). However both sample size (n=46) and number of loci examined (n=1) were again low and insufficient for conclusive results (McLaughlin 2008).

The Recovery Team has been engaging in outreach and in soliciting sightings from the public since 2004. People have been engaged through a variety of methods, including direct landowner contact, displays at community events, presentations at local schools and community groups, field trips, interpretive programs (KNPNHS), and media presentations. In addition, a toll-free hotline has been set up at the Mersey Tobeatic Research Institute to provide a number that people can call to report all sightings of species at risk. These efforts have already produced a number of credible sightings, mostly within the known range. Volunteers have been helping with all aspects of ribbonsnake research ranging from participating in guided surveys led by Parks Canada staff to conducting independent surveys. A number of outreach tools have been developed including an information pamphlet, a Species at Risk Identification Guide, a website (www.speciesatrisk.ca/ribbonsnake), and a Landowner Stewardship Guide. The latter, first distributed in 2009, is a collaborative effort designed to inform landowners and land users of ways to minimize the impacts of their activities on ribbonsnakes, Blanding's turtles, and Atlantic Coastal Plain Flora.

4. KNOWLEDGE GAPS

Currently, there are knowledge gaps on all aspects of the life history of eastern ribbonsnakes, including demography and current population trends, historical status, habitat requirements at specific life stages, and severity of threats. At the present time, the three most important questions are as follows:

1) What is the current status of the Nova Scotia population of eastern ribbonsnakes?

It is important to identify the current range of the population and the spatial distribution within that range. It is not known at what spatial scale genetic structure is evident, if ribbonsnakes from neighbouring sites interact with one another, and what factors constrain movements, if any, between concentrations of ribbonsnakes. If individual concentrations are isolated, it will be important to determine if it is historical or the result of recent anthropogenic events. Crucial information on basic life history traits such as abundance, survivorship and longevity is also lacking; all required to determine if populations are increasing, decreasing or stable. It is currently not known if high density concentrations are typically short-lived.

2) What are the critical features of the habitat, and are they limiting?

It is not currently known why ribbonsnakes occur in some wetlands and not in others and a suite of habitat features that would predict which habitats are suitable for ribbonsnakes have not yet

been identified. It is important to understand how habitat change, connectivity and long-term habitat trends affect persistence of ribbonsnake populations.

Much remains unknown about overwintering. It is important to know where ribbonsnakes of all life stages spend the winter, identify the characteristics of those sites, determine if sites are used communally or singly and determine if fidelity is shown to specific sites. It is not known if overwintering mortality is a significant threat to the population and have not identified how factors, such as water level fluctuations, affect winter survival.

It is also not known if ribbonsnakes have specific habitat requirements for other activities (including feeding, basking, mating and gestation/birthing), if sites are used repeatedly over time, or if snakes aggregate at certain sites. The relationship between ribbonsnakes and their prey is not fully understood, and it is not known if there are temporal shifts in prey and feeding locations throughout the season and how significant side pools are as feeding sites.

3) What are the threats limiting the recovery of this population?

It is important to identify which threats are the most significant and also the appropriate scale to manage these threats. It is not known how changes in water level, habitat fragmentation, development or climate will affect populations or why the range is limited in the province. Determining if individual concentrations are currently experiencing deleterious effects from small population size (inbreeding, genetic drift, reduced fitness) is necessary to understand factors limiting the population.

Answering these questions requires basic information on all life stages including basic demography (longevity, stage specific survivorship, population trends, predator and prey relationships), habitat use (sites used for specific life stages, large scale range, habitat characteristics, current movement patterns), and genetic structure (assessment of population structure, evaluation of inbreeding depression, estimate of genetic variation, identification of past events that may have influenced patterns seen today).

5. RECOVERY

5.1 Feasibility of species recovery

At this time, recovery of the eastern ribbonsnake in Nova Scotia is considered to be feasible according to the criteria outlined in the Policy on the Feasibility of Recovery (Government of Canada 2009). The policy states that recovery is deemed feasible if all of the following four criteria are met.

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.
2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.
3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

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

The population contains individuals capable of reproduction, it is believed that sufficient habitat is available or can be made available through habitat management or restoration. The severity of threats, methods to avoid or mitigate those threats, and effectiveness of recovery techniques are poorly known at this time. Having said that, the information currently available supports the view that recovery is feasible.

5.2 Population and distribution objectives

The population objective is to achieve a self-sustaining population of eastern ribbonsnakes with a 95% probability of persistence across its current range. A self-sustaining population is necessary for the full recovery of any species; however, at this time, number of ribbonsnakes required for a stable population in Nova Scotia is unknown.

The distribution objective is to maintain or expand the current distribution of wetlands used by eastern ribbonsnakes in southwestern Nova Scotia. The distribution in Nova Scotia is already limited and the species would likely be further jeopardized by loss of range. The current lack of knowledge of present and historical status prevents any quantitative assessment to determine a precise recovery target. Consequently, two intermediate distribution objectives have been identified, that are designed to prevent the species from declining and to acquire the knowledge necessary to determine appropriate recovery targets.

The intermediate objectives are to:

1. *maintain populations of eastern ribbonsnake at known locations; and*
2. *gain a sufficient understanding of distribution, demography, population structure, and habitat associations to conduct a sensitive assessment of population viability.*

5.3 Actions recommended to meet recovery objectives

5.3.1 Recovery planning

The goals and objectives can be addressed through four broad, interrelated strategies: Communication and Stewardship, Research, Habitat Managed for Securement and Monitoring. These broad strategies provide a framework for the development of species recovery approaches, help participants identify their role in the recovery process, and can increase efficiency and cost-effectiveness of recovery approaches.

The following broad approaches to achieving the recovery objectives have been identified:

1. Achieve conservation of currently known critical habitats and new habitats as they are identified, through stewardship, land acquisition, and management actions.

2. Overcome challenges in conducting research on this small, cryptic species to gain a better understanding of population dynamics and habitat use.
3. Determine the extent of the range in Nova Scotia and the population structure, abundance, and trends within that range in order to identify the appropriate scales for recovery.
4. Identify habitat features used for each life stage and activity, and determine if they are limiting.
5. Identify population threats, evaluate their significance and take steps to mitigate those threats.
6. Develop long-term monitoring protocols and techniques to evaluate the success of recovery actions.

Table 4 provides a summary, organized according to the above approaches, of the recommended steps required to meet the objectives and address threats. Section 5.3.2 provides rationale to support the approaches outlined in Table 4.

Table 4. Recovery planning table for the eastern ribbonsnake (*Thamnophis sauritus*) in Nova Scotia.

Recommended approach to meet objective	Priority +	Broad strategy *	Threats addressed	Outcomes	Timeline
Objective 1. Achieve conservation of currently known critical habitats and new habitats as they are identified through stewardship, land acquisition, and management actions.					
1.1 Continue public education campaign. • Target approach to people who will be living or working on the land. • Improve species at risk awareness in schools and promote inclusion in the curriculum.	U	C	• Negative perception of snakes	• Informed public • Promotion of activities that minimize impact to snakes and their habitat	Ongoing
1.2 Support Mi'kmaw participation in all aspects of ribbonsnake recovery. • Continue to assist with the facilitation of Mi'kmaq-organized cultural events that celebrate the ribbonsnake. • Promote species at risk and ribbonsnake awareness with local Mi'kmaq and facilitate and encourage their involvement in recovery efforts • Acknowledge the significance that the Mi'kmaq people have shared a long history with the ribbonsnake in Kespukwitk. • Engage youth and encourage them to ask their elders to share stories with them about ribbonsnakes and their habitats	U	C, R	• Negative perception of snakes • Lack of information	• Meaningful participation of local Mi'kmaq • Increased public awareness • Promotion of activities that minimize impact to snakes and their habitat • Inclusion of Mi'kmaq philosophies to ensure the value of netukulimk for the long term sustainability of Kespukwitk.	Ongoing
1.3 Continue to develop volunteer opportunities and promote public involvement in research and recovery.	U	C, R	• Lack of information • Negative perception of snakes	• Network of knowledgeable stewards dedicated to ribbonsnake recovery	Ongoing
1.4 Work with landowners, Aboriginal organizations, industry, recreational groups, and developers to minimize impact on snakes and their habitat. • Continue to participate in the development and distribution of a Best Practices guide. • Work directly with stakeholders to minimize impacts at specific sites.	U	C, H	• Habitat degradation and fragmentation • Changes to water level and seasonal water flow • Vehicular mortality	• Promotion of activities that minimize impact to snakes and their habitat • Discourage activities that negatively impact snakes and their habitat	Ongoing
1.5 Continue to develop and error-proof a central database for all ribbonsnake information in Nova Scotia to provide high quality information and maps to recovery planners.	U	C, R	• Lack of information	• Database available for identifying and planning recovery actions and for identifying knowledge gaps	Ongoing
1.6 Continue to work with other recovery teams and organizations to prevent overlap. • Coordinate stewardship activities. • Identify and manage in a collaborative manner priority sites containing more than one species at risk.	U	C, H	• Habitat degradation and fragmentation	• Network of organizations that work toward species at risk recovery in SW Nova Scotia • Focused resources on high priority sites	Ongoing
1.7 Collaborate with private landowners, Aboriginal organizations, industry, and government to secure habitat and develop management	N	C, H	• Habitat degradation and fragmentation	• Habitat secured • Critical habitat delineated and	Ongoing

Recommended approach to meet objective	Priority +	Broad strategy *	Threats addressed	Outcomes	Timeline
plans. • Work with landowners to secure habitat at high priority ribbonsnake sites through formal and informal agreements. • Identify additional critical habitat (see Table 5 for steps to identify critical habitat). • Consult with landowners and industry to develop site-specific management plans for critical habitat as it is delineated.			• Changes to water level and seasonal water flow	management plans developed • Fears of property owners alleviated	
Objective 2. Overcome challenges in conducting research on this small, cryptic species to permit better understanding of population dynamics and habitat use.					
2.1 Incorporate Mi'kmaw perspectives on research methodology as part of recovery team deliberations. • Continue to openly discuss method approaches and explore alternatives to address, where possible, concerns raised by Mi'kmaq people	N	R,C	• Lack of information	• Decisions on methodological approaches will be made as part of recovery team actions, with the participation of Mi'kmaq representatives	Ongoing
2.2 Identify the best technique to mark individuals that is permanent, minimizes risk to snakes, and reduces identification error. • Continue assessment of PIT tags as a permanent marking technique and refine protocols for inserting PIT tags. • Investigate alternative technology to mark snakes, especially neonates.	U	R	• Lack of information	• Ability to assess abundance, estimate age survivorship, and document individual movements	2010-2015
2.3 Refine visual survey techniques and evaluate the influence of habitat structure, weather, season, and search effort on detectability. • Conduct analysis to determine the amount of effort needed to reliably determine if ribbonsnakes are present in an area and under what conditions to maximize search efficiency. • Develop protocols to ensure sufficient effort is put into searching new areas for the presence of ribbonsnakes. • Evaluate the effect of detectability on population estimates.	U	R	• Lack of information	• More accurate population estimates • Refined search protocol that maximizes efficiency	2010-2015
2.4 Explore alternative means of capturing snakes. • Explore the potential of artificial cover (e.g., boards, tarps, sheet metal, landscape fabric) in attracting snakes. • Investigate the use of drift fences, particularly around known or suspected hibernacula, to monitor population and locate new individuals. • Contact other scientists working on small, cryptic herpetofauna to discover what techniques have been successful.	N	R	• Lack of information	• Improved ability to assess an area for the presence of snakes • Development of efficient, standardized techniques that can be incorporated into the volunteer program	2010-2015
2.5 Explore technology to track individuals to allow us to assess movement and habitat use. • Investigate the potential of using harmonic radar to locate snakes	N	R	• Lack of information	• Ability to document movement patterns and habitat use	2010-2015

Recommended approach to meet objective	Priority +	Broad strategy *	Threats addressed	Outcomes	Timeline
• Explore other low invasive technological means to track snakes. • Continue to explore the most efficient ways to observe snakes and document behaviour.				• Identification of critical habitat	
Objective 3. Determine the extent of the range in Nova Scotia and identify population structure, abundance, and trends within that range in order to identify the appropriate scales and priorities for recovery.					
3.1 Design and implement a Mi'kmaw knowledge acquisition project. • Work with the Mi'kmaw community to develop a culturally appropriate Mi'kmaw knowledge acquisition project and submit to the Mi'kmaw Ethics Board for approval. • Work with a Mi'kmaw researcher to acquire and interpret appropriate results that would benefit ribbonsnake recovery.	U	C, R	• Lack of information	• Mi'kmaq knowledge and perspectives contributing to recovery actions	2010-2015
3.2 Conduct surveys and solicit public sightings to determine the extent of the range in Nova Scotia. • Continue to solicit sightings from the public and follow up credible sightings with systematic surveys • Conduct systematic surveys of priority sites and around the periphery of the known range. • Solicit and train volunteers in the region to help conduct surveys. • Investigate local and aboriginal knowledge to determine the availability of information on current or historical range.	U	C, S	• Lack of information • Negative perception of snakes	• Determination of the extent of the range • Identification of new concentrations of ribbonsnakes • Development of a network of trained, local volunteers dedicated to ribbonsnake recovery	Ongoing
3.3 Identify the spatial scale of population genetic structure. • Continue to collect genetic samples from known sites throughout the range to obtain a sufficient sample size. • Continue to develop primers for a suite of microsatellite loci for the eastern ribbonsnake. • Conduct genetic analysis to determine population structure. • If overwintering concentrations are found, conduct genetic analysis to determine if they play a role in genetic structure.	U	R	• Lack of information • Small population effects	• Assessment of population genetic structure and identification of the appropriate scale for management	Ongoing
3.4 Evaluate current movement patterns and identify travel routes between concentration sites. • Conduct surveys around the perimeter of intensively surveyed sites and in adjacent habitats to explore how far individual snakes move. • Estimate home ranges based on mark-recapture studies.	U	R	• Lack of information • Habitat degradation and fragmentation	• Assessment of movement between sites and the effect of habitat configuration on that movement • Identification of travel routes to be complete the identification of critical habitat	2010-2015
3.5 Evaluate abundance and population trends. • Continue to mark and re-capture snakes at specific study sites to acquire a sufficient dataset to determine abundance, survivorship,	N	R,M	• Lack of information • Small population effects	• Estimates of population abundance and trends • Collection of data necessary for	Ongoing

Recommended approach to meet objective	Priority +	Broad strategy *	Threats addressed	Outcomes	Timeline
longevity, and growth.				development of PVA	
Objective 4. Identify habitat features used for each life stage and activity, and determine if they are limiting.					
4.1 Locate and characterize habitat features used for each life stage and activity, particularly overwintering sites. • Locate and characterize overwintering sites. • Locate feeding sites and identify prey and timing of feeding. • Locate other sites used for specific activities (e.g. mating, birthing).	U	R	• Lack of information	• Identification of sites to complete the identification of critical habitat • Identification of important characteristics of these sites and assessment of how limiting they are	Ongoing
4.2 Characterize habitat used at the wetland scale and develop models to predict occurrence and identify critical habitat features.	B	R	• Lack of information	• Assessment of potentially limiting features at the wetland scale that could explain the current distribution • Development of models to refine the search for additional concentrations	2013-2015
4.3 Document the response of ribbonsnakes to dam removal in KNPNHS (if applicable).	B	R	• Lack of information • Dam construction or removal	• Assessment of the effect of dam removal on snake distribution and abundance	As applicable
Objective 5. Identify population threats, evaluate their significance and take steps to mitigate those threats.					
5.1 Document current development in and around critical habitats and evaluate its effect on the species.	U	R	• Lack of information	• Assessment of threats and development of a strategy to address those threats	Ongoing
5.2 Evaluate susceptibility to inbreeding	N	R	• Small population effects	• Assessment of the current genetic variability in local concentrations	2010-2015
5.3 Assess the attitude of people toward snakes.	B	R	• Negative perception of snakes	• Assessment of level of intentional killing of snakes • Development of best techniques to approach landowners and encourage participation in snake recovery	2010-2015
5.4 Collaborate with Dept. of Fisheries and Oceans, NS Dept. of Natural Resources, and other fisheries and research agencies to monitor exotic fish and assess their impact. • Collaborate with the Mersey Tobeatic Research Institute's current campaign to inform the public about the dangers of introducing these fish.	N	R	• Exotic predatory fish	• Development of a system to monitor watersheds containing ribbonsnakes for the presence of exotic fish • Assessment of potential impact of these fish on prey abundance and composition	Ongoing
5.5 Conduct Population Viability Analysis (long-term objective).	B	R	• Lack of information	• Assessment of the current health of the population	>2015
Objective 6. Develop long-term monitoring protocols and techniques to evaluate the success of recovery actions.					

Recommended approach to meet objective	Priority +	Broad strategy *	Threats addressed	Outcomes	Timeline
6.1 Develop and implement protocols for long-term monitoring of populations and their habitats and threats. • Identify the appropriate temporal and spatial scales for monitoring populations and their habitats. • Monitor populations over the long-term to assess changes in abundance in relation to changes in habitat and/or threats. • Monitor sites over time to document changes in habitat, water level, and climate. • Model potential impact of water level, water temperature, and climate change (long-term objective).	U	M	• Lack of information • Climate change • Changes to water level and seasonal water flow	• Development of efficient protocols that allow long-term monitoring of populations and their habitats • Allow for assessment of how population trends vary with changes in habitat, water level, and climate • Potentially, assessment of threats that are not immediately apparent from short-term studies	Ongoing
6.2 Evaluate the success of educational initiatives in affecting knowledge and attitudes; develop a protocol outlining the best methods to approach landowners.	B	M	• Negative perception of snakes	• Development of best techniques to approach landowners and encourage participation in snake recovery	2010-2015
6.3 Evaluate recovery actions as they are undertaken.	N	M	• Lack of information	• Assessment of the effect of recovery actions	Ongoing

+ Priority: U = urgent; N= necessary; B= beneficial
*** Broad strategy: C =communication and stewardship; R=research; H = habitat managed for securement; M=monitoring**

5.3.2 Rationale to support recovery planning table

A more detailed rationale has been developed to support each approach recommended in the recovery planning table (The Eastern Ribbonsnake Recovery Team, 2008). A complete copy of this document is available from Parks Canada. However, a few key points regarding public engagement are included below as engagement is deemed as central to ribbonsnake recovery.

1.2 Support Mi'kmaw participation in all aspects of ribbonsnake recovery.
The Mi'kmaq are traditional stewards of the territory where ribbonsnakes are found and are being monitored. There are legends and dances pertaining to snakes as well as petroglyphs of snake beings, demonstrating the cultural significance of snakes for the Mi'kmaq. For these reasons, it is imperative that the Mi'kmaq are invited to participate in planning as well as the recovery process. Participation will include being involved as recovery team members, community advisors to the recovery team (minimum of two Elders or Culture Keepers from the local Mi'kmaq community), and sharing of Mi'kmaw knowledge relating to ribbonsnakes or its critical habitat. It will also include participation in traditional ceremonies and active management for ribbonsnakes.

Supporting Mi'kmaw cultural events that celebrate the ribbonsnake will increase public awareness and help overcome the negative perception of snakes. Combining traditional approaches with conventional research will encourage a greater understanding of ribbonsnakes and develop cooperative approaches to recovery.

1.3 Continue to develop volunteer opportunities and promote public involvement in research and recovery.
Encouraging volunteers to participate directly in meaningful research and recovery activities helps to create snake advocates and allows for the implementation of cost-effective recovery programs. By developing standard protocols, training participants, and implementing error checking procedures, both volunteers and researchers can collect high quality, useful data. This is particularly helpful with species such as the ribbonsnake where knowledge is poor and research is very labour intensive.

1.4 Work with landowners, Aboriginal organizations, industry, recreational groups, and developers to minimize impact on snakes and their habitats.
A best practices guide will be distributed to landowners in ribbonsnake critical habitat. The purpose of this manual is to inform landowners about wetland species at risk, alleviate fears surrounding critical habitat identification, and provide useful information on how to minimize the impact of activities on ribbonsnakes and their habitats. One-on-one landowner contact and site visits will complement the guide. Landowners will be encouraged to implement these best practices on their properties.

6. CRITICAL HABITAT

Critical habitat is defined in the *Species at Risk Act* (S.C. 2002, c.29) as "…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" (s. 2(1)). Critical habitat for the eastern ribbonsnake is identified below, to the extent possible, using the best available information. However, at this time, sufficient information is available for only the partial identification of critical habitat and it is recognized that that this may be insufficient to achieve the population and distribution objectives for the species. Included below is a summary of the rationale for partial identification, followed by the identification of critical habitat which includes a summary of the approach and guidelines employed. The schedule of studies (section 6.3) outlines the activities required to identify additional critical habitat necessary for the recovery of the species.

6.1 Rationale for partial critical habitat identification

This is a partial identification of critical habitat. The current distribution of ribbonsnakes is still being ascertained. In particular, the assessment of wetlands used by ribbonsnakes is incomplete, and the terrestrial use by ribbonsnakes for overwintering and movement among concentrations is poorly understood. As such, the precautionary approach is employed to identify critical habitat in wetlands and immediately adjacent terrestrial areas based on the best available current knowledge.

Describing critical habitat for the eastern ribbonsnake is challenging since little is known about the distribution, population trends, densities or habitat requirements in Nova Scotia. Additionally, the detectability of ribbonsnakes is low and may be influenced by season, weather, and habitat conditions. This may confound the interpretation of visual survey results; ribbonsnakes present in significant numbers in an area could be missed by occasional surveys. Despite fairly high search effort over the last several years (>5000 person hours over 50+ waterbodies), only five sites with a high density of ribbonsnake sightings (>50 sightings) have been identified. For most of the remaining areas there are less than ten sightings per waterbody (Table 7). There are many possible interpretations for this observed distribution pattern, including: 1) snake densities may fluctuate greatly over time at all sites; 2) snakes may exist in high densities in these areas but were not seen due to little or no search effort, effort in the wrong place, effort under sub-optimal conditions (weather, season), or lower detectability due to the habitat; 3) snakes may naturally exist in low densities in these habitats; 4) snakes may be declining at these sites due to unidentified threats.

Overwintering habitat for ribbonsnakes is poorly understood. Laboratory experiments have shown that they can endure immersion in water for extended periods of time so it is possible that at a portion of the population overwinters in the wetlands within habitats that are at least temporarily flooded (Todd *et al.* 2009, Todd 2007). Still, there is evidence that ribbonsnakes overwinter in terrestrial habitats well away from wetlands (Nova Scotia ribbonsnake database, 2010). The extent of terrestrial habitat use is unknown. It is certainly possible that terrestrial areas are a very important component of critical habitat for ribbonsnakes. Until this is more thoroughly understood critical habitat can only be partially identified.

Critical habitat for the species will be identified based on an occupancy approach and the precautionary principle. Although little is known about ribbonsnakes in Nova Scotia, their occurrence has been confirmed at a number of locations on three watersheds in the province (Table 7). Location data include: historic sightings (1950-1997), current unconfirmed sighting reports (1998-2009), current general observations (1998-April 2010), sightings from snake-specific search efforts (2004-April 2010), and sightings incidental to Blanding's turtle research (1999-2009). The majority of the sightings, particularly those resulting from snake-specific search effort and Blanding's turtle research, can be pinpointed to specific sites (within 20 m or less).

Critical habitat identification will be based on known currently occupied locations (confirmed sightings within the last 10 years). Because ribbonsnakes are difficult to locate, a single recent, confirmed sighting is considered to be enough to suggest that a concentration of ribbonsnakes likely exists at that location.

6.2 Identification of critical habitat

Critical habitat will encompass all wetlands falling within an identified *location* as well as the terrestrial and aquatic zone that extend 100 m around each wetland. This is not a buffer zone; it is fundamentally part of the critical habitat used by ribbonsnakes and their prey. The *location* is the geographical place where ribbonsnakes occur (e.g., the entire lake, fen or bog, or selected portions of a river or stream). Although *locations* in their entirety are not identified as critical habitat, they are both functional ecological units and recognized political units; identifying these *locations* will facilitate management and recovery. All wetlands within the *location* will be included in critical habitat identification based on the precautionary principle and the reasonable inference that ribbonsnakes, if found in one wetland, are also likely to be found in other wetlands within that location. This reflects a balance between a minimal identification of critical habitat at wetlands where they have been observed and the identification of all wetlands within the range providing suitable habitat. Given the low detectability of ribbonsnakes it is reasonable to suspect that ribbonsnakes occur in adjacent wetlands at the same *location* (waterbody).

In this strategy, wetlands are defined according to the accepted legal definition in the *Nova Scotia Environment Act* (S.N.S. 1994-95, c. 1) which states that "'wetland' means land commonly referred to as a marsh, swamp, fen or bog that either periodically or permanently has a water table at, near or above the land's surface or that is saturated with water, and sustains aquatic processes as indicated by the presence of poorly drained soils, hydrophytic vegetation and biological activities adapted to wet conditions" (s. 3(bg)). Eastern ribbonsnakes have been found in a variety of wetland types and very little is currently known about their ecology. Some of the more typical wetland habitats in which ribbonsnakes have been found are described in Section 1.8, and include, but are not limited to, slow flowing water, abundant aquatic and terrestrial vegetation, and the presence of shallow pools and side channels.

The zone extending 100 m out from the edges of the wetlands is part of critical habitat for ribbonsnakes. It recognizes occasional use of terrestrial habitats by ribbonsnakes, including travel to and from, and use of, hibernacula in forested areas adjacent to wetlands. Moreover, the one confirmed hibernacula at the time of writing is 155m from the closest adjacent wetland.

Eleven ribbonsnakes were identified in this area between mid-November 2009 and late March 2010. Several other sightings in late spring and early fall, of up to 140m away from the wetlands, have indicated that this isn't the only inland hibernacula. More study is required to better define this usage. This component of critical habitat also includes the incorporation of difficult to define wetland edges, seasonal flooding zones, vernal pools, beaver channels, and other areas that may not fit into the traditional definition of wetlands but do, on occasion, provide seasonal habitat for ribbonsnakes. Finally, this is consistent with literature of other semi-aquatic reptiles and amphibians with respect to habitat use adjacent to the aquatic component of wetland areas (Semlitsch and Bodie 2003, Semlitsch and Jensen 2001).They recommend including areas ranging from 164-304m from the edge of the wetland. The use of 100m for ribbonsnake critical habitat in Nova Scotia is conservative. This number may have to be revised once terrestrial habitat use by ribbonsnakes adjacent to wetlands is better understood.

6.2.1 Guidelines for delineating critical habitat

Critical habitat was mapped at each location, using the guidelines for mapping critical habitat, outlined in Table 6. Maps show the approximate boundaries of the *location* and the critical habitat areas (as of April 15, 2010). A summary of locations is presented in Table 7.

Critical habitat was mapped based on existing wetland spatial GIS data provided by the Nova Scotia Department of Natural Resources (Figures 6 and 7). This dataset does not necessarily contain all wetlands that fall within the above wetland definition (e.g. vernal pools, treed bogs and other small wetlands may not by identified as such on the existing spatial data) and that the extent of wetlands varies seasonally. Current ribbonsnake sightings at the water's edge that did not fall within a wetland polygon in the spatial dataset, are indicated with a 200m buffer. This was done to help us deal with resolution challenges for identifying small wetlands in the spatial dataset.

Currently known critical habitat locations are identified in Table 7 and the location and extent of critical habitat is shown in Figure 8. A fine-scale version of Fig. 8 is available on the SAR Public Registry and more detailed information will be provided to affected parties upon request.

Table 6. Guidelines for mapping ribbonsnake *locations.*

Mapping Guidelines
Only include locations with current confirmed sightings occurring near waterbodies: • Sightings were considered confirmed if reported by a knowledgeable observer (e.g., researcher, park interpreter, experienced volunteer) or if supporting evidence was provided (e.g., photograph, specimen). • Current sightings are those that occurred from 1998- April 2010). • Sightings >100m from a waterbody were not incorporated at this time due to lack of knowledge of terrestrial habitat requirements. • *Locations* with only unconfirmed reports and/or historical sightings were added to the list of priority sites for future surveys. Additional critical habitat will be identified in the future as sightings are confirmed (Section 5.3).
Use official Nova Scotia place names to identify locations: • *Locations* will be identified using official Nova Scotia Place Names, as documented in the Nova Scotia Atlas, and the description will include the 'NS Atlas Square Reference' (Province of Nova Scotia, 2001). • In instances where a *location* does not have an official place name, the name used is noted in Table 1 along with UTM (NAD 83) coordinates (Table 7). • In places where two or more named waterbodies form a single functional ecological unit, it will be considered as one *location*, but both official names will be included in the *location* description (e.g., McGowan-Deans Lake).
Lake locations include the entire lake: • For sightings that occur on a lake, the entire lake will be included as the *location*. This will also include all wetlands on the lake, including those along stream inlets and outlets that are within 100 m of the lake.
River or stream locations include only the occupied portion of the river/stream: • For sightings occurring on a stream or river, the *location* will be named separately from the associated lake. • The *location* will include the extent of the sightings along the brook/stream or river as well as an additional 200 m linear area downstream and upstream of the outermost sightings. • Where portions of adjacent wetlands occur within the extent of the sightings and the 200 m zones downstream or upstream, the entire wetland will be included in the *location.* This definition uses the precautionary principle, and is justified by field observations of individual snakes moving up to a maximum of 391 m along waterways (Imlay 2009). For unusually long contiguous wetlands (> 500m beyond the 200m buffer), a natural breakpoint was chosen through reasonable inference.

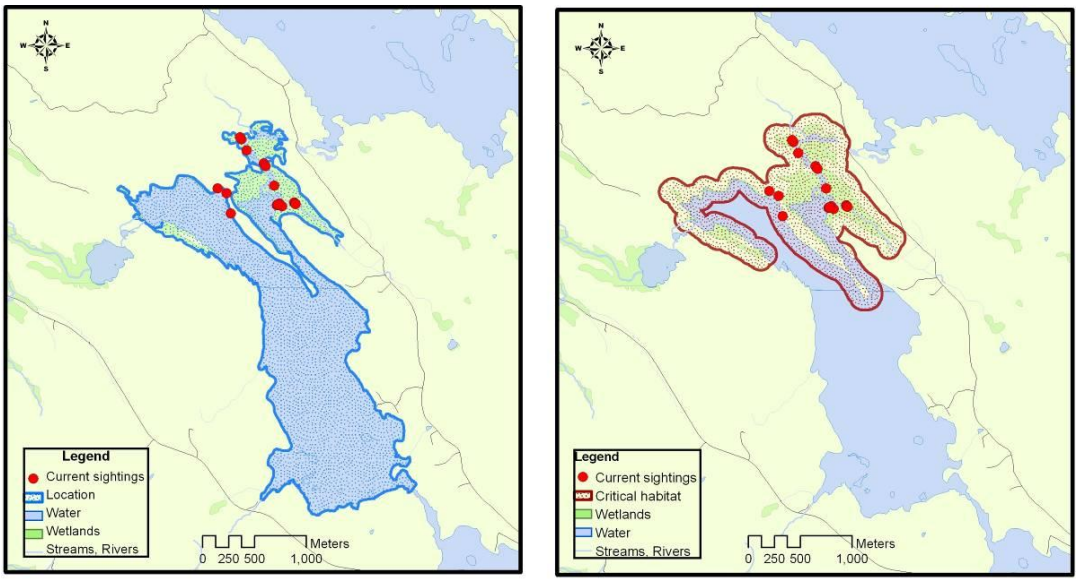

Figure 6. Example of critical habitat identification on a lake*. The left map shows the outline of the *location*, which includes the entire waterbody. The right map shows the identified critical habitat. Critical habitat includes all wetlands that fall within the outlined location and a 100 m zone around each wetland.

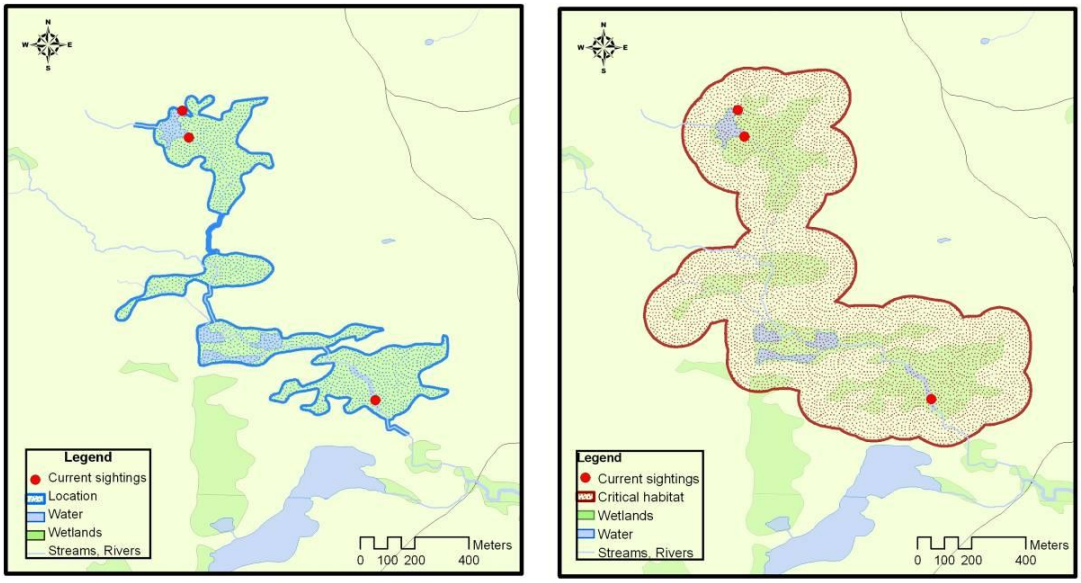

Figure 7. Example of critical habitat identification along a stream*. The left map shows the outline of the *location*, which includes the extent of the brook and associated wetlands 200m upstream and downstream of the outermost sightings. The right map shows the identified critical habitat. Critical habitat includes all wetlands that fall within the outlined location and a 100 m zone around each wetland.

*These maps are included for illustration purposes only

Table 7. List of critical habitat locations, based on current, confirmed ribbonsnake sightings. All sightings are listed with official Nova Scotia place names (Province of Nova Scotia 2001), unless otherwise indicated with an asterisk. For more details see the full resolution version of Figure 8 posted on the SARA registry.

Location	Watershed / County	Map square (Figure 8)	Current (1998-April 2010)			Historic Sightings (<1998)	Total sightings	Land ownership
			Survey effort (person/ hrs)	Sightings from survey effort	Other sightings			
Barren Meadow Brook / Keddy Brook	Medway River Lunenburg Co.	P9	141.5	49	39	0	88	Provincial / Private
Beaver Brook	Medway River Queens Co.	N10	0.0	0	1	0	1	Private
Bull Moose Brook	Medway River Queens Co	N10	15.0	0	1	0	1	Provincial / Private
Charlotte Lake	Medway River Queens Co	L11	0.0	0	1	0	1	Private/ Provincial
Cobrielle Lake / Cobrielle Brook / Peskowesk Lake complex	Mersey River Annapolis / Queens / Digby Co.	G13	173.3	93	7	0	103	Federal
Cow Moose Brook	Mersey River Queens Co.	M14	9.4	2	0	0	2	Private/ Provincial
Deep Brook	Medway River Queens Co.	09	44.7	2	4	0	6	Private
East Lake	Medway River Annapolis Co.	L1	4.3	1	2	0	3	Private/ Provincial
Eel Lake	Medway River Queens Co.	K10	22.8	3	0	0	3	Provincial/ Private
Eighteen Mile Brook	Medway River Queens Co.	N14	28.5	8	0	0	8	Private/ Provincial
Faulkenham Brook	Medway River Queens Co.	N11	0.0	0	1	0	1	Private
Fox Lake	Medway River Lunenburg Co.	Q10	0.0	0	3	0	3	Provincial/ Private
Grafton Lake / Grafton Brook / Little Kempton Lake / Sweeney Brook complex	Mersey River Queens Co.	I11	3096.1	1313	76	65	1454	Federal
Harmony Lake	Medway River Queens Co.	J10	3.1	2	0	1	3	Private/ Provincial
Herring Cove Lake	Mersey River Queens Co.	R18	16.6	1	0	1*	2	Private

Location	Watershed / County	Map square (Figure 8)	Current (1998-April 2010)			Historic Sightings (<1998)	Total sightings	Land ownership
			Survey effort (person/ hrs)	Sightings from survey effort	Other sightings			
Hog Lake Lake * (UTM 347356 4918566)	Medway River Queens Co.	N10	15.7	9	1	0	10	Provincial
Hog Lake offshoot* (UTM 348117 4917065)	Medway River Queens Co.	N11	3.0	0	1	0	1	Private
Horseshoe Lake	Mersey River Annapolis / Digby	C9	0.0	0	1	0	1	Private/ Provincial
Joe Tom Brook	Medway River Queens Co.	K10	4.7	4	2	0	6	Provincial
Kejimkujik Lake / George Lake / Snake Lake	Mersey River Annapolis/Queens	H11	43.5	3	15	21	39	Federal
Lake Rossignol	Mersey River Queens Co.	I16	36.7	3	1	5	9	Provincial / Private / First Nations
Little Rocky Lake / Moccasin Lake Brook	Medway River Queens Co.	L14	0.0	0	2	0	2	Provincial / Private
Long Lake	Medway River Lunenburg Co.	R13	0.4	0	1	0	1	Private/ Provincial
Mary Lake	Medway River Queens Co.	L11	3.9	0	1	1	2	Private/ Provincial
McBride Brook	Medway River Queens Co.	K13	24.4	2	1	0	3	Provincial/ Private
McGowan Lake / Deans Lake / Schroders Swamp	Medway River Annapolis / Queens	K9	146.8	52	47	0	99	Provincial/ Private
McGuire Lake and Bradley Lake Brook	Medway River Queens Co.	K13	6.8	1	1	0	2	Provincial/ Private
McKay's Pond * (UTM 354700 4923630)	Medway River Lunenburg Co.	P9	0.0	0	2	0	2	Private
Medway River (upstream of Ponhook Lake)	Medway River Queens Co.	N12	0.0	0	1	0	1	Private
Mersey River (upstream of Lake Rossignol)	Mersey River Queens Co.	I13	15.3	4	1	0	5	Provincial/ Private
Mersey River (at Big Guzzle Island)	Mersey Queens	P19	26.5	1	0	3	4	Private
Molega Lake / Hog Lake / Beavertail Lake	Medway River Queens Co.	011	830.6	360	46	13	419	Private / Provincial / First Nations

Location	Watershed / County	Map square (Figure 8)	Current (1998-April 2010)			Historic Sightings (<1998)	Total sightings	Land ownership
			Survey effort (person/ hrs)	Sightings from survey effort	Other sightings			
North Brookfield Pond (UTM 346195 4919955)	Medway River Queens Co.	N10	1.7	0	2	0	2	Private
North Cranberry Lake	Mersey River Queens Co.	H12	0.0	0	1	0	1	Federal
Ponhook Lake – Cameron Lake complex	Medway River Queens Co.	013	4.7	0	4	2	6	Private/ Provincial
Second Christopher Lake	Medway River Queens Co.	M13	11.8	2	0	0	2	Private
Seven Mile Lake	LaHave River Lunenburg Co.	Q9	91.8	14	3	0	17	Private/ Provincial
Shinglemill Brook	Medway River Queens Co.	010	21.3	0	2	0	2	Private
Ten Mile Lake / Little Ten Mile Lake / Lower Great Brook complex	Mersey River Queens Co.	017	79.8	10	2	0	12	Private/ Provincial
Tupper Lake – Hen Lake	Medway River Queens Co.	M9	0*	0	11	0	11	Private / Provincial
Westfield Bog* (UTM 339469 4921991)	Medway River Queens Co.	L9	1.7	0	4	0	4	Private

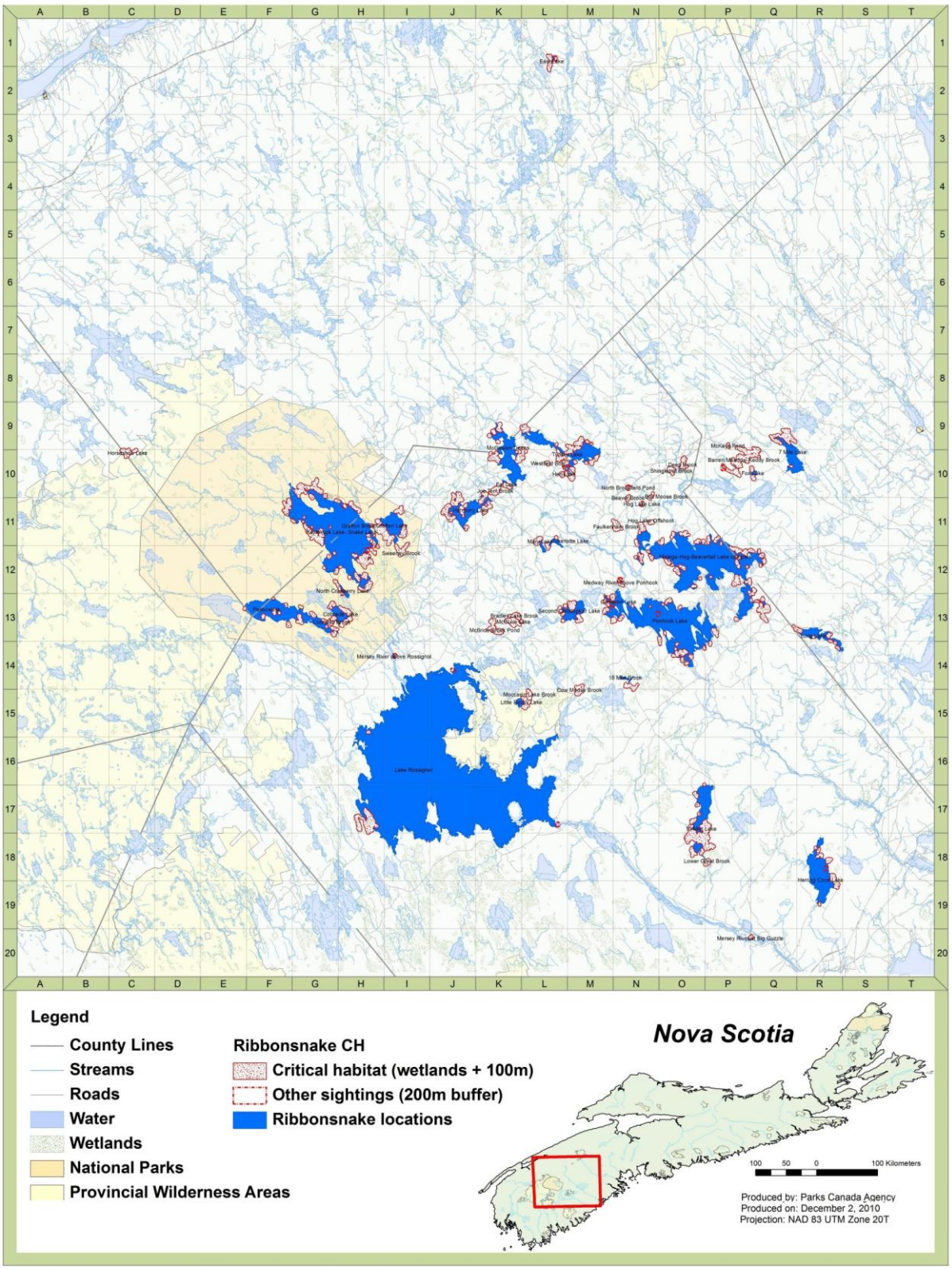

Figure 8. Critical habitats identified for eastern ribbonsnakes in Nova Scotia (as of April 2010). A full resolution version of this map can be obtained from the Species At Risk Public Registry.

6.3 Schedule of studies to identify critical habitat

At this time, only a partial identification of critical habitat is possible; more information about the basic biology, distribution, movement patterns, and habitat requirements of ribbonsnakes at all life stages is necessary for a full identification. In particular, this recovery strategy does not incorporate habitat over 100m away from wetlands that may be used by ribbonsnakes and could be important in maintaining connections between sites. A number of priority sites have been identified for future surveys to confirm the presence of ribbonsnakes. Critical habitat identification will be reviewed on a regular basis as more information becomes available. A schedule of studies for identifying further critical habitats is listed in Table 8.

Table 8. Schedule of studies to identify further critical habitat for the eastern ribbonsnake, *Thamnophis sauritus*, Atlantic population.

Study to be undertaken	Outcome/Rationale	Timeline
Determine location and habitat characteristics of overwintering sites	Will permit the identification of terrestrial habitat to ensure that critical overwintering habitat characteristics are not adversely changed.	2012
Determine extent of overland movements and other connections between concentration sites	Will permit the identification of terrestrial habitat to ensure that critical overland habitat corridors are not adversely changed.	2014
Determine the population abundance and genetic structure to refine population and critical habitat targets to achieve viable populations	Will achieve population and habitat targets for a viable population(s).	2015

6.4 Examples of activities likely to result in destruction of critical habitat

The *Species at Risk Act* (S.C. 2002, c. 29) contains prohibitions against the destruction of critical habitat on federal lands (s. 58(1)). Current federal policy (Government of Canada 2009) defines how destruction of habitat will be assessed. "Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. When critical habitat is identified in a recovery strategy or an action plan, examples of activities that are likely to result in its destruction will be provided." Any activity that may result in the destruction of critical habitat as described above must therefore be managed, mitigated, or prohibited to ensure the continued protection of critical habitat.

Activities may have impacts on critical habitat sites or the entire *location* the critical habitat is in, or both. It is important to identify the scale(s) at which various activities may have an impact to ensure the protection of critical habitat. Activities likely to result in the destruction of critical habitat include, but are not limited to, the examples listed in Table 9.

Table 9. Examples of activities likely to result in the destruction of the critical habitat for the eastern ribbonsnake.

Examples of Activities
Road and trail development that fragments habitat, alters the natural hydrologic regime and/or damages vegetation
Causeway development that fragments habitat, alters hydrologic regime and/or damages vegetation
Off-highway vehicle use that damages vegetation
Cottage and residential development that fragments habitat, alters hydrologic regime and/or damages vegetation
Shoreline alterations that degrade habitat, including such activities as mowing and raking or construction of breakwaters
Draining and infilling of wetlands or other direct removal of vegetation
Hydroelectric dam operations that impact shoreline and wetland vegetation due to water level alterations
Crop and animal production resulting in degradation of water quality or the alteration of the natural hydrologic regime
Forest harvesting practices resulting in alteration of water quality or the hydrologic regime
Industrial development resulting in alteration of water quality or the hydrologic regime
Extensive trapping of beavers or removal of beaver dams that result in significant changes in the hydrological regime.
Peat mining that eliminates or degrades habitat

7. Performance Measures

Recovery efforts must be evaluated to assess their success. Because so little is known about ribbonsnakes, achieving the population and distribution objectives is a long-term goal, beyond the scope of a single recovery strategy. Intermediate performance measures, to be assessed by 2015, are presented here. Additional evaluation tools will be identified in future action plans.

- Known habitats and populations maintained
- Increased number of sites under formal habitat securement
- Public awareness of ribbonsnake recovery occurs throughout the NS range leading to more landowners employing best practices to manage habitat
- Critical habitat identification refined to incorporate overwintering habitats and terrestrial movements
- Appropriate management identified scales though increased knowledge of the species' range, distribution, and movements between concentration sites within that range

- Standard protocols for effectively locating, capturing, marking, and tracking ribbonsnakes developed and integrated into recovery programs leading to ability to assess the true status of the population through improved understanding of population dynamics and habitat use
- Increased awareness of traditional knowledge of ribbonsnakes and their habitat
- Baseline demographic data collected at three or more concentration areas to allow future assessment of the effectiveness of recovery activities
- Site specific threats evaluated and management strategies implemented to mitigate those threats

8. Effects on other species

Overall, it is anticipated that the approaches outlined in this recovery strategy will have a beneficial impact on non-target species (other species at risk and those not at risk), ecological processes, and the environment.

Management is likely to include protection of wetland habitat. This has the potential to benefit many wetland species, including some that are at risk. In Nova Scotia, the distribution and habitats of ribbonsnakes overlap considerably with that of the Endangered Blanding's turtle (COSEWIC 2005). There are also a number of Atlantic Coastal Plain Flora species at risk that occur in similar wetlands. There are examples, such as the red root, where the habitats of Atlantic Coastal Plain Flora species overlap with those of eastern ribbonsnakes. Where other species at risk coexist with ribbonsnakes, recovery and conservation initiatives outlined in this strategy will be coordinated with other recovery teams. It will ensure that actions are mutually beneficial and not detrimental to other species at risk.

Stewardship actions, educational programs and awareness initiatives with landowners, Aboriginal organizations, and the general public; all levels of government; industry; and other audiences; will lead to increased understanding, appreciation of, and concrete action towards the conservation of wetlands and the recovery of species at risk in general. In particular, the development of a best practices guide for landowners with species at risk on their property will help encourage stewardship of species at risk on private lands and inform landowners of ways to minimize their impacts on these species.

9. Statement on action plans

One or more action plans will be developed by 2014.

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