COSEWIC
Assessment and Update Status Report

on the

Eastern Foxsnake
Elaphe gloydi

Carolinian population
Great Lakes/St. Lawrence population

in Canada

ENDANGERED
2008

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

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COSEWIC
Assessment Summary

Assessment Summary – April 2008

Common name
Eastern Foxsnake – Carolinian population

Scientific name
Elaphe gloydi

Status
Endangered

Reason for designation
The species is confined to a few small increasingly disjunct areas that are subject to intensive agriculture, high human populations and extremely high densities of roads. Roads fragment populations leading to increased probability of extirpation. There are no large protected, roadless areas for this species in this region. The species is also subject to persecution and illegal collection for the wildlife trade.

Occurrence
Ontario

Status history
The species was considered a single unit and designated Threatened in April 1999 and May 2000. Split into two populations in April 2008. The Carolinian population was designated Endangered in April 2008. Last assessment based on an update status report.

Assessment Summary – April 2008

Common name
Eastern Foxsnake – Great Lakes/St. Lawrence population

Scientific name
Elaphe gloydi

Status
Endangered

Reason for designation
In this region, the species swims long distances often in cold, rough open water where it is subject to mortality due to increasing boat traffic. It is uniquely vulnerable to habitat loss because it is confined to a thin strip of shoreline where it must compete with intense road development and habitat modification due to recreational activities. The species' habitat is undergoing increasing fragmentation as development creates zones that are uninhabitable.

Occurrence
Ontario

Status history
The species was considered a single unit and designated Threatened in April 1999 and May 2000. Split into two populations in April 2008. The Great Lakes / St. Lawrence population was designated Endangered in April 2008. Last assessment based on an update status report.

COSEWIC
Executive Summary

Eastern Foxsnake
Elaphe gloydi

Carolinian population
Great Lakes/St. Lawrence population

Species information

The Eastern Foxsnake commonly attains lengths of 91–137 cm. Adults usually lack any distinct patterns or conspicuous markings on the head, and head colouration varies from brown to reddish. The dorsum is patterned with bold, dark brown or black blotches on a yellowish background that alternate with smaller, dark blotches on the sides. The ventral scutes are most often yellow and strongly checkered with black. The scales are weakly keeled and the anal scale is divided. Juveniles have a lighter ground colour (commonly grey), lighter blotches bordered in black, a transverse line anterior to the eyes, and a dark line extending from the eye to angle of jaw on each side. The dark lines on the head of juveniles fade with age, and are usually quite faint in adults.

Distribution

The global distribution of the Eastern Foxsnake is restricted to the Great Lakes region of North America. Approximately 70% of the species' range is in Ontario, Canada with relatively small distributions in Michigan and Ohio, USA. Within Ontario, the species' distribution is highly disjunct, occupying three discrete regions along the Lake Erie-Lake Huron waterway shoreline. The three regional populations from south to north are (1) Essex-Kent, (2) Haldimand-Norfolk, and (3) Georgian Bay Coast.

Habitat

Eastern Foxsnakes in the Essex-Kent and Haldimand-Norfolk regions use mainly unforested, early successional vegetation communities (e.g., old field, prairie, marsh, dune-shoreline) as habitat during the active season. Hedgerows bordering farm fields and riparian zones along drainage canals are regularly used. In some areas of intensive farming, these linear habitat strips likely make up the bulk of habitat available for foxsnakes.

The populations of the Georgian Bay Coast predominantly use open habitats along shorelines (e.g., coastal rock barrens and meadow marshes) as habitat during the active season. The foxsnakes inhabiting this coastline do not venture far inland, restricting the majority of their activity to within 150 m of the water.

Biology

Emergence from hibernation generally occurs from mid-April to mid-May, mating occurs from late May to mid-June, and egg laying occurs from late June to mid-July. Retreat into hibernacula occurs in September and October. Eastern Foxsnakes of the Georgian Bay Coast use much more space than those in Essex-Kent: on average, Georgian Bay females disperse 3.5 times farther from their hibernacula.

Predators of Eastern Foxsnakes include the larger birds of prey and carnivorous mammals such as raccoon and fisher. Small mammals and birds make up the bulk of the Eastern Foxsnake's diet. Both active searching and ambush (sit-and-wait) foraging strategies are employed.

Eastern Foxsnakes can adapt to limited anthropogenic disturbance, an example being their use of human-made structures for shelter during the summer despite high levels of human activity.

Population sizes and trends

Several studies with the aim of documenting local population sizes and trends have been conducted on Eastern Foxsnake populations in Ontario. However, as is the case with other rare and cryptic snake species, obtaining reliable quantitative estimates has been difficult. Monitoring of communal hibernacula in areas where access is not restricted, and risks to the site can be minimized, probably offers the best chance of obtaining reliable estimates of population sizes and trends for specific hibernacula.

Despite the lack of direct quantitative data demonstrating a decline in Eastern Foxsnake numbers, the sheer magnitude of wetland loss that has occurred in southwestern Ontario, coupled with the concomitant proliferation of roads in that region, makes the probability of range contraction and population reduction extremely high.

Limiting factors and threats

The threats facing Eastern Foxsnakes in Ontario remain roughly the same as those identified in the previous status report: namely, habitat loss and degradation, road effects, other inadvertent effects caused by human activities, and intentional persecution by humans.

Special significance of the species

The Eastern Foxsnake has an extremely restricted global range with approximately 70% of the species' distribution existing within Ontario, Canada. That the greatest proportion of the species' distribution is situated in Canada is unusual within the national herpetofaunal assemblage and makes the Eastern Foxsnake a distinctively Canadian species.

Existing protection or other status designations

The Eastern Foxsnake has a global rank of G3 and sub-national ranks of S2 in Michigan, S3 in Ohio, and S3 in Ontario. The species was officially designated by COSEWIC as Threatened in April 1999 and May 2000, and subsequently designated Threatened by the Ontario Ministry of Natural Resources in 2001.

In Canada, the Eastern Foxsnake is legally protected under the Ontario *Fish and Wildlife Conservation Act* which makes it illegal to harass, possess (without a permit), or kill the species. Additional protection is afforded in National Parks through the *Canada National Parks Act,* in National Wildlife Areas through the *Canada Wildlife Act*, and on all federal lands through the *Species at Risk Act* (Threatened designation; Schedule 1). Ontario's *Endangered Species Act* will provide protection for the species throughout the province.

COSEWIC HISTORY

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

COSEWIC MANDATE

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

COSEWIC MEMBERSHIP

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

DEFINITIONS
(2008)

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

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.
** Formerly described as "Not In Any Category", or "No Designation Required."
*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment Canada
Canadian Wildlife Service

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

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SPECIES INFORMATION

Name and classification

Conant (1940) described the foxsnake throughout its range and concluded that specimens from eastern localities differed from the typical western variety in both habitat and colour pattern. As a result of these differences, and because the eastern and western forms were geographically separated, Conant (1940) described two subspecies: the Western Foxsnake (*Elaphe vulpina vulpina*) and the Eastern Foxsnake (*E. v. gloydi*). Morphologically, the only “distinguishing” feature is the number of dorsal blotches: the Western Foxsnake with 32–52 (mean = 41) and the Eastern Foxsnake with fewer and larger dorsal blotches, 28–43 (mean = 35) (Ernst and Barbour 1989, Harding 1997). However, there is no completely reliable morphological separation and the best distinction is simply that their ranges do not overlap (Harding, 1997).

The Latin name *vulpina* (= fox) has been reported by many authors to derive from the fox-like musk which the snake exudes when disturbed. However, this seems unlikely due to two factors. First, because the specimen originally described by Baird and Girard (1853) was preserved, and was collected by a Reverend Charles Fox, it is more probable that the species name was intended as a Latin translation of the collector’s name (Conant 1940, Rivard 1979, F. Cook pers. comm. 1998). Second, those familiar with both foxsnake and fox odours have commented that they bear little resemblance to each other (J. Wright pers. comm. 1997). The eastern form was named to honour the American herpetologist H. K. Gloyd.

Because the distributions of the Western and Eastern Foxsnakes are allopatric (likely since the end of the Wisconsin glaciation) with no evidence of gene exchange, and are distinct based on external morphology, Collins (1991) recommended that the Eastern Foxsnake be designated a full species, *E. gloydi*. This proposal was majority approved by a North American snake taxonomy group composed of John E. Cadle, Brian I. Crother, Harry W. Greene, L. Lee Grismer, James A. MacMahon, James R. McCranie, and Samuel S. Sweet. The taxonomic change was not without its detractors, however, as Cook (1991) suggested that splitting the western and eastern forms into two distinct species would obscure important zoogeographic relationships. Nevertheless, this taxonomic change (Eastern Foxsnake = *E. gloydi*) was recognized in Crother (2001), which standardized names for North American herpetofauna, and has been adopted by federal and provincial agencies in Canada. The taxonomic designation of the Foxsnake remains unsettled, however, both on the specific level (see Genetic Description), and on the generic level. For example, given the recent phylogenetic examinations of Utiger *et al.* (2002) and Burbrink and Lawson (2007), it seems clear that North American *Elaphe* (new world ratsnakes), as formerly classified, would comprise a paraphyletic genus. Consequently, reclassification schemes are being examined. Utiger *et al.* (2002) argued that the Eastern Foxsnake should be called *Pantherophis gloydi*. However, according to the rationale detailed in Burbrink and Lawson (2007 p.186), the Eastern Foxsnake would most correctly be called *Pituophis gloydi.*

Morphological description

The Eastern Foxsnake commonly attains lengths of 91–137 cm, and large individuals have measured up to 179 cm SVL (Conant and Collins 1991). Adults usually lack any kind of distinct head pattern or conspicuous markings, and head colouration varies from brown to reddish. The dorsum is patterned with bold, dark brown or black blotches on a yellowish background that alternate with smaller, dark blotches on the sides. The ventral scutes are most often yellow and strongly checkered with black. The scales are weakly keeled and the anal scale is divided. Juveniles have a lighter ground colour (commonly grey), lighter blotches bordered in black, a transverse line anterior to the eyes, and a dark line extending from the eye to angle of jaw on each side (Johnson 1989, Conant and Collins 1991). The dark lines on the head of the juveniles fade with age, and are usually quite faint in adults. Although extremely rare, leucistic specimens are occasionally discovered in wild populations. A melanistic individual was reported from an industrial area in Ohio (Kraus and Schuett 1983).

Elaphe gloydi has many common names which vary by locality. The species has been called timber snake in Ohio, hardwood rattler in parts of Ontario (Johnson 1989), womper in southwestern (SW) Ontario, marsh womper on Pelee Island, and, unfortunately, foxsnakes are also commonly referred to as copperheads due to their reddish head colouration. In Ontario, *E. gloydi* may be confused with several blotched snake species. These include Massasauga (*Sistrurus catenatus*), Milksnake (*Lampropeltis triangulum*), Eastern Hog-nosed Snake (*Heterodon platirhinos*), Northern Watersnake (*Nerodia sipedon*), juvenile Blue Racer (*Coluber constrictor foxii*), and juvenile Gray Ratsnake (*Elaphe spiloides*). However, Massasaugas have a darker ground colouration with lighter brown or black blotches, a vertical eye pupil, heat-sensitive facial pit, and a distinct rattle at the tip of the tail. Milksnakes are similar in colouration but have smooth scales, undivided anal plates, and a conspicuous head pattern (Y- or V-shaped blotch). Eastern Hog-nosed Snakes have a distinctive upturned snout; watersnakes have a banded, rather than blotched, dorsal pattern; and juvenile Blue Racers have similar blotching patterns but have smooth scales, different colouration on the ventral scutes, and lack the stripe extending from the eye to angle of the jaw in the foxsnake (Harding 1997). Juvenile Gray Ratsnakes can be distinguished from juvenile Eastern Foxsnakes (both are dorsally blotched) by counting ventral scutes: Gray Ratsnakes have 221 or more and Eastern Foxsnakes have 216 or fewer (Conant and Collins 1991).

The foxsnake is heavier and stouter than its congeners (Froom 1972) and while the species is an adept climber, it is probably the least arboreal of the North American *Elaphe*. The Eastern Foxsnake is a proficient swimmer and will take to the water and swim long distances across bays and between islands (Froom 1972, M. Villeneuve unpubl. data, MacKinnon 2005, Lawson 2005). The foxsnake is one of the most inoffensive of ratsnakes (Staszko and Walls 1994); however, it is particularly prone to ejecting a foul-smelling glandular secretion from the cloacal scent glands when initially disturbed.

Genetic description

Based on analyses of genetic samples collected from Eastern and Western Foxsnake populations, Corey *et al.* (2005) found that the current species designations (*E. gloydi* and *E. vulpina*)—as distinguished by differences in morphological characters and geographical distributions—do not reflect fundamental underlying patterns of genetic differentiation. Specifically, the haplotype "that is found in most *E. gloydi* individuals is widely shared with at least some *E. vulpina* individuals, suggesting that *E. gloydi*, as currently defined, is not a genetically distinct clade within fox snakes as a whole." (Corey *et al.* 2005). With further improvements to our understanding of these genetic relationships, it is important to examine whether *E. gloydi* is sufficiently distinct from *E. vulpina* to warrant specific status, as this would have implications for estimates of the proportion of the species' range in Canada. Work currently being conducted by Row and Lougheed (2006, 2007) will help to expand and clarify the findings of Corey *et al.* (2005), as well as examine the genetic relationships among the foxsnake populations in Ontario. This work is in its second season and is part of the PhD. research of Jeffrey Row.

One of the most interesting results of Row and Lougheed's work thus far is that populations along Georgian Bay appear to be severely genetically depauperate relative to those in SW Ontario; this pattern is suggestive of a bottleneck or founder effect (Row and Lougheed 2006). Analysis of molecular variance (AMOVA) revealed that a large and significant amount of the total genetic variation could be attributed to differentiation between regional populations (~24%, $p < 0.001$). Similarly, a significant proportion of the variation could also be attributed to differentiation between local sub-populations (~13%, $p < 0.001$). At the regional level all pairwise FST and RST comparisons were significant (mean FST = 0.25; mean RST = 0.25 $p<0.001$ in all pairwise comparisons).

More recent research by Row and Lougheed (2007) indicates that there is much more genetic population structure in the Essex-Kent region than in Haldimand-Norfolk. In brief, Row and Lougheed (2007) genotyped ~250 individuals for ~10 microsatellite loci and estimated the number of genetic populations across southwest Ontario using a program that combines genotypic data and geographic locations. Both ecological and genetic data indicated significant fragmentation of habitat and populations at a fine scale. Overall, there were five Bayesian clusters or "populations", four in Essex-Kent and one in Haldiman-Norfolk. There was no evidence of recent gene flow among any of these populations. Although, the data indicated less fragmentation in Haldiman-Norfolk, there were fewer samples and more work needs to be done to verify this result (Row and Lougheed, 2007).

Designatable units

Eastern Foxsnakes occupy two Faunal Provinces: Carolinian (Essex-Kent populations and Haldimand-Norfolk populations) and Great Lakes/St. Lawrence (Georgian Bay Coast populations). There are large genetic differences among the three regional populations (Row and Lougheed, 2006, 2007, Jeff Row, e-mail communication Feb 10, 2008). However, mtDNA indicates that the separation was not pre-glacial (Corey *et al.*, 2005). Two DUs (Great Lakes/St. Lawrence (Georgian Bay Coast population) and Carolinian) are justified according to the following points;

Discreteness

1. There are significant genetic differences (DNA microsatellies) between the Georgian Bay Coast populations and those of Essex-Kent or Haldimand-Norfolk
2. There is no gene flow between Georgian Bay Coast populations and the other regions nor is there likely to be in the future.
3. Although there are no known morphological differences between the two regions, there are large behavioural differences (see Biology section). These may be expressions of phenotypic plasticity, but they also could represent adaptive genetic variation.
4. The Georgian Bay Coast populations occupy a clearly disjunct and separate Faunal Province from the other two regional populations (Essex-Kent and Haldimand-Norfolk). This separation has likely been longstanding and movement between the two Faunal Provinces will not occur in the foreseeable future. Furthermore, this disjunction is likely to lead to evolution of different local adaptations if indeed it has not already done so.

Significance

1. Persistence of the two putative DUs is likely to lead to local adaptations given the distinct differences in ecological setting.
2. Loss of either DU would result in a large gap in the range of the foxsnake in Canada.
3. It can be asserted that the Great Lakes/St. Lawrence populations represent a unique natural occurrence of this species globally given this DUs unique habitat and behaviour/ecology.

DISTRIBUTION

Global range

Foxsnakes are thought to have extended their range eastward along a post-Wisconsin glaciation prairie (steppe) corridor during the warm, arid Xerothermic period approximately 4000–6000 years ago (Schmidt 1938, Conant 1940, Smith 1957). According to Schmidt (1938) the foxsnake is a mid-western endemic, either restricted to, or centred in, the steppe peninsula and not widely distributed toward the southwest. This distribution has been interpreted as a postglacial spread, favoured by the impoverishment of the fauna of the coniferous forest during the glacial retreat (Schmidt 1938). Subsequent invasion of the prairie peninsula by forest resulted in the species being separated into two allopatric groups of populations (Schmidt 1938, Conant 1940, Smith 1957). The Eastern Foxsnake survived as a Xerothermic relict along portions of the Lake Huron-Lake Erie waterway (Schmidt 1938, Conant 1940, Smith 1957).

Elaphe gloydi is found in Ontario, southeastern Michigan, and northern Ohio, USA (Figure 1). In Michigan, Eastern Foxsnakes are reported in Iosco, Macomb, Monroe, Saginaw, St. Clair, and Wayne Counties, and in Ohio they are reported to occur in Erie, Lucas, Ottawa, and Sandusky Counties (NatureServe 2006). Records of Eastern Foxsnakes in Wood County, Ohio were reported by Conant (1938); however, recent data suggest that the species no longer persists there (Harding, 1997).

Canadian range

The Eastern Foxsnake's Canadian range lies entirely within Ontario. Much of the insight into the distribution of *E. gloydi* in Ontario is made possible by the observation records compiled and organized by the Ontario Herpetofaunal Summary (OHS; Oldham and Weller 2000) maintained by Ontario's Natural Heritage Information Centre (NHIC). Refinements to the species' distribution were informed by focal studies recently conducted at several locations in Ontario, through discussions amongst members of the Eastern Foxsnake/Eastern Hognosed Snake recovery team, and increased scrutiny of observation records by (Doucette 2005) and (Willson and Rouse 2006).

Within Ontario, the species' distribution is highly disjunct, occupying three discrete regions (hereafter regional populations) along the Lake Erie-Lake Huron waterway shoreline, including tributaries, and several islands in Lake Erie, Detroit River-Lake St. Clair, and the 30,000 islands of Georgian Bay. The three regional populations from south to north are (1) Essex-Kent, (2) Haldimand-Norfolk, and (3) Georgian Bay Coast (Figures 2, 3). The Extent of Occurrence, calculated as a single Minimum Convex Polygon encompassing all NHIC records is 68,505 km^2.

Figure 1. Eastern Foxsnake (*Elaphe gloydi*) distribution in North America

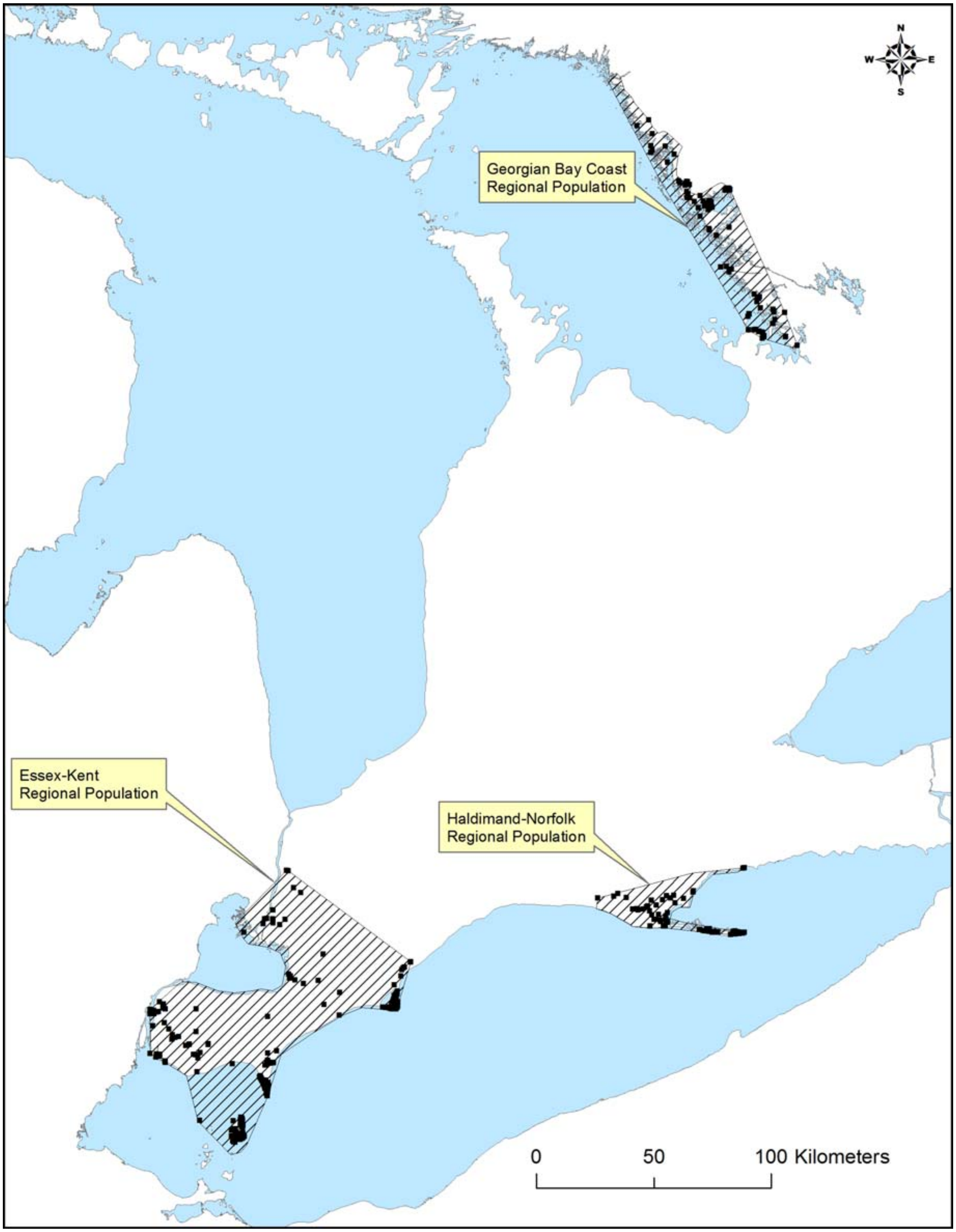

Figure 2. Eastern Foxsnake (*Elaphe gloydi*) distribution in Ontario, Canada

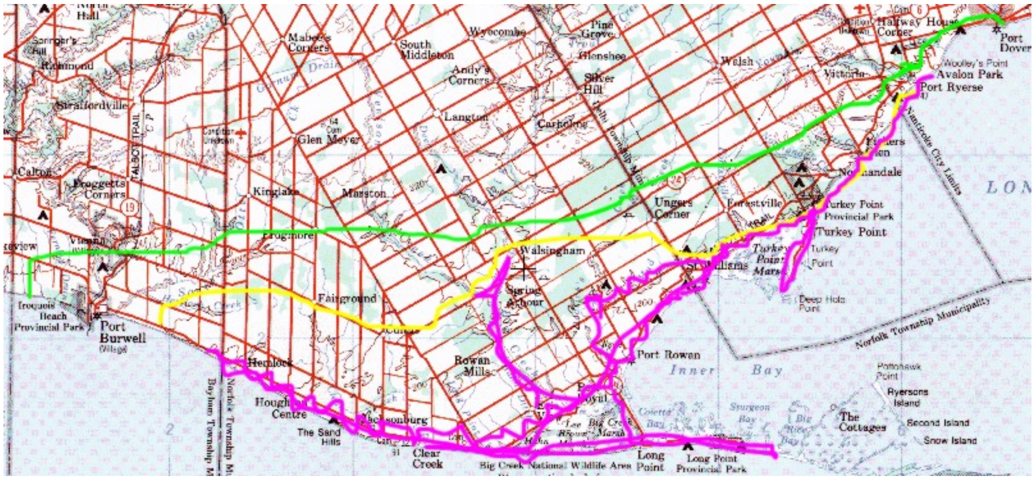

Figure 3. Eastern Foxsnake (*Elaphe gloydi*) observations in Haldimand-Norfolk region showing the northern limit of observations (green line), 5 snakes observed per year (yellow line), zones of most frequent reports usually ending with death of observed foxsnake) (purple line). Map courtesy of M. Gartshore.

The northernmost reliable record of *E. gloydi* comes from a small unnamed island in Georgian Bay, approximately 50 km northwest of Pointe au Baril, Ontario (recorded 17 June 1982; Mills *et al.* 1983). The farthest west that Eastern Foxsnakes are found in Ontario is Fighting Island in the Detroit River, whereas the tip of the Long Point sandspit, probably represents the species' easternmost extent. *Elaphe gloydi* has been reported from Canada's southernmost point, Middle Island, within the Lake Erie archipelago; however, recent snake surveys (2001–2006) of that island have failed to find foxsnakes (D. Jacobs and Pt Pelee NP unpublished data). The small size of the island (23-ha) may preclude establishment of a resident, self-sustaining population; instead, occasional migrants from Pelee Island (the "Fish Point" sandspit is only 5 km to the north) may result in the periodic observation of foxsnakes on Middle Island.

The Georgian Bay coast regional population occurs within the Ontario Shield Ecozone (Great Lakes/St. Lawrence Forest Region). As illustrated in Figures 2 and 4, the species' distribution in this region is tightly coupled to the shoreline of Georgian Bay. In fact, except for the southernmost extent of the foxsnake's distribution in this region, the species occurs predominantly within a 1-km band of the shoreline (mainland and islands). The southern extent of the Georgian Bay Coast population is ≈225 km from the bounds of the central population, Haldimand-Norfolk.

The other two regional populations occur in the Mixedwood Plains Ecozone (Deciduous Forest Region) of SW Ontario. Despite this commonality, their closest extents are ≈88 km apart (Figures 2, 5). The gap between these two populations is seemingly real because it is unlikely to be the result of inadequate search coverage in that area—particularly because there is no shortage of roads close to the shoreline of Lake Erie (Figures 3, 4, 6). Furthermore, although small, isolated populations could exist within this distribution gap, it is highly unlikely that they would be numerous enough to function as a continuous band. Therefore, treating the Haldimand-Norfolk and Essex-Kent populations separately seems prudent. Within the Essex-Kent regional population, further subdivision and delineation of sites or populations may be beneficial because of the considerable barriers to movement (e.g., roads) that almost certainly prevent movement of individuals between populations in some cases (See also Genetics section). Regardless of whether all the sites are completely isolated from their nearest neighbour, their tentative delineation is simply helpful to visualize the current state of knowledge and possibly to define conservation or management units. Despite its grouping with the Essex-Kent regional population, the foxsnake populations of the Walpole Island wetland complex are technically within the bounds of Lambton County.

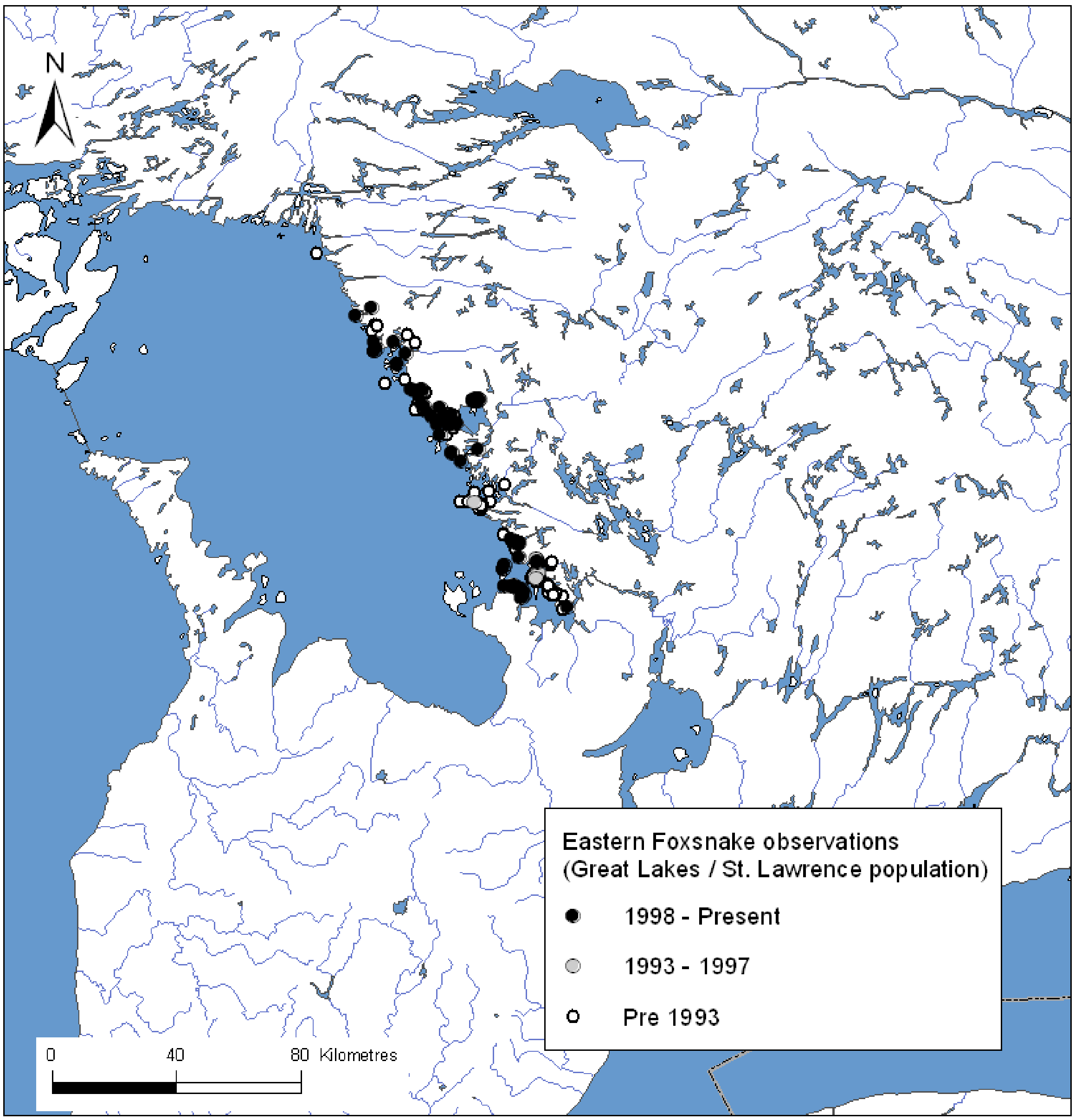

Figure 4. Locations (NHIC see text) of Eastern Foxsnakes in the Great Lakes/St. Lawrence populations showing those recorded from 1998-present (black dots), those recorded from 1995-present (black + gray dots) and those recorded from 1984-present (all dots).

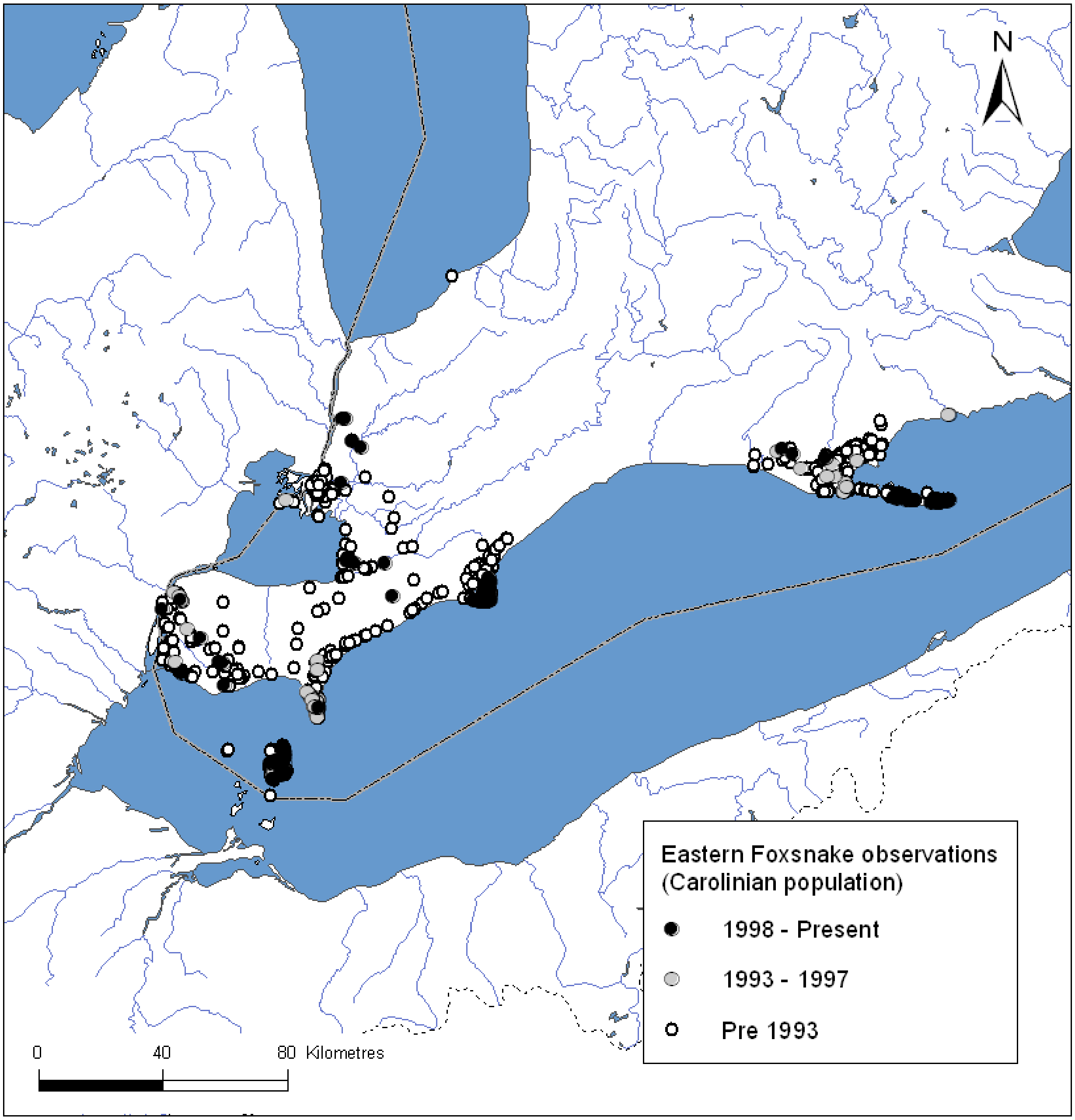

Figure 5. Locations (NHIC-see text) of Eastern Foxsnakes in the Carolinian Faunal Province showing those recorded from 1998-present (black dots), those from 1993-present (grey +black dots), and those from 1984-present (all dots). (Further details are in Technical Summary.)

Although historic records from the southwestern shoreline of Lake Ontario exist (i.e., Hamilton-Wentworth and Niagara Regional municipalities), Lamond (1994) concluded that the records were likely sightings and/or captures of released or escaped individuals. The lack of evidence suggesting viable populations in that area since 1994 supports that assertion. Several other Ontario records from northern Lambton, Middlesex, Huron, and Bruce Counties are suspect, and are possibly released/escaped captives, but more probably, are inaccurate identifications of Milksnakes (*Lampropeltis* *triangulum*) as Eastern Foxsnakes. Milksnakes are often mistaken as foxsnakes and vice versa, but the former is more widespread and common. For example, most reports of foxsnakes from Middlesex, including some with photographs, have been confirmed to be milksnakes (S Gillingwater, pers. comm.). Interestingly, specimens deemed to be of local origin were apparently collected from southern Bruce County in the early 1900s (Logier and Toner 1961).

Areas of Occupancy of the two DUs were calculated as follows. Observational records were available from the past 50+ years, but there were few before 1984, the year the Ontario Herpetofaunal Survey was begun in 1984. Therefore, only records from 1984 to the present were used. All NHIC records from 1984 onward were scrutinized and retained or rejected according to utility (some were rejected because location could not be verified or there were errors in identification, location etc.) (Wilson and Rouse 2006).On inspection, it was clear that many of the older records were no longer viable, particularly in the Carolinian populations, because habitat had been destroyed. Therefore, for the Carolinian populations, it was decided that the data would be considered on a temporal basis such that AO would be calculated every 5 years (roughly the generation length of this species). These dates were 1984, 1988, 1993, and 1998. For the Great Lakes/St. Lawrence populations, the AO was only calculated for all observations from 1984, and 1998, onward. The 1998 value was considered the current AO. In all cases, the AO was calculated as the sum of a 2x2km^2 grid overlain on all locations. As a result, the AO of the Carolinian region was 188km^2 and, by remarkable coincidence, the AO of the Great Lakes/St. Lawrence was also 188km^2. (See Technical Summaries for all computed values.) It is of interest that the AO values declined from 1984 to 1998, especially in the Carolinian region, indicating that both DUs are declining (see Figure 4, 5).

HABITAT

Habitat requirements

Traditionally, the Eastern Foxsnake has been considered a snake closely tied to the marsh ecosystems of Lakes Erie and Huron. However, as demonstrated by several extant populations in Ontario, marshland habitat is not required for persistence, at least not in the short term for SW Ontario populations, and not at all for the Georgian Bay Coast regional population (see below). Although there are similarities among the three regional populations, in terms of habitats used, the differences can be examined more effectively by discussing them separately.

Essex-Kent

Surveys (Rivard 1976, Freedman and Catling 1978, Willson 2002), focal telemetry studies (Watson 1994, M'Closkey *et al.* 1995, Brooks *et al.* 2000, Willson 2000), and general species observations (e.g., OHS, naturalist's observations) suggest that foxsnakes throughout most of the Essex-Kent regional population use mainly unforested, early successional (old field, prairie, marsh, dune-shoreline) habitat during the active season. Hedgerows bordering farm fields and riparian zones along drainage canals are regularly used. In some areas of intensive farming, these linear habitat strips likely make up the bulk of habitat available to foxsnakes.

Examination of the OHS records in Essex County shows that foxsnakes are found considerable distances from the Great Lake's shoreline—and superficially at least, from marsh or other wetland habitats. However, a closer examination of the species' distribution, taking into account historical land changes, reveals that many of the locations where foxsnakes occur are either currently associated with wetland habitat features (e.g., Hillman Marsh, Pt Pelee National Park), or were likely associated with more extensive wetland features in the recent past. Essex County, as described in Habitat Trends, has experienced drastic reductions in wetland cover over the last 100 years: the "Black Swamp" wetlands formerly extended a considerable distance from the Lake Erie shoreline. Additionally, the majority of the populations (as best as can be determined with the OHS records) that are seemingly extant are actually situated within, or close to, the presumed drainage basins of several of the county's watersheds (e.g., Big Creek, Cedar Creek, Turkey Creek, Canard River). Finally, within many of these watersheds, drainage features (e.g., ditches, drains) that retain wetland characteristics are still present. Therefore, it is likely that the dryer areas where foxsnakes persist have either retained remnant wetland features, or were formerly wet, and this suggests that wetland attributes were at least important to the initial colonization of these areas by foxsnakes.

For snakes inhabiting northern latitudes, the three most important microhabitat features, in order of importance, are (1) hibernation sites, (2) oviposition and/or gestation sites, and (3) basking-shelter sites (e.g., features that promote ecdysis, digestion). Foxsnakes in this region have been found to hibernate in a variety of both natural and anthropogenic features including limestone bedrock fissures, small mammal burrows (e.g., muskrat (*Ondatra zibethicus*) and possibly eastern mole (*Scalopus aquaticus*); T. Linke pers. obs.), bases of utility poles, canals, wells, cisterns, and building foundations. Many of the hibernacula are used by multiple individuals and species. The largest documented site harboured 33 *E. gloydi*, 22 Northern Watersnakes, and 84 Eastern Gartersnakes (*Thamnophis sirtalis*) (Watson 1994, M'Closkey *et al.* 1995). Yet, single occupancy of hibernacula was noted on Pelee Island (Brooks *et al.* 2000) and in Point Pelee (M'Closkey *et al.* 1995).

On Pelee Island, sites used for oviposition included rotting cavities within downed trees; decaying leaf, woodchip, and herbaceous vegetation piles; rodent burrows excavated in loamy soil at roadside edges, and hay piles (Porchuk and Brooks 1995, Brooks *et al.* 2000, Willson and Brooks 2006).

Frequently used basking and shelter sites usually have thermal properties (e.g., ideal solar exposure) that permit foxsnakes to maintain body temperatures near the upper end of their preferred range, but at the same time provide protection from predators. Brush piles, table rocks, tree stumps, root systems of downed trees, driftwood, and combinations of these features provide this functionality. Foxsnakes are also often found in, or under, old pieces of tin, wooden planks, abandoned vehicles, car hoods and parts, asphalt, masonry, etc. (Rivard 1976, 1979; Catling and Freedman 1980; Watson 1994; M'Closkey *et al.* 1995; R. Willson unpubl. data).

Clearly, foxsnakes are somewhat adept at using anthropogenic structures for hibernation, oviposition, and shelter. The use of natural versus anthropogenic microhabitat features seems to vary depending upon the level of landscape modification and, presumably, the availability of natural sites. For example, 12 of 14 foxsnakes radiotracked to hibernacula on Pelee Island used natural limestone fissures (R. Willson unpubl. data), whereas 6 of 10 *E. gloydi* radiotracked in Point Pelee used hibernacula that were clearly associated with anthropogenic habitat structure (e.g., wells and canals; Watson 1994, M'Closkey *et al.* 1995).

Haldimand-Norfolk

The landform-vegetation types available (e.g., beach-dune, extensive marsh) within the foxsnake's distribution in the Haldimand-Norfolk region, as well as the areas where foxsnakes are regularly encountered by researchers and naturalists, suggests that habitat usage and requirements within this regional population are generally similar to those of Essex-Kent. Habitat types at Long Point and Big Creek Marsh are similar to those used by foxsnakes at Rondeau Provincial Park and Point Pelee. Many sightings in this region are close to Big Creek suggesting that Big Creek is a corridor for the species to move into surrounding slough-swamp-forests (S. Gillingwater pers.comm.) (see Figure 3). However, the extensive dune-slough complex along Long Point is somewhat unique amongst sites where foxsnakes occur in southern Ontario (S. Gillingwater pers. comm.). At this site, large dunes, along with a mosaic of ponds, sloughs, and marsh combine with mixed Carolinian forest to provide a varied habitat for this species. Hedgerows and riparian zone vegetation are also likely used by foxsnakes in this region.

Intensive telemetry-based studies have not been conducted at sites within this region; thus, knowledge of hibernacula is limited to a few locations. Two snakes radiotracked in 1993 hibernated separately in abandoned mammal burrows (M. Gartshore *et al.* unpubl. data). Whereas these hibernation sites did not appear to be communal, multiple foxsnakes have been observed hibernating in the basement foundation of a house that is currently occupied by humans (S. Gillingwater *et al.* pers. obs).

Oviposition sites are likely similar to those used in Essex-Kent, as downed Cottonwoods (*Populus deltoides*) similar to those used on Pelee Island are common (R. Willson pers. obs.), and the agricultural environment would provide for ample composting-type sites (e.g., decaying leaf and woodchip piles). Several nests have been discovered under rotting wood on the beaches of Long Point and along the edges of dune blow-outs where eggs are laid along or within the root systems of dune grasses (S. Gillingwater pers. obs.). At Rondeau, eggs have been found under driftwood, as well as partially buried in sand under the large leaves of broad-leafed plants along the margin of beach and wetland sites (S. Gillingwater pers. obs.).

Basking-shelter sites are likely similar to those used in Essex-Kent given the similar landform-vegetation types and climatic conditions. Juniper shrubs are often used as shelter by foxsnakes in the Long Point area (S.Gillingwater, pers.comm.).

Georgian Bay Coast

For the most part, the landscape inhabited by Eastern Foxsnakes along the Georgian Bay Coast is considerably different from the areas where they are found in SW Ontario. Open rock barrens with intermittent trees and shrubs such as white pine (*Pinus strobus*) and common juniper (*Juniperus communis*) dominate the shoreline of the mainland coast and the numerous islands. Lawson (2005) and MacKinnon (2005) found that foxsnakes use a variety of open habitats (e.g., rock barren, coastal meadow marsh) along the coast for foraging, thermoregulating, and mating. Individuals did not move very far into, nor did they spend a lot of time in, forested habitats. The two most striking results of these investigations were the high affinity Eastern Foxsnakes showed for the shoreline (e.g., 95% of all radiolocations obtained from individuals at their Killbear study site and at their Honey Harbour-Port Severn study site were within 149 m and 94 m of the shoreline respectively: MacKinnon 2005), and the degree to which most individuals used water as the primary medium for locomotion. Indeed, rather than inhibit the movement of this snake which heretofore had been considered terrestrial, water seemed to greatly facilitate and possibly promote movement. For example, radiotagged individuals readily swam considerable distances, up to 10 km, in open water to rocky offshore islands (MacKinnon 2005, Lawson 2005). At least one Eastern Foxsnake population within the Georgian Bay Coast regional population diverges somewhat from the pattern of habitat use described thus far. This population is centred on a regionally rare limestone formation and is at the southernmost extent of the species' Georgian Bay distribution. Interestingly, individuals radiotracked from this area occupy an agricultural landscape wherein old field habitats reminiscent of the SW Ontario landscape are used in addition to anthropogenic microhabitats around farmsteads (MacKinnon 2005).

Lawson (2005) and MacKinnon (2005) found that the majority of foxsnakes in the Georgian Bay Coast region hibernate in granite or limestone fissures in the bedrock. At least nine hibernacula were documented in the Killbear study area and three were documented in the Honey Harbour-Port Severn study area. All of the hibernacula located thus far have been within 100 m of the waters of Georgian Bay except one: the hibernaculum located within the limestone outlier was ≈900 m from the closest point of Georgian Bay. Furthermore, potential hibernation habitat within this landform exists up to 960 m from the waters of Georgian Bay. Use of communal hibernacula would seem to be more common in the Georgian Bay region, as would the average and maximum number of foxsnakes hibernating at a site. This finding accords well with the predicted pattern of communal hibernacula use in temperate-zone snakes; that is, increasing communalism at these sites as latitude increases (Gregory 1982).

Documented oviposition sites along the Georgian Bay coast include rock crevices and composting vegetation piles (MacKinnon 2005, Lawson 2005). Whereas compost piles are similarly used as oviposition sites in SW Ontario, oviposition in rock crevices appears to be unique to this region.

Not surprisingly, basking-shelter sites along the Georgian Bay coast are predominantly rock-based: either table rocks with suitable rock-substrate gaps, or fissures in the bedrock that provide analogous structure (e.g., overlying rock of a thickness that promotes temperature regimes preferred by the snakes). Brush piles, root systems of living and downed trees, and common junipers also provide basking-shelter sites.

Habitat trends

The current distribution of marshland along the lower Great Lakes is a minor remnant of the previous extent of this habitat type. Greater than 90% of the original wetlands (possibly greater than 95% in Essex County and the municipality of Chatham-Kent) have been converted to other uses—primarily drained for agriculture and waste disposal (Snell 1987). Some of these changes have occurred relatively recently. For example, although 95% of the original wetlands present in Essex County in the early 1800s had been lost by 1967, a further loss of 15.8% of the remaining 5% occurred between 1967 and 1982 (Snell 1987). Further wetland loss of this scale is not likely to occur in SW Ontario given the limited occurrence of remaining wetlands, and the focus of conservation authorities on natural watershed preservation and enhancement.

The agricultural landscape that replaced the vast network of wetlands in SW Ontario was almost certainly lesser quality habitat for the Eastern Foxsnake. Yet, because of the relatively low human density in those rural environments, as well as the vestiges of natural features occasionally left by farmers (e.g., hedgerows, small fields and woodlots), the Eastern Foxsnake has persisted in several highly modified (by agriculture) areas (Figure 6). However, ongoing removal of these features, in some areas, to facilitate larger cropped fields or residential developments may lead to further disappearance of these remnant populations.

In the Georgian Bay Coast, a similar situation exists in the Port Severn area where low intensity agriculture and low density residences are being replaced with high density developments (MacKinnon *et al.* 2005) and this area is growing faster than any other in Ontario (Watters, 2003). More important, because the foxsnake is largely confined to habitats < 100m from the Georgian Bay shoreline, its habitat throughout the region is succumbing to cottage and other recreational development (See Figure 7, for example).

Within protected areas, the loss of important microhabitats occurs when erosion and flood control structures along shorelines eliminate natural treefall, an important source of oviposition and shelter sites. Outside of protected areas, loss of important microhabitats along shorelines occurs with steady frequency as the majority of lots are “cleaned up”: i.e., downed trees, woody debris, and native herbaceous vegetation is removed. Although the destruction of these potentially important microhabitats is strongly discouraged by responsible ecological consultants (e.g., in site plans that restrict the ways a property can be modified), many landowners have a sense of entitlement that trumps environmental concerns and enforcement of site plan agreements is currently lacking.

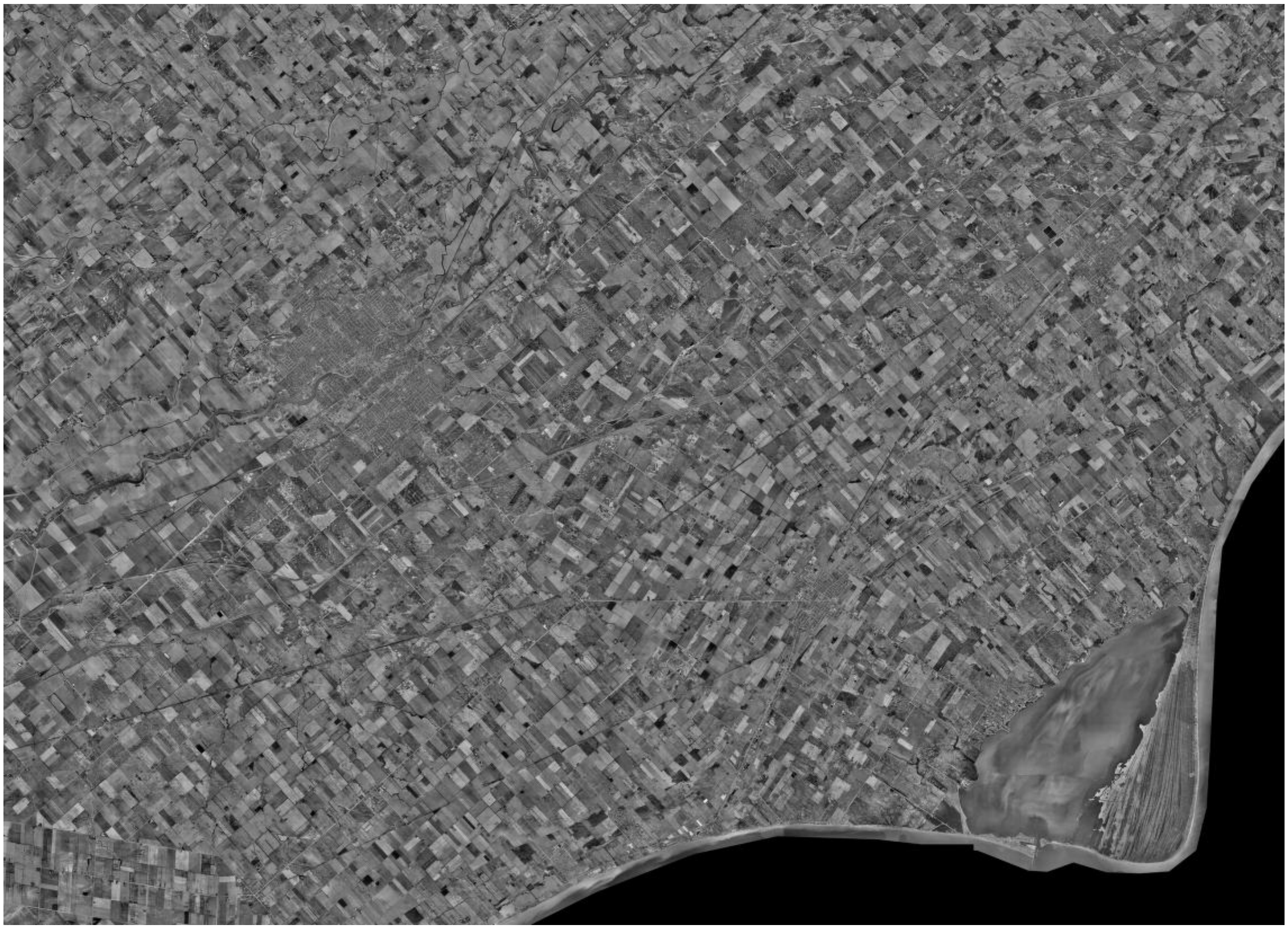

Figure 6. Area surrounding Rondeau Provincial Park (peninsula on extreme lower right) showing the park's isolation by agriculture and housing and how close these activities are to the park and Lake Erie shoreline. Dark colour on bottom right is Lake Erie). Photo courtesy of S. Gillingwater

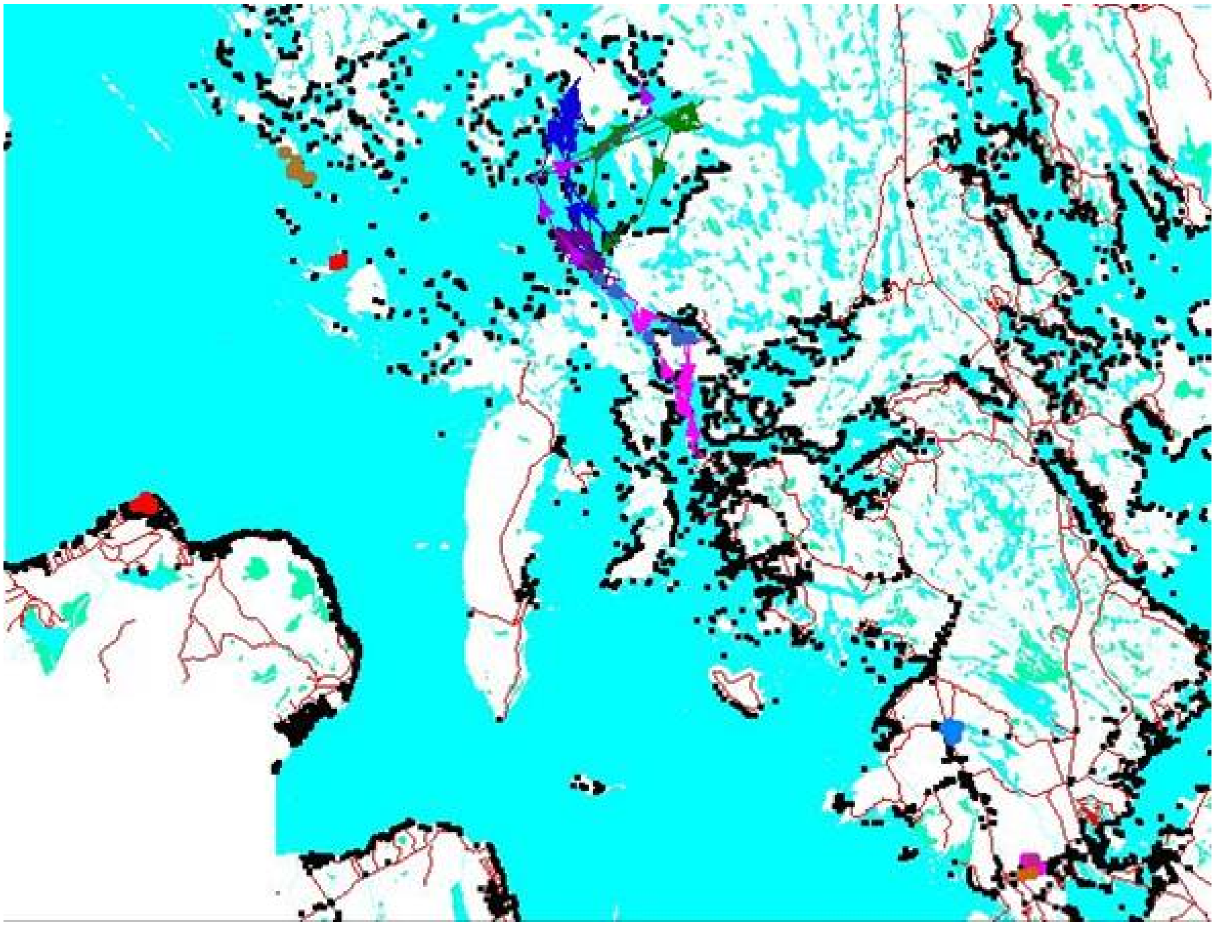

Figure 7. Cottage development in southern Georgian Bay in the southern part of the range of the Eastern Foxsnake on the Georgian Bay Coast. Black dots are cottages/buildings and turquoise is water. Purple and dark blue are ranges of radiotracked Eastern Foxsnakes. Map courtesy of C. MacKinnon.

Habitat protection/ownership

Measures to protect the habitat of the Eastern Foxsnake are in place for both public and private lands, although it must be noted that Critical Habitat for the Eastern Foxsnake has not yet been identified under SARA. Eastern Foxsnakes are known to occur in two National Parks (Point Pelee and Georgian Bay Islands; hereafter GBI), several Provincial Parks, and several National Wildlife Areas (e.g., Long Point, Big Creek, St. Clair) and conservation areas (e.g., Hillman Marsh). Protection of important habitat (micro and macro) within the two national parks should be strong because of measures in both the *Canada National Parks Act* (2000) and the federal *Species at Risk Act* (SARA) (2002): specific to SARA, “residence” habitat features and “critical habitat” are to be protected on federal lands (see http://laws.justice.gc.ca/en/showtdm/cs/S-15.3). Although the area encompassed by the two national parks is small relative to the species’ area of occupancy, both parks engage in efforts to expand protection to the greater park ecosystem outside of their boundaries (e.g., land stewardship agreements). The provincial *Planning Act* also provides protection for those wetlands that are deemed provincially significant and threatened by planning applications. Ultimately, however, although much is being done to protect habitat, this protection occurs at the scale of the fragments which are themselves under threat. The historic loss of connectivity and subsequent isolation of habitats and populations (Figure 6, 7 and 11) is not being addressed.

Within the Provincial Parks and Reserves where *E. gloydi* is found, the degree of habitat protection varies considerably, depending on both park classifications and management. Provincial Nature Reserves have the highest protection mandate and are relatively free from large-scale habitat disturbance. However, destruction of important microhabitats may occur due to unregulated use of motor vehicles (e.g., ATVs) and lack of enforcement. Provincial Parks with a "Recreation" designation provide the least protection of habitat because mandates for environmental protection are secondary to human use. Roads and trails in parks also contribute to mortality of snakes from both cars and bicycles. An example of conflicting land uses is the removal, for aesthetic reasons, of downed trees that could provide oviposition sites for foxsnakes.

Several conservation reserves along the Georgian Bay Coast harbour foxsnake populations. These reserves and Crown land in the region are managed by the Ontario Ministry of Natural Resources. Applications for development or potentially damaging activities on these lands require a comparatively rigorous environmental assessment.

On private lands, proposals or actions that invoke the *Planning Act* (e.g., lot severance, zoning change) set into motion a process whereby Ontario's Provincial Policy Statement (Ontario 2005) issued under Section 3 of the *Planning Act* is supposed to provide for the protection of habitat for species of concern. Section 2.1.2 states that *the diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features.* Section 2.1.3 states that *development and site alteration shall not be permitted in…significant habitat of endangered species and threatened species.* Section 2.1.4 states that *development and site alternation shall not be permitted in…significant wildlife habitat … unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions.* Section 2.1.6 states that *development and site alteration shall not be permitted on adjacent lands to the natural heritage features and areas, unless the ecological function of the adjacent lands has been evaluated and it has been demonstrated that there will be no negative impacts on the natural features or on their ecological functions.*

When triggered and properly implemented, the habitat protection measures of the PPS can provide for effective protection of important habitat for endangered and threatened species. Additionally, many site alterations detrimental to habitat do not invoke the *Planning Act* (e.g., road building on private land), and thus no evaluation of potential impacts is required. Moreover, many municipalities do not have site alteration by-laws thereby limiting the effectiveness of the ppS. Encouragingly, an updated *Endangered Species Act* (Ontario 2007) that mandates protection of habitat for both endangered and threatened species received Royal Assent 17 May 07. The habitat protection measures within the act are seemingly robust, and should be more effective than either the PPS or the previous *Endangered Species Act*.

BIOLOGY

Life cycle and reproduction

In general, egress from hibernation occurs from mid-April to mid-May, mating occurs from late May to mid-June, and oviposition occurs from late June to mid-July. Ingress to hibernacula occurs in September and October.

The most detailed observations of mating behaviour were made during recent telemetry studies in Georgian Bay (MacKinnon 2005, Lawson 2005). Briefly, the researchers were able to observe numerous mating events wherein males were observed chasing, mounting (i.e., biting and/or grasping of the neck), and copulating with females (Figure 8). Both males and females mated with multiple partners, males engaged in combat and mate defence, and there was a male-biased size dimorphism. Gestation periods probably range from 30–50 days depending on environmental conditions, and the amount of time a female is able to allocate to thermoregulation (Willson and Brooks 2006). Within the 1–4 days spent sequestered at their oviposition site (R. Willson, A. Lawson, C. MacKinnon pers. obs.), females lay 6–29 white, flexible-shelled eggs (Ernst and Barbour 1989; R. Willson unpubl. data). Communal oviposition has been documented in all three regional populations and heterospecific communal clutches have been found on Pelee Island (Porchuk and Brooks 1995). Incubation periods range from 50 to 65 days (Harding 1997) and hatchlings emerge from late August to mid-October.

Figure 8. A pair of copulating foxsnakes on a bed of pine needles on the coast of Georgian Bay. Photo by C. MacKinnon.

Predation

Natural predators of adult Eastern Foxsnakes include the larger birds of prey (e.g., Red-tailed Hawk (*Buteo jamaicensis*)*,* Great Horned Owl (*Bubo virginianus*)) and carnivorous mammals such as raccoon (*Procyon lotor*), skunk (*Mephitis mephitis*), and mustelids (e.g., fisher (*Martes pennanti*) and mink (*Mustela vison*)). Hibernating foxsnakes were excavated from one of the few soil-based hibernacula in Georgian Bay by mammal(s) during the 2003–2004 winter (Lawson 2004). Remains of Eastern Foxsnakes have also been found in fox (*Vulpes vulpes* or *Urocyon cinereoargenteus*) bedding areas on Pelee Island (Porchuk pers. obs.). Feral and free-ranging house cats (*Felis cattus*) and dogs (*Canis familiaris*) are known to prey upon adult and juvenile foxsnakes.

The eggs and young are likely vulnerable to a wider variety of avian and mammalian predators. Juveniles are likely eaten by herons and egrets (Ardeidae) and gulls (Laridae). For example, a juvenile approximately 34 cm in length was observed being attacked by a gull in Point Pelee National Park; although the individual was able to thwart the predation attempt by striking repeatedly (Kraus 1991). Foxsnake nests have been preyed upon by racoons (Porchuk and Brooks 1995, S. Gillingwater pers. obs.) and coyotes (*Canis latrans*) (S. Gillingwater pers. obs.). Skunk, fox, and Virginia opossum (*Didelphis virginiana*) may also prey on nests. Similar to the accounts of nest parasitism by the burying beetle (*Nicrophorus pustulatus*) on Gray (Eastern) Ratsnake eggs reported by Blouin-Demers and Weatherhead (2000), *E. gloydi* eggs are also preyed upon by this insect (Willson 2000).

Physiology

As ectotherms, Eastern Foxsnakes are constrained by the thermal characteristics of their local environment. Key temperature-dependent processes that have been examined in Eastern Foxsnakes include thermoregulation by gravid females immediately prior to oviposition (Willson and Brooks 2006) and body temperature fluctuations in individuals swimming in cold water (MacKinnon *et al.* 2006). Willson and Brooks (2006) found that gravid females did not maintain higher or less variable body temperatures than nongravid females in a thermally favourable environment on Pelee Island. MacKinnon *et al.* (2006) documented 49 radiotagged foxsnakes swimming 313 times in 2003 and 2004 (Figure 9). For 11 of these swimming events they were able to continuously record the body temperatures of the snakes as they entered water as cold as 11°C. The maximum body temperature decrease during one of these cold water swims was 22.6°C (over 11 min) as the snake cooled to 13°C. Given the influence of body temperature on speed of locomotion, and hence presumably on predation risk, it is curious that foxsnakes would enter the cold waters of Georgian Bay to relocate so often—obviously the benefits of moving between land-based features outweigh the risks of moving in water (MacKinnon *et al.* 2006).

Figure 9. An adult Eastern Foxsnake swimming between islands in Georgian Bay. Photo by A. Lawson.

Dispersal/migration

Because the hibernaculum is crucial to the survival of snakes inhabiting temperate latitudes, and Eastern Foxsnakes show a high degree of fidelity to these sites, distance-based metrics that incorporate this microhabitat feature will be the measures of spatial dispersion most relevant to conservation efforts. When an individual's hibernaculum cannot be located, range length—or the maximum linear dispersion amongst a group of observations (i.e., radiolocations or opportunistic observations)—will be the next most useful metric to compute. Moreover, a comparison of both metrics provides a useful gauge of hibernacula location relative to the active season range. Maximum distance from hibernacula (MDH) and range length (RL) values for 5 females radiotracked for full active seasons on Pelee Island were $\bar{x}$ = 930 ± 80.7 m SE (MDH range: 660–1080 m) and $\bar{x}$ = 1186 ± 131.3 m SE (RL range: 849–1527 m) respectively (R. Willson unpubl. data). In marked contrast, MDH and RL values computed for females radiotracked for full active seasons on the Georgian Bay coast were $\bar{x}$ = 3229 ± 568.1 m SE (MDH range = 836–6253 m; n = 9) and $\bar{x}$ = 3593 ± 618.5 m SE (RL range = 879–6738 m; n = 9) respectively (MacKinnon *et al.* 2005, Lawson 2005). These values amply demonstrate that foxsnakes along the Georgian Bay coast use far more space than foxsnakes on Pelee Island. Only female values are compared here because males were not radiotracked on Pelee Island and intersexual differences in space use are common in snakes. Values for male foxsnakes in Georgian Bay were $\bar{x}$ = 3820 ± 642.4 m SE (MDH range = 1151–9178 m; n = 13) and $\bar{x}$ = 4624 ± 871.4 m SE (RL range = 1421–11365 m; n = 13) respectively (MacKinnon *et al.* 2005, Lawson 2005), and illustrate the magnitude of the spatial dispersion exhibited by the foxsnakes along the Georgian Bay coast. Interestingly, it is doubtful that individuals within any SW Ontario foxsnake population could use as much space as their Georgian Bay conspecifics because of habitat and landscape constraints. In particular, the density of roads within the Haldimand-Norfolk and Essex-Kent regional populations would necessitate numerous road crossings by an individual within a single active season—each road crossing increases the risk of mortality. Also, the island-water mosaic inhabited by the Georgian Bay snakes would presumably be more conducive to movement (assuming terrestrial locomotion is energetically more costly for snakes than aquatic locomotion) than would the largely terrestrial landscape inhabited by the southern populations.

Interspecific interactions

Small mammals and birds make up the bulk of the Eastern Foxsnake's diet (Figure 10). Both active searching and ambush (sit-and-wait) foraging strategies are employed. Smaller prey items (e.g., neonatal mice, bird nestlings, and eggs) are simply seized and swallowed, whereas larger prey are killed by constriction (Harding 1997).

Small mammal prey includes meadow vole (*Microtus pennsylvanicus*), mice (*Peromyscus spp.*), eastern chipmunk (*Tamias striatus*) and young eastern cottontail (*Sylvilagus floridanus*). Eastern Foxsnakes will readily forage in shrubbery, trees, and barns for birds' eggs and nestlings. Adult birds are also taken. Eastern Foxsnakes have been observed feeding on Mallard (*Anas platyrhynchos*) eggs (B. Porchuk pers. obs. A. Lawson pers. obs.), Ruffed Grouse (*Bonasa umbellus*) eggs (C. MacKinnon pers. obs.), Yellow Warbler (*Dendroica petechia*) eggs and nestlings Wilson 1985), Common Grackle (*Quiscalus quiscula*) nestlings, and Mourning Dove (*Zenaida macroura*) eggs (R. Willson pers. obs.), Purple Martin (*Progne subis*) nestlings (I. Fisher pers. comm.), and American Robin (*Turdus migratorius*) eggs and nestlings (B. Porchuk pers. obs.). Frogs are also occasionally eaten (Johnson 1989), and Logier (1958) found a young specimen at Long Point that disgorged a bundle of earthworms and another individual from Go Home Bay that regurgitated a salamander. Upon palpation, a juvenile approximately 36 cm in length regurgitated two large slugs (2 g each) on Pelee Island (B. Porchuk pers. obs.).

Figure 10. An adult Eastern Foxsnake consuming duck eggs on the Georgian Bay Coast. Photo by A. Lawson.

Adaptability

Because much of *E. gloydi*'s distribution overlaps with areas heavily populated by humans, and the species inhabits areas that experience high levels of human use (e.g., shoreline), encounters are common. Fortunately, foxsnakes are able to adapt to limited anthropogenic disturbance, an example being their use of human-made structures for shelter during the summer despite high levels of human activity (e.g., when whole families are at the cottage). As previously mentioned, foxsnakes regularly use anthropogenic structures for hibernation and oviposition.

POPULATION SIZES AND TRENDS

Search effort

In 1972 and 1973, D. Rivard made 155 observations of *E. gloydi* at 14 localities along the Lake St. Clair-Lake Erie waterway during surveys to examine the distribution of the species in North America (Rivard 1976). Since that time, several researchers have conducted capture-recapture studies within Ontario: northeast of Amherstburg (Essex-Kent) (Freedman and Catling 1978), Point Pelee (Essex-Kent) (M'Closkey *et al.* 1995; T. Linke unpubl. data), GBI during the early 1980s (Georgian Bay Coast) (Parks Canada, unpubl. data), Pelee Island (Essex-Kent) (Brooks *et al.* 2000, Willson 2002), Killbear Provincial Park and surrounds (Georgian Bay Coast) (Chora *et al.* 2001, Lawson 2004, Paleczny *et al.* 2005), Awenda Provincial Park and surrounds (Georgian Bay Coast) (T. Tully, pers. comm., Coxon 2002), East Sister Island (Essex-Kent) (D. Jacobs unpubl. data), (Honey Harbour-Port Severn (Georgian Bay Coast) (MacKinnon 2005, Row and Lougheed 2006), and Point Pelee-Hillman Marsh (Essex-Kent) (Row and Lougheed 2007, ongoing). Surveys for foxsnakes have also been conducted within the Haldimand-Norfolk regional population by M. Gartshore *et al.* and most intensively and consistently by S. Gillingwater *et al.* These efforts, along with other observations compiled in the OHS database, form the basis of our current understanding of the Eastern Foxsnake's abundance in Ontario.

Abundance

Simple ground searches were carried out on Long Point from 1996-99 and again from 2003-04 (S. Gillingwater pers. comm.). The number of foxsnakes observed was consistent across years, but the search effort increased markedly over the years from about 20 person days in 1996 and 1997 to about 85 person days with a larger search area in 2003-2004. These results suggest a decline in population on Long Point. Similar sorts of surveys for both turtles and snakes in the Big Creek area (See Figure 3) indicate that few snakes occur east, west or north of Big Creek where there is intensive farming and land use (S. Gillingwater pers. comm.).

Despite the number of capture-recapture and survey studies conducted on Eastern Foxsnakes since Rivard's (1976) pioneering surveys in the early 1970s, reliable population estimates have been elusive. For example, although Freedman and Catling (1978) estimated a population size of 128 Eastern Foxsnakes at a 40-ha site in Amherstburg, Ontario, their estimate was based on 16 captures and only 1 recapture. Similarly, Rivard (1976) marked 135 individuals at Point Pelee but had a low recapture rate of 6.7%. Recapture numbers below a certain threshold are problematic because they invalidate most capture-recapture models. In response to low recapture rates with opportunistic sampling, and because of the need to acquire snakes early in the active season for telemetry studies, researchers at Point Pelee National Park (M'Closkey *et al.* 1995; T. Linke unpubl. data) and on Pelee Island (Porchuk 1996) encircled known hibernacula with perimeter-funnel traps. This methodology yielded substantially better foxsnake recapture rates at both sites. Unfortunately, just as the potential for sufficient data collection was being realized on Pelee Island, hostilities towards snakes became strong enough to make vandalism of hibernacula, made readily visible by perimeter fencing, likely (Willson 2002). Consequently, the trapping methodology was deemed too risky and only opportunistic sampling continued. However, based on these experiences, and also the success of researchers monitoring Gray (Eastern) Ratsnake hibernacula (e.g., Blouin-Demers *et al.* 2002), A. Lawson and C. MacKinnon attempted to trap foxsnakes hibernating at suspected sites in Georgian Bay (Brooks *et al.* 2003). Although some of the trapping efforts were successful, much of the terrain was not conducive to perimeter fence setup. Nevertheless, even at sites where trapping was not effective, the island-based hibernacula facilitated relatively thorough sampling—although sites where traps were ineffective required considerable persistence and commitment by the researchers. Consequently, A. Lawson was able to monitor several communal hibernacula and C. MacKinnon was able to thoroughly monitor a large hibernaculum from 2003–2005. Monitoring of this latter hibernaculum is continuing through a partnership between Parks Canada, Ontario Ministry of Natural Resources, and collaborating researchers (Row and Lougheed 2006), and offers the best chance to document demographic characteristics of a foxsnake hibernaculum.

For the most part, foxsnakes are easier to find in SW Ontario than they are along the Georgian Bay coast, and this is likely the result of several factors. First, anthropogenic refuse with favourable thermal and shelter properties for a foxsnake is far more common in SW Ontario. These shelter features are far easier to check (i.e., flip or lift) than table rocks along the Georgian Bay coast. Second, overall abundance of the species in the areas where it remains in SW Ontario is likely higher because of the decreasing reproductive output or success of oviparous snakes at increasing latitudes; specifically, clutches of eggs will hatch later in Georgian Bay than in SW Ontario. Third, the high spatial dispersion levels exhibited by individual foxsnakes in Georgian Bay—levels that are not possible in SW Ontario—will further decrease the species' density at any one site. Despite these factors, monitoring of Eastern Foxsnake population demographics may be more effective in the Georgian Bay region simply because the number of individuals attending any one hibernaculum is higher.

Fluctuations and trends

Froom (1972) speculated that Eastern Foxsnake numbers were rapidly declining, and an anecdotal survey of population trends in 1973 suggested that the majority of Ontario populations did indeed appear to be on the decline (Rivard 1976, Rivard 1979). Many naturalists and biologists believe that large snake species (e.g., Eastern Foxsnakes, Gray Ratsnakes, Eastern Hog-nosed Snakes, and Massasaugas) have significantly declined in southern Ontario in the last few decades. Although it is not possible to demonstrate a recent range contraction with data contained in the OHS, the putative decline of Eastern Foxsnake numbers in Ontario is undoubtedly real if loss of suitable habitat (e.g., the conversion of the vast majority of wetlands in Essex-Kent) and the high density of roads in southern Ontario can be shown to have a negative impact on foxsnake populations. Evidence for negative effects of the first factor, wetland habitat loss, comes from the less frequent observations of foxsnakes in areas completely devoid of wetland features, in comparison to the number of foxsnake observations in areas with marshland habitat (e.g., Point Pelee, Hillman Marsh). That these observation differences are not merely the result of differing sampling regimes (e.g., more researchers and naturalists looking for wildlife in natural areas) comes from the fact that despite the extensive road network covering all SW Ontario, snakes are reported more often on roads in or adjacent to natural areas such as Point Pelee and Rondeau. Indeed, consider that there are few areas in SW Ontario where foxsnake populations would not come into contact with roads using even the most conservative space use requirements documented for the species. In light of the extensiveness of this road network and the number of studies that have documented substantial foxsnake mortality on small stretches of road (e.g., Ashley and Robinson 1996, Brooks *et al.* 2000, MacKinnon *et al.* 2005, Farmer 2007), it logically follows that the number of foxsnakes that have been killed on roads in Ontario has been considerable. Although population-level effects were not demonstrated by these studies of road mortality, the regular loss of mature individuals from a population has been modelled for other reptiles and shown to result in population decline (Brooks *et al.* 1991, Garber and Burger 1995).

Rescue effect

The rescue effect is defined by COSEWIC as the “Immigration of gametes or individuals that have a high probability of reproducing successfully, such that extirpation or decline of a population, or some other Designatable Unit, can be mitigated. If the potential for rescue is high, the risk of extirpation may be reduced.”

Eastern Foxsnake populations on the Canadian islands of the Lake Erie Archipelago are within movement distance of foxsnake populations residing on American islands, and snakes may be able to cross from the USA to Ontario at the Detroit River and the north end of Lake St. Clair (to Walpole Island) (Figure 1). Although migration between islands is likely rare, the species definitely shows the capacity to move long distances over water. However, such rescue, if it ever occurs, would only provide some possible genetic benefit as the USA populations are also at risk and could not provide sufficient migrants for recruitment. Given the vast distances between the three regional populations in Ontario, interchange of individuals between them is not possible (Figure 2).

LIMITING FACTORS AND THREATS

The threats facing the Eastern Foxsnake in Ontario remain roughly the same as those identified in the previous status report: namely, habitat loss and degradation, road effects, inadvertent effects caused by human activities, and intentional persecution by humans. Studies conducted since the first report have helped clarify the relative importance of some of these threats and also expanded the list of potential threats.

Foxsnake habitat continues to be lost at varying rates throughout the species' range, as discussed in Habitat Trends, and this loss of wetlands, hedgerows, ditches, shoreline habitat, etc. almost certainly has negative consequences for local populations. Loss of key microhabitats, such as oviposition and hibernation sites, occurs when areas are cleared for development or when they lie in the path of recreational motor vehicles such as ATVs.

Inadvertent mortality caused by human activities

As described previously (see Adaptability), foxsnakes can function reasonably well in areas occupied by humans (e.g., farms and cottages); however, recent studies have revealed that negative impacts inadvertently caused by human activities may be substantial. The most commonly reported source of mortality is by vehicles on roads. Substantial levels of road mortality have been documented for this species in several regions where investigators have conducted road surveys: Long Point (Ashley and Robinson 1996); Pelee Island (Brooks *et al.* 2000, Willson 2002); Georgian Bay (MacKinnon *et al.* 2005); and Rondeau (S. Gillingwater and R. Brooks unpubl. data, Farmer 2007) and Point Pelee (Farmer 2007). In addition, the OHS contains a large number of roadkill records. Given the Eastern Foxsnake's relatively slow locomotion, large size, and tendency to become immobile when vehicles or persons approach, it is not surprising that roadkills represent a major source of mortality for this species. Construction of new roads, as well as changes in traffic flow (i.e. volume and/or speed, (Farmer, 2007), increase the probability that foxsnakes inhabiting an area will be killed on a road. In addition to the loss of individuals via direct mortality on roads, foxsnake populations are also likely impacted indirectly by ancillary road effects: namely, reduction of habitat quality, resource inaccessibility, and population fragmentation (See: Crowley, 2006, Kerr and Cihlar 2004, Hawbaker *et al.* 2006, and Figure 11 for further data, discussion and references on fragmenting effects of roads, even in a protected area). Off-road vehicles also cause foxsnake mortality and include ATVs, farm machinery, bicycles (R. Willson, S. Gillingwater pers. obs.), and motor boats.

A second source of mortality related to people comes from other species associated with anthropogenic activities. For example, domestic cats and dogs, inevitably associated with any residential development, are known to kill even the most formidable snakes (e.g., Whitaker and Shine 2000). Raccoons and skunks, species that potentially prey upon foxsnakes, have also been documented to increase in number when human occupancy of a site, including provincial and national parks (see Case Study below, Figure 11), increases.

A third source of mortality is more unusual. There have been many observations of foxsnakes “snared” in nylon erosion fencing. For example, a 5-m section of nylon erosion fencing entangled and killed three foxsnakes in Amherstburg (J. Kamstra pers. obs), and M. Gartshore observed three foxsnakes trapped in garden netting (pers. obs.) and there have been advisories citing this problem both in Ontario and the USA. Mortality of snakes from netting may be much more significant than thought, but needless to say, data are hard to come by (See Figure 12 for example of *Sistrurus catenatus* tangled in netting).

There are other less significant sources of mortality caused by human actions, and these sources illustrate how intensive alteration of the habitat by people can kill snakes. For example, an unintentional spring fire at Rondeau PP killed at least 18 adult foxsnakes (S. Gillingwater pers. obs.), and three radiotagged snakes tracked by Lawson (2005) and MacKinnon (2005) were killed by motorized vehicles not on roadways (i.e., a ditch mower, forklift, and tractor/backhoe).

Figure 11. Aerial picture of Rondeau Provincial Park showing cottages and roads in this protected area. Photo courtesy of S. Gillingwater.

Figure 12. Massasauga (rattlesnake) entangled in garden netting in Parry Sound area. Photo by J. Rouse.

Environmental pollution also falls in the category of inadvertent negative impacts. Meeks (1968) found DDT residues in three Eastern Foxsnakes up to 12 months after application of DDT to a 1.5-ha marsh in Ohio and Russell *et al.* (1995) found that large snakes from Point Pelee NP, including *E. gloydi*, had high concentrations of DDT and metabolites in their tissues over 20 years after application had ceased. Kraus and Schuett (1983) found an aberrantly melanistic *E. gloydi* with visible deformities along with other oddly coloured individuals in a "moderate to heavily" contaminated industrial area in Lucas county, Ohio in 1977. Therefore, foxsnake populations residing in heavily contaminated regions (e.g., Fighting Island in the Detroit River) may be experiencing negative effects of environmental pollution.

The relative contribution to population persistence of any of these anthropogenic threats will of course vary by site. The increased individual mortality probabilities in areas where snake-human interactions are common may be considerable, and in some cases inadvertent mortality may simply be too high for the resident population to remain viable (see case study discussion below).

Intentional persecution by humans causing mortality

Many humans have an abhorrence of snakes and thus many Eastern Foxsnakes are killed on sight. The Eastern Foxsnake's large size, reddish head colouration, bold markings, and habit of vibrating its tail when alarmed, have, because of its resemblance to some venomous species (e.g., copperheads, rattlesnakes) acted as cues to induce people to kill foxsnakes deliberately. An example of irrational fear of snakes comes from a hotel manager in Honey Harbour who assured a researcher that foxsnakes were quite capable of strangling and consuming human babies and even toddlers, and this was why she hired a man to kill the snakes on her property (R. Brooks pers. comm.).
The species' predation on birds has also elicited negative responses. Ashley *et al.* (2007) quantitatively demonstrated what some snake researchers have suspected for years: that is, a subset of the snakes killed by motor vehicles on roads were run over intentionally. Even when property owners tolerate or encourage the presence of foxsnakes on their lands, intentional persecution of the snakes by contract workers (e.g., construction, landscaping, crop harvesting) is common. The overall impact of intentional persecution of snakes by these groups is likely significant given that they may visit many locations where the species potentially resides. In areas such as Long Point there is tremendous pressure from visitors, and though the area is remote and not patrolled, many people traverse the dunes and many of them kill snakes including foxsnakes. Parks with roads and/or cottages (Figure 11) are also sources of intentional killing by vehicles or more personal methods.

Collection of foxsnakes for the pet trade could also be considered a form of persecution as individuals are permanently removed from their native populations. Because Eastern Foxsnakes often hibernate communally, their populations could potentially be significantly impacted by indiscriminate collection of individuals emerging from hibernation. Although *E. gloydi* seem to do fairly well in captivity, they have not been bred extensively and therefore few captive-bred Eastern Foxsnakes are available (Staszko and Walls 1994)—creating a demand for wild individuals.

Case study of anthropogenic impact on foxsnakes in a protected area

A particularly insightful illustration of the effects of high levels of human activity on foxsnake survivorship comes from Killbear Provincial Park in Georgian Bay. Foxsnake mortality on the park's main and campground roads have been monitored opportunistically since 1992. The road monitoring was conducted concurrently with a highly active natural heritage education program, with snakes and their preservation as a focus. The education and awareness programs make use of annual park tabloids, audio-visual presentations, ubiquitous posters (even erected in strategic locations in washrooms) and "Brake-for-Snake" signs on the park's roads. Therefore, the park's visitors, and also to a large extent the residents living just outside the park, have a heightened awareness of the need to protect snakes in the region. In 2000 and 2001, radiotransmitters were implanted in a number of Eastern Foxsnakes captured in the park. One of the most interesting results from that preliminary research was the observation that many of the radiotagged individuals actually moved to islands outside the park's peninsular boundaries (Chora *et al.* 2001). As this finding had obvious implications for conservation-based management of species at risk within the park (see Paleczny *et al.* 2005), the research effort was expanded. Lawson's (2005) M.Sc. research demonstrated that the majority of the foxsnakes observed in the park do indeed spend most of their time outside of the park's boundaries, some moving up to 9 km from the peninsula. From a conservation perspective, one of the most alarming results obtained during the study was the number of radiotagged individuals that perished when they returned to the mainland (either to the peninsular parkland or close surrounds). For example, Lawson (2004) stated that *"Of 23 transmitter-equipped Foxsnakes monitored in 2003 and 2004, nine were killed (and an additional three died over winter). Six of the nine deaths were likely caused by humans, two were likely caused by predators, and one died of unknown causes. All but two of these deaths occurred on the mainland (four in Killbear, three just outside of the park) and six of the seven mainland deaths were caused by humans and traffic. However, only 411 of 3176 telemetry locations (13%) collected during this time were on the mainland. This suggests the possibility that Killbear and the area immediately outside of the park may be acting as a sink for the local Foxsnake population"*.

Given the enhanced environmental awareness of Killbear park visitors and residents living in the periphery, these results are both disconcerting and illustrative of a potentially unavoidable phenomenon. That is, there will be a baseline mortality level (i.e., the cumulative, compound, synergistic impact of human activity) associated with human occupancy of the landscape resulting from both inadvertent (e.g., motorized vehicles, domestic pets) and non-reducible intentional persecution—i.e., a proportion of the human population simply cannot be convinced not to kill snakes. It therefore follows that neither increased education, nor the foxsnake's tolerance of human activity, will be able to reduce mortality levels below this baseline. Thus, when the level of human disturbance reaches a certain threshold, education, and the foxsnake's adaptability to human disturbance will become irrelevant to questions of long-term population viability. Once the threshold is reached, the local population will simply not be able to sustain the baseline mortality level and will consequently be extirpated. Whether the mortality levels experienced by the foxsnake populations in the Killbear region exceed or approach the maximum sustainable level is unknown, but seems possible given the data in Lawson (2004, 2005). However, there are almost certainly foxsnake populations in Ontario where this threshold has been exceeded, even if individuals are still occasionally observed at these sites.

SPECIAL SIGNIFICANCE OF THE SPECIES

The Eastern Foxsnake has an extremely restricted global range with approximately 70% of the species' distribution existing within Ontario, Canada. That the greatest proportion of the species' distribution is situated in Canada is unusual within the national herpetofaunal assemblage and makes the Eastern Foxsnake a distinctively Canadian species. The Eastern Foxsnake's G3 ranking is one of the highest for a reptile occurring in Ontario.

The Eastern Foxsnake is an important predator of rodents, and thus its role in integrated pest management can be particularly beneficial in agricultural systems where rodent populations are elevated.

The Eastern Foxsnake is regularly featured in the interpretive programs of national and provincial parks, as well as by organizations that promote awareness and tolerance of reptiles (e.g., Sciensational Sssnakes and the Greater Georgian Bay Reptile Awareness Program). The species' docile demeanour and remarkable tolerance of handling despite its large size probably makes the Eastern Foxsnake a most effective native snake ambassador.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The Eastern Foxsnake has a global rank of G3 and sub-national ranks of S2 in Michigan, S3 in Ohio, and S3 in Ontario (NatureServe 2007). The species was officially designated by COSEWIC as Threatened in April 1999 and May 2000, and subsequently designated Threatened by the Ontario Ministry of Natural Resources in 2001.

In Canada, *E. gloydi* is legally protected under the Ontario *Fish and Wildlife Conservation Act* (Ontario 1997) which makes it illegal to harass, possess (without a permit), or kill the species. Additional protection is afforded in National Parks through the *Canada National Parks Act* (2000), in National Wildlife Areas through the Canada Wildlife Act (R.S. 1985, c. W-9), and on all federal lands via the *Species at Risk Act* (Threatened designation; Schedule 1). Ontario's new *Endangered Species Act* (2007) will provide protection for the species throughout the province.

TECHNICAL SUMMARY 1

Elaphe gloydi
Carolinian population
Eastern Foxsnake — Couleuvre fauve de l'Est
Range of Occurrence in Canada: Ontario

Extent and Area Information

• *Extent of occurrence (EO)(km²)* Simple Minimum Convex Polygon (MCP) computed using Ontario Herpetofaunal Summary records as per COSEWIC methodology adapted from IUCN 2001	18,117 km²
• *Specify trend in EO*	No Trend—because of the way an MCP areal value is calculated, only the loss of one of the regional populations would have a significant impact on EO values
• *Are there extreme fluctuations in EO?*	No
• *Area of occupancy (AO) (km²) (see page 20 and Figure 5 for details)* A 2km x 2km grid of cells was overlaid on the distribution of the species and the AO was calculated as the area of all the cells that intersect known occurrences. Occurrences from 1984 to present were used, and from that subset, the dataset was further restricted to those records determined to be valid for distributional analyses (Willson and Rouse 2006). The dataset was considered in 5-year intervals (5 years = ~1 generation) to evaluate both current AO (past 10 years) and trend in AO.	From all NHIC observations since: 1984; AO=860km² 1988; AO=580km² 1993; AO= 300km² 1998; AO= 188km²
• *Specify trend in AO*	Decline (see above)
• *Are there extreme fluctuations in AO?*	No
• *Number of known or inferred current locations*	~50
• *Specify trend in #*	Declining (see above)
• *Are there extreme fluctuations in number of locations?*	No
• *Specify trend in area, extent or quality of habitat*	Both area and quality are declining

Population Information

• *Generation time (average age of parents in the population)*	~5 years
• *Number of mature individuals*	Unknown
• *Total population trend:*	Likely declining
• *% decline over the last/next 10 years or 3 generations.*	Unknown
• *Are there extreme fluctuations in number of mature individuals?*	No
• *Is the total population severely fragmented?*	Yes
• *Specify trend in number of populations*	Likely declining
• *Are there extreme fluctuations in number of populations?*	No
• List metapopulations with number of mature individuals in each: Essex-Kent Haldimand-Norfolk	

Threats (actual or imminent threats to populations or habitats)

1. Mortality on roads 2. Loss and degradation of habitat especially loss of hedgerows and wetlands 3. Persecution by ophidiophobes 4. Illegal wildlife trade

Rescue Effect (immigration from an outside source)

• *Status of outside population(s)?* **USA: MI S2;OH S3** [other jurisdictions or agencies] None	
• *Is immigration known or possible?*	May be possible across Detroit River or Lake St Clair
• *Would immigrants be adapted to survive in Canada?*	Presumably
• *Is there sufficient habitat for immigrants in Canada?*	No
• *Is rescue from outside populations likely?*	Highly Unlikely

Quantitative Analysis

N/A

Current Status

COSEWIC: Carolinian Population - Endangered (2008) COSEWIC: Species considered as a single unit – Threatened (2000) COSEWIC: Species considered as a single unit – Threatened (1999)

Status and Reasons for Designation

Status: Endangered	**Alpha-numeric code:** B2ab(ii,iii,iv)
Reasons for Designation; The species is confined to a few small increasingly disjunct areas that are subject to intensive agriculture, high human populations and extremely high densities of roads. Roads fragment populations leading to increased probability of extirpation. There are no large protected, roadless areas for this species in this region. The species is also subject to persecution and illegal collection for the wildlife trade.	

Applicability of Criteria

Criterion A (Declining Total Population): Not applicable.
Criterion B (Small Distribution, and Decline or Fluctuation): Meets Endangered B2ab(ii,iii,iv) as the area of occupancy is < 500km² and severely fragmented. The AO is declining (ii), the area and quality of habitat are declining (iii) and locations are disappearing (iv) as habitat is lost
Criterion C (Small Total Population Size and Decline): Total population size not known.
Criterion D (Very Small Population or Restricted Distribution): Population too large
Criterion E (Quantitative Analysis): Not applicable.

TECHNICAL SUMMARY 2

Elaphe gloydi
Great Lakes / St Lawrence population
Eastern Foxsnake — Couleuvre fauve de l'Est
Range of Occurrence in Canada: Ontario

Extent and Area Information

• *Extent of occurrence (EO)(km²)* Simple Minimum Convex Polygon (MCP) computed using Ontario Herpetofaunal Summary records as per COSEWIC methodology adapted from IUCN 2001	1,984 km²
• *Specify trend in EO*	Possibly declining
• *Are there extreme fluctuations in EO?*	No
• *Area of occupancy (AO) (km²)See page 20 and Figure 4 for more details.* A 2km x 2km grid of cells was overlaid on the distribution of the species and the AO was calculated as the area of all the cells that intersect known occurrences. Occurrences from 1984 to present were used, and from that subset the dataset was further restricted to those records determined to be valid for distributional analyses (Willson and Rouse 2006). Also, the AO was calculated from all observations from the past 10 years (since 1998).	AO from all NHIC observations since: 1984 = 276 km² 1998 = 188 km^2
• *Specify trend in AO*	Declining
• *Are there extreme fluctuations in AO?*	No
• *Number of known or inferred current locations*	~50
• *Specify trend in #*	Declining
• *Are there extreme fluctuations in number of locations?*	No
• *Specify trend in area, extent or quality of habitat*	Loss of habitat from cottage development, increased number of roads

Population Information

• *Generation time (average age of parents in the population)*	~5 years
• *Number of mature individuals*	Unknown
• *Total population trend:*	Likely declining
• *% decline over the last/next 10 years or 3 generations.*	Unknown
• *Are there extreme fluctuations in number of mature individuals?*	No
• *Is the total population severely fragmented?*	Yes, by recreational shoreline development
• *Specify trend in number of populations*	Unknown
• *Are there extreme fluctuations in number of populations?*	No
• List populations with number of mature individuals in each: Unknown. Scattered along coast.	

Threats (actual or imminent threats to populations or habitats)

The main threat to these snakes comes from rapidly increasing recreational development along the Georgian Bay coastline and on the shores of the Georgian Bay Islands. Increases in power boats, and roads and traffic are killing more snakes. Housing developments particularly in the southern part of the snakes' distribution are also destroying their habitat.

Rescue Effect (immigration from an outside source)

• *Status of outside population(s)?* **USA: MI S2;Oh S3** [other jurisdictions or agencies] None	
• *Is immigration known or possible?*	No
• *Would immigrants be adapted to survive in Canada?*	Unknown
• *Is there sufficient habitat for immigrants in Canada?*	Likely yes
• *Is rescue from outside populations likely?*	No

Quantitative Analysis

N/A

Current Status:

COSEWIC: Great Lakes / St Lawrence Population - Endangered (2008) COSEWIC: Species considered as a single unit – Threatened (2000) COSEWIC: Species considered as a single unit – Threatened (1999)

Status and Reasons for Designation

Status: Endangered	**Alpha-numeric code:** B1ab(iii) + 2ab(iii)
Reasons for Designation: In this region, the species swims long distances often in cold, rough open water where it is subject to mortality from increasing boat traffic. It is uniquely vulnerable to habitat loss because it is confined to a thin strip of shoreline where it must compete with intense road development and habitat modification due to recreational activities. This species' habitat is undergoing increasing fragmentation as development creates zones that are uninhabitable.	

Applicability of Criteria

Criterion A (Declining Total Population): Not applicable.
Criterion B (Small Distribution, and Decline or Fluctuation): Meets Endangered B1ab(iii)+B2ab(iii) since the known extent of occurrence (1,984 km^2) is less than 5,000 km^2 and the area of occupancy (188 km^2) is less than 500 km^2. The species' habitat is fragmented by recreational developments along the species' coastal habitat. Important shoreline habitat is also being lost to cottage and other development.
Criterion C (Small Total Population Size and Decline): Numbers not known with reasonable certainty.
Criterion D (Very Small Population or Restricted Distribution): Population is too large
Criterion E (Quantitative Analysis): Not applicable.

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Because this Status Report Update is to function as a "living document", some information from the previous status report, Willson and Prior (1998), has been retained. Authorities that previously contributed information retained in the current document include the following: Mary Gartshore, Tom Linke, and Ben Porchuk.

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Robert Willson received his B.Sc. and M.Sc. degrees from the University of Guelph in 1997 and 2001 respectively. His graduate research involved an investigation of the reproductive ecology of Eastern Foxsnakes on Pelee Island (1998–1999). He has continued to be involved with Eastern Foxsnake research projects on Pelee Island and in Georgian Bay and has been an active member of the species' recovery team since its inception in 2003. Additional investigations of snake ecology and conservation include eight years working on Eastern Massasaugas and Eastern Hog-nosed Snakes as part of Killbear Provincial Park and Parry Sound MNR projects.