About the Ontario Recovery Strategy Series

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

What is recovery?

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

What is a recovery strategy?

Under the ESA, 2007, a recovery strategy provides the best available scientific knowledge on what is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA, 2007 outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. There is a transition period of five years (until June 30, 2013) to develop recovery strategies for those species listed as endangered or threatened in the schedules of the ESA, 2007. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What’s next?

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

For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of Natural Resources Species at Risk webpage at: www.ontario.ca/speciesatrisk
RECOMMENDED CITATION


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AUTHORS

Eastern Foxsnake Recovery Team

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DECLARATION

The Ontario Ministry of Natural Resources has led the development of this recovery strategy for the Eastern Foxsnake (Carolinian and Georgian Bay populations) in accordance with the requirements of the Endangered Species Act, 2007 (ESA 2007). This recovery strategy has been prepared as advice to the Government of Ontario, other responsible jurisdictions and the many different constituencies that may be involved in recovering the species.

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

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

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy.

RESPONSIBLE JURISDICTIONS

Ontario Ministry of Natural Resources
Environment Canada, Canadian Wildlife Service – Ontario
Parks Canada Agency
EXECUTIVE SUMMARY

The Eastern Foxsnake (Pantherophis gloydi) occurs in two restricted regions of Ontario, the Carolinian Forest region and the eastern side of Georgian Bay. Provincially, the Carolinian population and the Georgian Bay population are designated under the Endangered Species Act, 2007 as endangered and threatened respectively. Federally, the species is designated by the Species at Risk Act as endangered in both the Carolinian and Great Lakes/St. Lawrence populations. Causes of the species decline include wetland drainage for agriculture, impacts resulting from housing and cottage development, road mortality, human persecution and collection for the pet trade. For survival, Eastern Foxsnakes require a mosaic of habitat types that include open foraging habitat, thermoregulating sites, suitable hibernation sites, egg-laying sites and natural corridors linking them. They are usually associated with shorelines, islands or wetlands near the Great Lakes.

The recovery goal for Eastern Foxsnake in Ontario is to ensure population persistence, maintain the current range of occupancy and enhance connectivity of Eastern Foxsnake within both the Carolinian and Georgian Bay populations. The main objectives to achieving recovery are to:

1. track the state of populations and recovery of the species;
2. improve knowledge of populations, habitat use and threats;
3. identify and protect habitat and habitat connections within the current distribution;
4. reduce mortality by minimizing the threats;
5. enhance, restore and reconnect populations; and,
6. promote protection of the species through legislation, policies and land use plans.

Each of these objectives is divided into components and specific steps are recommended to achieve them.

The recovery team has recommended areas to be prescribed as habitat in a habitat for both the Georgian Bay and Carolinian populations. This recommendation includes hibernation and oviposition sites and associated habitat. For hibernacula, it is recommended that the area within 100 metres of known or suspected entrances/exits be prescribed as habitat in a habitat regulation. Additionally, for the Carolinian population it is recommended that natural or anthropogenic structures that extend below the frost line within 1500 metres of an area where one or more Eastern Foxsnakes have been observed in the past ten years also be prescribed as habitat to account for hibernacula that have not been identified. As a precautionary approach to protect undetected hibernacula used by the Georgian Bay population, the recovery team recommends that the area within 100 metres of the high-water mark be prescribed as habitat until such time as it has been determined that Eastern Foxsnake hibernacula do not occur in the those areas.
For oviposition (nesting) sites, it is recommended that known oviposition sites and surrounding 30 meters be prescribed as habitat in the habitat regulation. Additionally, any feature (natural or man-made) that may function as an oviposition site should be prescribed as habitat in the regulation if Eastern Foxsnakes have been observed within 30 metres of the feature during the oviposition period. For the Carolinian population all potential natural oviposition features that are consistent in composition with, and which occur within one kilometre of known occupied oviposition sites should also be prescribed as habitat for the duration of the feature’s natural life. For the Georgian Bay population, all potential oviposition structures in appropriate habitat within 100 metres of the high-water mark (or in the exception area in Port Severn) should be prescribed as habitat for the duration of the structure’s natural life.

In addition to sites for hibernation and oviposition, Eastern Foxsnakes require habitat areas for foraging, mating, thermoregulation, shedding and movement corridors. For the Carolinian population it is recommended that the marsh and prairie habitat within the current occupied range of the Carolinian population be prescribed as habitat. For the Georgian Bay population the water between the shoreline and the outer islands and all lands and islands within one kilometre from the high-water mark should be prescribed as habitat with the exception of urban areas where the buffer should be reduced to 100 metres.
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1.0 BACKGROUND INFORMATION

1.1 Species Assessment and Classification

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The glossary provides definitions for the abbreviations above.

1.2 Species Description and Biology

Species Description
The Eastern Foxsnake (Pantherophis gloydi) is Ontario’s second largest snake attaining lengths of up to 175 centimetres (Conant and Collins 1991). The species has a characteristic dorsal pattern of bold dark blotches on a yellowish background that alternate with smaller dark blotches on the sides. The scales are weakly keeled and the anal scale is divided. The head colouration varies from brown to red and generally lacks conspicuous markings except for a dark line extending from the eye to the angle of the jaw which is most prominent in juveniles (Conant and Collins 1991). Sexes are visually similar except that males have proportionately longer tails (Willson and Prior 1998). Juveniles have a similar pattern but have a lighter, usually gray background colour and distinct patterns on the head.
Eastern Foxsnake may be confused with several blotched snake species found in Ontario. These include the Massasauga (*Sistrurus catenatus*), Milksnake (*Lampropeltis triangulum*), Eastern Hog-nosed Snake (*Heterodon platirhinos*), Northern Watersnake (*Nerodia sipedon*), Blue Racer (*Coluber constrictor foxii*) and the Gray Ratsnake (*Pantherophis spiloides*). Because of their reddish head, Eastern Foxsnakes are sometimes mistaken for the venomous Copperhead (*Agkistrodon contortrix*), a species that does not occur in Canada. Juvenile Eastern Foxsnakes are most similar to juvenile Gray Ratsnakes and can be distinguished only on the basis of scale row counts.

The Eastern Foxsnake is docile in temperament, but is prone to exuding a foul-smelling secretion from the cloaca when disturbed (Froom 1972). It is an adept tree climber, a proficient swimmer and will take to the water and swim long distances across bays and between islands (MacKinnon 2003, Lawson 2004, MacKinnon et al. 2006). Natural predators of Eastern Foxsnake include large birds of prey such as Red-tailed Hawk (*Buteo jamaicensis*) and Great Horned Owl (*Bubo virginianus*) and carnivorous mammals (e.g., raccoon (*Procyon lotor*), skunk (*Mephitis mephitis*), fisher (*Martes pennanti*) and mink (*Mustela vison*) (COSEWIC, 2008).

It is estimated that male and female Eastern Foxsnakes in Georgian Bay reach maturity at 5.15 years and 3.61 years respectively, and reach a maximum age of approximately 12 to 15 years (Row and Lougheed, 2006). These variables have not yet been estimated for the Carolinian population, but due to a warmer climate, they may differ from the Georgian Bay population.

### 1.3 Distribution, Abundance and Population Trends

Eastern Foxsnakes have a very restricted global distribution, with about 70 percent of their entire range occurring in Ontario, Canada. In the United States, they are confined to southeastern Michigan and extreme northwestern Ohio. The species has a small global range and consequently has been given a conservation status rank of vulnerable (G3) by NatureServe. The Eastern Foxsnake is designated as threatened in Michigan with a rank of imperiled (S2) and special concern in Ohio with a rank of vulnerable (S3) (NatureServe 2010). The closely related Western Foxsnake (*Pantherophis vulpinus*), which has a more extensive range in the midwest of the United States, was considered to be another subspecies of the same species until Collins (1997) recommended it be recognized as a separate species.

The range of Eastern Foxsnakes encompasses two distinct regions of Ontario: the eastern side of Georgian Bay (Georgian Bay population) and the Carolinian Forest region (Carolinian population). Between the two regions is a gap of approximately 250 kilometres from which there are no records of Eastern Foxsnake except for two disjunct records in southern Bruce County. The Georgian Bay population consists of a large meta-population (or several sub-populations) that extends along the eastern shoreline of the Bay from the Midland-Penetang Peninsula north to the vicinity of the French
River. The Carolinian Forest region, along the north shore of Lake Erie, has two apparently disjunct areas of occurrence: Long Point and surrounding Norfolk Sand Plain; and extreme southwestern municipalities of Essex, Chatham-Kent and Lambton. The Georgian Bay population extends no more than five kilometres inland, whereas the Carolinian population occurs more than 20 kilometres inland (Oldham and Weller 2000).

No estimates of Eastern Foxsnake abundance for Ontario as a whole have been made. One communal hibernaculum is known to harbour as many as 264 individuals (MacKinnon 2005), although most contain far fewer and some contain only a single individual (Lawson 2005, MacKinnon 2005). Known records of Eastern Foxsnake observations were compiled by the Natural Heritage Information Centre (NHIC) (Figure 1). It is believed that these records accurately reflect the current distribution of Eastern Foxsnake in the province at the scale of Geographic Township.

![Figure 1. Current distribution of Eastern Foxsnake in Ontario (NHIC 2010)](image)

The species' overall geographic distribution in Ontario does not appear to have been significantly reduced, based on a comparison with Logier and Toner (1961) and more
recent NHIC data. It is believed that some local populations have declined or disappeared, however. Long-term empirical data on Ontario Eastern Foxsnake populations do not exist, consequently it is not possible to know the rate of population decline, or how present populations compare with historic ones. One recent indication of declining populations noted at both the Ojibway Prairie Complex Nature Reserve in Windsor (P. Pratt pers. comm. 2004) and Point Pelee National Park (T. Linke pers. comm. 2004) is that the average size of adults has declined over the past two decades, indicating that adults are dying before they attain a large size. A significant population decline has been reported on the eastern half of the Long Point peninsula (P. Ashley pers. comm. 2004). This area is exposed to minimal human disturbance and the cause for the decline of this population is unknown. High water levels in the 1980's are thought to have inundated hibernacula and could be a potential contributor to the population decline. Road mortality at the base of the Long Point peninsula and surrounding area may be a significant contributor to decline in these populations (Ashley and Robinson 1996, Ashley et al. 2007).

1.4 Habitat Needs

The Eastern Foxsnake requires a mosaic of habitat types that includes suitable sites for hibernation, foraging, thermoregulating and oviposition, as well as natural linkages that allow for free movement between locations that provide these important functions (MacKinnon 2005, Row et al. in prep.). While hibernacula may be the most sensitive and important component of habitat, identifying hibernacula is not easy because they are not recognizable on the landscape and are extremely difficult to locate (Prior and Weatherhead 1996).

Eastern Foxsnakes are typically associated with unforested habitats including old fields, prairies, savannas, shorelines, rock barrens, marshes and beach dunes, though they can utilize a broad range of habitat types including forest (MacKinnon 2005, Row et al. in prep.). They exhibit a strong preference for shoreline edge habitats, especially where field, marsh or rock barrens meet along the shoreline, as well as the forest-scrub ecotone. Eastern Foxsnakes are reasonably tolerant of anthropogenic habitats and/or areas with limited or low human activity such as fields, hedgerows, canals, abandoned buildings, cottages and dump sites. Eastern Foxsnakes frequently move along the shoreline through a mosaic of habitat types and readily swim for considerable distances (up to 10 km) in open water to offshore islands in the Georgian Bay area (MacKinnon 2003, A. Lawson pers. comm. 2004, MacKinnon et al. 2006). They are excellent arboreal predators, foraging for bird eggs and nestlings.

Mature females require oviposition sites, which can include rotten, interior cavities of large logs and stumps, dune slopes, decaying leaf piles, compost or wood chips. On Pelee Island, large, fallen tree trunks along shorelines offered the best oviposition sites (Porchuk and Brooks 1995, R. Willson pers. comm. 2004). Large rotting logs and driftwood were also found to provide important oviposition sites at Rondeau Provincial Park (S. Gillingwater pers. comm. 2004) and Point Pelee National Park (J. Row pers.
Recovery Strategy for the Eastern Foxsnake (Carolinian and Georgian Bay populations) in Ontario

comm. 2007). In Georgian Bay, rock crevices were most commonly used as oviposition sites and compost piles were used occasionally (MacKinnon 2003, A. Lawson pers. comm. 2004). Eastern Foxsnakes hibernate communally in traditionally used underground bedrock fissures, animal burrows and anthropogenic features such as old wells and foundations (COSEWIC 2008). Hibernation normally extends for as much as seven months (October to April) of each year (COSEWIC 2008). Neonate and juvenile Eastern Foxsnakes have been found hibernating communally with the mature snakes, however their active-season habitat needs remain largely unknown.

Georgian Bay population
In eastern Georgian Bay, the Eastern Foxsnake distribution is strongly linked with the Bay; 99.5% of radio-telemetry locations (representing 46 individual Eastern Foxsnakes and 5,091 radio-telemetry locations) occurred within one kilometre of the shoreline (MacKinnon 2005). Further evidence of this shoreline affinity was elucidated by measuring the distance between all Eastern Foxsnake records compiled by the NHIC and the Georgian Bay shoreline. Of 107 records, 96 (90%) were within one kilometre of the Georgian Bay shoreline with the most distant record occurring approximately 2.3 kilometres from the shoreline.

Shorelines along eastern Georgian Bay are variable but generally consist of expanses of exposed bedrock with limited soil and irregularly scattered trees, shrubs and forbs. It is these open habitats that are favourable to these large snakes. Current data indicate that all the essential habitat components are contained within one kilometre of the Georgian Bay shore for nearly all individual Eastern Foxsnakes. Anthropogenic sites are not avoided in these shorelines as Eastern Foxsnakes are frequently seen in the vicinity of cottages or buildings. Habitat use by Eastern Foxsnakes was found to be non-random with respect to habitat availability; individuals used rock barrens and sparse forests significantly more than mixed, deciduous or coniferous forests (MacKinnon 2005). Radio-telemetry data has shown that Eastern Foxsnakes generally avoid closed canopy forest (Lawson 2003, MacKinnon 2005), likely because of cool microclimates and lack of thermoregulating opportunities.

Individuals of the Georgian Bay population of Eastern Foxsnake are highly aquatic and on occasion are known to swim for more than 10 kilometres, and therefore can occur on islands well offshore and a considerable distance from their hibernation site (Lawson 2004, Lawson 2005, MacKinnon 2005).

Carolinian population
Eastern Foxsnakes in the Carolinian population of southwestern Ontario do not show the same affinity for open water as observed in the Georgian Bay population. The NHIC has documented some records more than 20 kilometres inland. Although some individuals may, most individuals do not regularly swim out across large expanses of open water (e.g., between the islands in Lake Erie).

Unlike the Georgian Bay area, the landscape used by Eastern Foxsnakes in southwestern Ontario has changed dramatically. Across the distribution of the
Carolinian population, the conversion of original habitats (often wetlands) to agricultural fields has been extensive (Whitaker 1938). Most of the original wetlands in this part of the province have been drained. For example, Essex County and the municipality of Chatham-Kent lost 95 percent of their original wetlands between 1800 and 1982 (Snell 1987). Nevertheless, Eastern Foxsnakes regularly frequent some human-modified habitat as long as there is a sufficient amount of wetland and natural vegetation cover nearby.

A recent study quantified habitat-use patterns of Eastern Foxsnakes in the Carolinian population at two locations (Point Pelee National Park and Hillman Marsh Conservation Area) using radio telemetry and across the range of Eastern Foxsnakes in Essex and Chatham-Kent counties using occurrence records (Row et al. in prep.). This study showed that Eastern Foxsnakes had a strong preference for marsh and natural and semi-natural open habitat and a strong avoidance for agricultural fields. Open natural and semi-natural habitat included features such as natural and restored prairie habitat down to semi-maintained grass and fields greater than 15 metres in width along drainage ditches, creeks, roads and railway tracks. These trends were consistent across three spatial scales: (1) locations within the active-range; (2) active-range within the study area; and (3) across a large regional population. Thus, similar habitat-use patterns of Eastern Foxsnakes (e.g., use of open natural and semi-natural habitat) are likely across the Carolinian population.

Through the research in the Carolinian population, a number of natural and anthropogenic nesting features were identified (Row et al. in prep). Root wads and logs provide cover and shelter; once these features begin decomposing they provide nesting habitat, particularly in dune or prairie habitat. In addition to these natural oviposition sites, Eastern Foxsnake oviposition sites are frequently leaf, wood chip or compost piles created by humans. These nests can be large and support clutches from multiple females (J. Row pers. comm. 2009). Other anthropogenic oviposition sites include abandoned drains under roads and intentionally-created artificial nests.

Radio-telemetry studies at Point Pelee National Park and Hillman Marsh Conservation Area found the majority of radio-tracked Eastern Foxsnakes hibernated in anthropogenic features such as old wells, canal dikes, septic tile beds and building foundations (Watson 1994, J. Row pers. comm. 2009). Eastern Foxsnakes have also been known to hibernate in buildings and people’s homes (J. Row pers. comm. 2009). Anthropogenic features do provide habitat for Eastern Foxsnakes and the presence and use of these features as hibernacula or oviposition sites may be necessary for the survival of some populations, because suitable natural (pre-settlement condition) features may no longer occur in some areas.

1.5 Limiting Factors

Life history features such as age of maturity, spring and fall concentrations at hibernacula, fidelity to hibernacula, and intermittent juvenile recruitment predispose
Eastern Foxsnake populations to major demographic fluctuations when subjected to disturbances or stresses. Large seasonal movements to and from hibernacula may increase the probability of mortality by predators or human traffic (boat and road traffic). These seasonal congregations can also make Eastern Foxsnakes more susceptible to predation or collection for the pet trade. The presence of suitable hibernacula may be a limiting factor, particularly towards the northern part of their range where cold temperatures can make potential hibernacula unsuitable. Exceptionally cold winters (e.g., winter of 1994) can result in high mortality to snakes during hibernation (M. Gartshore pers. comm. 2004, R. Willson pers. comm. 2004). Even small increases in the rate of adult mortality may alter the reproductive capacity of a population to such an extent that it becomes highly vulnerable to extirpation.

1.6 Threats to Survival and Recovery

Road Mortality
Vehicle collisions with Eastern Foxsnakes on roads are one of the most significant causes of Eastern Foxsnake mortality. A very extensive road network and increasing traffic are leading to increasing incidences of road mortality in both regional populations in Ontario. The causeway at the base of Long Point, which crosses three kilometres of marsh, shows consistently high mortality of Eastern Foxsnakes and many other herpetofauna (P. Ashley pers. comm. 2004, Ashley and Robinson 1996). In 2003 alone, 15 Eastern Foxsnakes were killed along a short stretch of highway approximately 10 kilometres north of Point Pelee National Park (V. McKay pers. comm. 2004). High rates of road mortality have also been reported on Pelee Island (R. Willson pers. comm. 2004). Even within protected areas such as Point Pelee National Park (V. McKay pers. comm. 2004) and Rondeau Provincial Park (S. Dobbyn pers. comm. 2004), Eastern Foxsnake road mortalities are well documented.

By comparison, there are fewer roads in the Georgian Bay range of the Eastern Foxsnakes, nevertheless, development is increasing in this area, and with that, more access roads are being constructed (J. Rouse pers. comm. 2010). Populations present in mainland areas with road networks are experiencing mortality. Even lightly used roads are taking a significant toll on Eastern Foxsnakes (G. Clayton pers. comm. 2004). Eight Eastern Foxsnakes were noted as being killed on a 10 kilometre stretch of a Muskoka road in 2003 (MacKinnon 2003) and another nine in 2004 (MacKinnon et al. 2005). In Killbear Provincial Park, two out of nine radio-telemetered Eastern Foxsnakes were killed on roads in 2003 (Lawson 2003). Heavy boat traffic is believed to be causing some mortality as well, since the snakes are known to swim long distances in open water between islands. However, it is difficult to substantiate or quantify this mortality risk. It is believed that the greatest threat to Eastern Foxsnakes in the Georgian Bay population are new or upgraded roads within one kilometre from the shoreline of eastern Georgian Bay because they increase both habitat fragmentation and vehicle caused mortality.
Habitat Loss, Degradation and Fragmentation

The loss of wetland and forest-field mosaics are thought to be a key cause of the species decline throughout its range in southwestern Ontario (Willson and Prior 1998). Historically, wetlands covered a large portion of what are now the Municipality of Chatham-Kent and Essex County. Most have been drained for agriculture so that now, less than five percent of wetland habitat remains (Snell 1987). It is reasonable to assume that Eastern Foxsnakes, which show a strong affinity to wetlands, would have been much more common and widespread prior to these extensive losses. Agricultural and housing development continues along the Lake St. Clair and Lake Erie shorelines, including the Lake Erie Archipelago, reducing the snakes’ favoured habitat, nesting and hibernation locations (Willson and Porchuk 2001).

The amount of wetland loss has been low in recent decades because there was little left to drain. However, the trend to larger cropped fields results in removal of hedgerows and small patches of natural or disturbed vegetation that still function as habitat (e.g., field and edge). In addition, debris such as logs and fallen trees are cleared along shorelines, thereby eliminating important micro-habitat features.

Although the availability of habitat in eastern Georgian Bay has not declined to the same degree as in the Carolinian population, increasing development and recreational land use in this region is almost certainly resulting in a reduction of suitable habitat (COSEWIC 2008).

Because Eastern Foxsnakes seem to require a variety of habitat elements (e.g., shorelines, marshes, fields, a suitable hibernaculum) within an active range, the overall suitability or quality of a landscape is presumably highest where these elements occur in certain proportions. Habitat quality may vary with the relative proportion of requisite elements; consequently Eastern Foxsnake habitat may be degraded by:

1) the absolute loss of specific habitats (e.g., marsh, natural shorelines, hibernation sites);
2) an alteration in the relative proportions and or juxtaposition of the habitat elements; and,
3) the fragmentation of habitat elements with roads and other barriers

Such changes in landscape composition may affect spatial and activity patterns of snakes and limit the capacity of a given region to support a population. Retaining the appropriate habitat composition and linkages may be a key to the future persistence of populations, particularly in southwestern Ontario.

The Carolinian population occurs within a predominantly agricultural landscape. As such, this population has been subjected to severe landscape-scale habitat alteration including the fragmentation and reduction of wetland and forest to be replaced by largely unsuitable habitat (e.g., intensive agricultural crops like corn, soybeans and vegetables). Given the avoidance of agricultural fields by Eastern Foxsnakes (Row et. al. 2009), the amount of suitable habitat available to the population has been drastically
reduced and fragmented. The remaining large patches of suitable habitat are found mainly in provincially and nationally protected areas and private land preserved for hunting. However, Eastern Foxsnakes are found in small patches of suitable habitat on private and municipal land (e.g., old fields, sewage lagoons, riparian habitat along drainage ditches, small creeks and roadside drainages where there are patches of relatively undisturbed grasses).

Confusing the issue, however, is that Eastern Foxsnakes in southwestern Ontario are frequently using, and may now be forced to depend on, abandoned anthropogenic features (e.g., building foundations, garbage piles and wells) for shedding sites, hibernacula, oviposition sites, and foraging habitat. As these features get ‘cleaned up’ with newer developments or changed agricultural practices, the snakes may lose their ability to persist in such a human influenced landscape.

Recent research into the genetic structure of Eastern Foxsnakes in southwestern Ontario indicates that the Carolinian population consists of a number of genetically distinct sub-populations (DiLeo et. al. in press). Based on the distribution of suitable habitat, some or all of this genetic distinctness appears to be attributable to the isolation of clusters of individuals resulting from habitat loss and fragmentation, which has reduced connectivity between populations. Small isolated populations have an increased extirpation risk (Saccheri et al. 1998, O’Grady et al. 2006). Therefore, it is likely that further fragmentation through habitat loss and/or road, urban and residential development would increase the number and likelihood of local extirpations across this region.

Due to deforestation and shoreline development, many Eastern Foxsnakes across southwestern Ontario are unlikely to have access to natural nest sites. It is likely, however, that they now rely on nest features that are created by humans, especially compost piles. These nests can be large and support clutches from multiple females (J. Row pers. comm. 2009). Regular turning of occupied compost piles during the reproductive period (early July to early September inclusively) likely results in nest failure or egg or neonate mortality. The protection of natural nesting sites and creation of artificial nest sites would decrease the reliance of Eastern Foxsnakes on active anthropogenic features. For example, driftwood and snags along the shorelines in both the Georgian Bay and Carolinian regions provide important cover and oviposition sites, but these habitat features are often removed or burned, in both protected and non-protected areas (Gillingwater 2001). Without safe and productive nesting habitat, populations are unlikely to persist. Although it is less common for Eastern Foxsnakes in the Georgian Bay population to use compost piles as nesting sites, similar impacts would result from disturbance of any compost pile nest during the incubation period.

Subterranean disturbances associated with development (e.g., disturbance through blasting or excavation for building foundations or septic systems), digging of wells and removal of old foundations have been reported to unearth Eastern Foxsnakes while in hibernation in the Georgian Bay population, resulting in the destruction of hibernation
habitat and death to the Eastern Foxsnakes through exposure (J. Rouse pers. comm. 2010).

**Direct Persecution**
There is a segment of the human population that strongly dislikes snakes and kills them on sight. Eastern Foxsnakes, being large and rather slow, in addition to being mistakenly identified as rattlesnakes or copperheads (because of their blotched pattern and habit of tail vibrating), are feared and therefore frequently killed, especially when they turn up near homes or cottages. Even in Rondeau Provincial Park, cottage owners have admitted to killing Eastern Foxsnakes when encountered on their property. Similarly, Eastern Foxsnakes have been found killed by humans within the Long Point National Wildlife Area (S. Gillingwater pers. comm. 2004). This likely pertains to other protected areas as well.

**Collection**
Some Eastern Foxsnakes are collected for pets since they are impressive, attractive, docile and rare. In most cases, these are probably individual specimens that are taken from the wild for personal pets. Even the removal of a single reproductive animal from the gene pool of some populations may be significant. The extent of larger scale collection for the pet trade is unknown but there are unconfirmed reports of collectors removing snakes from protected areas. The significance of this activity needs to be assessed. Collecting could have a highly significant impact if hibernacula were discovered, since a large proportion of a local population could be removed. Hibernation traps for research are potentially vulnerable to would be collectors, which underlies the need for confidentiality of known hibernacula.

**Subsidized Predation**
Eastern Foxsnakes are susceptible to predation and are particularly vulnerable at hibernacula where a large number of individuals may concentrate. Although natural predation occurs from species such as mink and raptors, predation is a particular concern where human-subsidized predators such as raccoons or cats are numerous. Domestic dogs have also been reported killing Eastern Foxsnakes within Norfolk County, though the extent of such losses is unknown (S. Gillingwater pers. comm. 2004). Eastern Foxsnake nests have also been predated by subsidized predators such as raccoons and coyotes (*Canis latrans*). Skunk, Red Fox (*Vulpes vulpes*) and Virginia Opossum (*Didelphis virginiana*) may also prey on nests (COSEWIC, 2008).

**Chemical Toxins**
Eastern Foxsnakes at Point Pelee National Park have been found to contain relatively high levels of DDT in their tissues even though DDT has not been used there since the 1960s (Russell et al. 1994). The large snakes at Point Pelee National Park exhibited some of the highest concentrations of chemical contaminants detected in any Point Pelee National Park organisms to date. Biomagnification of PCBs and DDT was observed in Eastern Foxsnakes, with higher concentrations than in one of their main prey items, mice. No differences in tissue chemical concentrations were found in Eastern Foxsnakes with respect to sex, size and condition. The impact to their health is
not known. Eastern Foxsnakes outside of Point Pelee National Park in southwestern Ontario may be subjected to high levels of contaminants, particularly those living near polluted waterways or any agricultural areas where persistent pesticides have been applied.

Other Threats
A number of other human activities result in unintentional mortality of Eastern Foxsnakes. For example, they get run over by boats, mowers or farm equipment. Some types of nylon mesh used to prevent erosion or used in gardening are of a size that can entangle adult Eastern Foxsnakes. In a number of cases, multiple Eastern Foxsnakes were found strangled in this type of material (M. Gartshore pers. comm. 2004). MacKinnon (2003) reported that 2 of 13 transmitter-equipped Eastern Foxsnake deaths resulted from interactions with non-passenger vehicles off the roadways (forklift and ditch mower). Fire can also be a cause of mortality. An accidental fire is reported to have killed 18 adult Eastern Foxsnakes at Rondeau Provincial Park in May 2000 (Gillingwater 2001). Scientific field studies also inadvertently cause negative effects (including mortality) on study animals. It is likely that most populations are subject to a variety of stresses, and therefore any additional increase in mortality could tip the balance of sustainability.

The timing of maintenance and restoration activities can contribute to accidental Eastern Foxsnake mortality. The deep grasses along drainage ditches (20 to 30 cm in length) provide cover for Eastern Foxsnakes, however maintenance and mowing of these drainage ditches removes this cover and can directly injure or kill individuals (R. Gould pers. comm. 2010). During June and July when gestating females often congregate around rock piles found in drainage ditches (J. Row pers. comm. 2010), removal of the deep grass cover could be having an impact on survival.

1.7 Knowledge Gaps

Distribution, Abundance and Population Trends
Comparative population data from representative sites across the Eastern Foxsnake range are needed to determine whether populations are stable or declining and, where they are declining, the causes and rates of decline. Comparative population data at specific locations (e.g., Long Point, Port Severn) is needed to understand if, and at what rate, the Eastern Foxsnakes at those locations are declining, and the causes of the declines.

For populations that occur partly within protected areas (e.g., Point Pelee National Park/Hillman Marsh, Rondeau Provincial Park, Ojibway Prairie, Fish Point and Lighthouse Point Provincial Nature Reserves, Big Creek, Long Point and St Clair National Wildlife Areas, The Massasauga Provincial Park, Killbear Provincial Park and Georgian Bay Islands National Park), further study is required to determine the significance of the respective protected area in the context of the surrounding unprotected lands.
Habitat Needs
The size and condition of logs and root wads preferred as nesting sites need to be determined. This information is necessary to effectively identify and protect natural nest sites and to create or enhance nesting habitat.

The micro-climate conditions found within natural and anthropogenic hibernacula need to be determined. Such information will assist in the creation of artificial features and in determining the suitability of existing structures that may or may not currently be used by snakes but have the potential to act as hibernacula.

Methods for identifying hibernacula should be devised and tested. Further habitat studies should be conducted to determine, as closely as possible, the ideal proportions of habitat types required within a mosaic; as well as determining threshold values below which Eastern Foxsnake populations begin to decline.

Threats to Survival and Recovery
The degree of human induced mortality in aquatic habitat warrants further studies to determine if, and to what extent, it occurs as well as possible mitigation strategies to reduce impacts to Eastern Foxsnakes.

The eggs of some other reptiles, including snakes, are afflicted by parasitoids that can cause significant mortality. It is presently unknown, but should be determined, if this is a problem with Eastern Foxsnakes.

A comprehensive health and disease screening study would be useful in determining if pathogens are affecting populations.

At Point Pelee National Park, tissues of Eastern Foxsnakes were found to contain high levels of contaminants, particularly DDT (Russell et al. 1994). Kraus and Schuett (1983) reported finding an aberrant melanistic (having unusual amounts of black pigment) Eastern Foxsnake with visible deformities, as well as other oddly coloured individuals in a contaminated, industrial area of Lucas County, Ohio. It is not known how this is affecting survival of that population or if other populations are similarly affected. Populations whose area of occupancy is in agricultural or industrial areas (e.g., near the Detroit River) are likely exposed to contaminants. The impacts of pesticide contamination at Point Pelee National Park should be determined. Impacts should also be determined in any other areas where contamination might be affecting Eastern Foxsnake populations.

The effect of subsidized (e.g., raccoons, cats) and hyperabundant (e.g., wild turkeys) predators on Eastern Foxsnake populations is unknown but may be a significant threat. A study investigating how these predators are affecting Foxsnakes is needed.
Species Biology and Ecology
More information is required about population level habitat requirements and what conditions allow for population viability. For example, an understanding of neonate and juvenile dispersal and habitat use is required. Ideal conditions for egg development are currently unknown. Sex-specific mortality factors could be investigated (e.g., Are females or males more likely to cross roads or be killed in particular areas? Is there a difference in water crossings/movement between sexes?).

Radio-telemetry studies in Georgian Bay (Georgian Bay Islands National Park and Killbear Provincial Park) and the Carolinian region (Point Pelee National Park and Hillman Marsh Conservation Area) have documented habitat use and movement patterns for individuals. For the Carolinian population, more research is needed on the movement patterns and habitat of individuals outside protected areas. Although Row et al. (in press) showed that individuals avoided agricultural fields, there are areas across this region where individuals persist in much more disturbed habitat and these individuals are essential to maintaining and hopefully restoring connectivity. Understanding how individuals use and move through habitat in these heavily disturbed areas will assist with protecting this population. Unfortunately, there are challenges associated with filling this knowledge gap. For instance, it can be difficult to attain landowner permission for accessing private property in this area. In addition, locating Eastern Foxsnakes can be an issue because of low densities and studies can be difficult due to high mortality rates.

In order to gain baseline data on population trends, mark-recapture studies have been carried out for selected populations in Georgian Bay (near Georgian Bay Islands National Park) and the Carolinian region (Point Pelee National Park to Hillman Marsh Conservation Area). This research should be continued to have a better idea of long-term demography and population trends (e.g., population fluctuations, population increases or decreases). Without such baseline data it is difficult to accurately assess population viability.

Mitigation of Threats to Survival and Recovery
Effective mitigation against the various human caused impacts needs to be developed in order to minimize unnatural mortality.

Little is known about how the threat of road mortality could be mitigated. Research and development of effective crossing structures that increase the permeability of linear barriers (i.e., roads) would assist in recovery for the species.

1.8 Recovery Actions Completed or Underway

Research and Monitoring
- The NHIC maintains a database that compiles all known records of Eastern Foxsnake in Ontario, including hibernation data where possible. The database is continually updated as new information is obtained.
• The Georgian Bay Reptile Awareness Program (GBRAP) collected records of species at risk in the Georgian Bay area, which were forwarded to the NHIC.
• Radio-telemetry studies at three locations on Georgian Bay; Killbear Provincial Park (2000 to 2004), Georgian Bay Islands National Park of Canada (GBINP) (2003 and 2004) and Awenda Provincial Park, are providing data on movement patterns, habitat characteristics (vegetation types, distance to shoreline), habitat use, hibernation locations, mating behaviour, egg laying sites, population characteristics, etc. Communal hibernacula in the central Georgian Bay (A. Lawson pers. comm. 2004) and southern Georgian Bay (C. MacKinnon pers. comm. 2004) areas have been monitored.
• Radio-telemetry, habitat use and demography (mark-recapture) research was conducted at Point Pelee National Park and Hillman Marsh Conservation Area in Essex County (2006 to 2009) and a mark-recapture study was continued in southern Georgian Bay area (2007 to 2009) (J. Row pers. comm. 2009). Large scale habitat use and population genetic patterns were established across southwestern Ontario and updated landcover maps were developed (DiLeo et al. in press, Row et al. in prep).
• Previous radio-telemetry studies were conducted at Point Pelee National Park in 1992 and 1993 (Watson 1994), Pelee Island (Wilson 2000), and at Norfolk County in 1992 and 1993 (M. Gartshore pers. comm. 2004). The 1992 and 1993 Point Pelee National Park radio-telemetry data was analyzed by Row (2007) to identify habitat characteristics.
• Blood samples were collected from several sites for DNA analysis by Queens University researchers (R. Brooks pers. comm. 2004). Samples from Long Point area snakes have been sent to Carleton University.

**Education**

• The GBRAP, based out of Parry Sound produced an extensive outreach program on all reptile species at risk in the Georgian Bay area. This program was delivered to about 2000 students and 2300 members of the public in 2003. Outreach programs were delivered at schools (targeting grades 4 and 10) and to cottage associations. Snake sensitivity training was offered for construction workers (G. Clayton pers. comm. 2004).
• The GBRAP produced a poster and brochure on reptiles of Georgian Bay. These materials have been distributed throughout the area.
• The Georgian Bay Biosphere Reserve provides outreach programs and materials that include information on the Eastern Foxsnake and other species at risk.
• Outreach programs delivered by the Upper Thames River Conservation Authority promote species at risk including Eastern Foxsnakes. These programs reach between 2000 and 5000 people each season.
• Natural history interpretation programs that include information on Eastern Foxsnakes are in effect at GBINP, Point Pelee National Park, Rondeau
Recovery Strategy for the Eastern Foxsnake (Carolinian and
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Provincial Park, Killbear Provincial Park, Awenda Provincial Park, Ojibway Nature Centre in Windsor and the Pelee Island Heritage Centre. Nature interpretation programs are not currently available to the public at Long Point and Turkey Point Provincial Parks where nature interpretation would greatly enhance public attitude.

- Staff from Point Pelee National Park, GBINP, Rondeau Provincial Park, Killbear Provincial Park, Awenda Provincial Park, Ojibway Nature Reserve and MNR District Offices respond to concerned local people who find Eastern Foxsnakes on their lands.
- Toronto Zoo (Adopt-a-Pond) created and distributes an “Ontario Snakes” poster to promote snake appreciation and conservation. Prior to that, the Norfolk Field Naturalists produced and distributed a different “Ontario Snakes” poster to every public school in Norfolk County.
- Non-profit organizations such as “Sciensational Sssnakes” provide education and encourage appreciation of snakes.
- In response to declining reptile populations and ongoing habitat threats, the Long Point Basin Land Trust launched its “Conserving Carolinian Reptiles” project in 2009. The Land Trust developed a multi-faceted project including reptile surveys and population monitoring, education and outreach and a variety of on-the-ground habitat creation projects which benefit reptiles.
- Parry Sound District MNR produced a fact sheet outlining the danger of erosion blanket mesh to large snakes.
- Queen’s University researchers in collaboration with the Essex County Stewardship Network and Chatham-Kent Stewardship Network developed an educational website and pamphlet, which was delivered to landowners across Essex County and the Municipality of Chatham-Kent. Continuing with this stewardship, they have attempted to get the public involved in Eastern Foxsnake conservation through an ongoing artificial nest program.

Management

- Most of the large remaining wetland and prairie habitat patches within the range of the Carolinian population (Essex/Chatham-Kent/Lambton and Norfolk) are in protected areas (national parks, national wildlife areas, provincial conservation reserves, conservation areas and First Nation reserves) (J. Row pers. comm. 2009). Most of these protected areas are small and poorly, if at all, connected to other natural areas. In themselves, these areas may not contain enough habitat to support a viable population of Eastern Foxsnake. Along eastern Georgian Bay, there are a series of larger protected areas that are fairly well connected.
- Outside of protected areas, some of the larger habitat areas in the range of the Carolinian population are lands preserved for hunting and are under the ownership of private hunt clubs. These areas indirectly provide protection for Eastern Foxsnake (J. Row pers. comm. 2009).
- A landowner agreement exists to protect hibernacula on private lands near GBINP.
- The Provincial Policy Statement (PPS 2005) requires that significant natural heritage features will be protected from incompatible development. In particular
the policy states “Development and site alteration shall not be permitted in: significant habitat of endangered species and threatened species”.

- The ESA 2007 provides general habitat protection for the Eastern Foxsnake in Ontario until such time as a species-specific habitat regulation is developed.
- Seasonal road closures are used within Rondeau Provincial Park to lessen road mortality associated with snakes basking on park roads on cool sunny days in the fall.
- Point Pelee National Park implements a Wildlife Mortality Monitoring Protocol that allows a staged approach, from public education to road closures, to control traffic on days when weather is expected to lead to snake and other wildlife road mortality.
- Control of Common Reed (*Phragmites australis ssp. australis*) has been initiated within wetland areas of Rondeau Provincial Park and is ongoing.
2.0 RECOVERY

2.1 Recovery Goal

The recovery goal for Eastern Foxsnake in Ontario is to ensure population persistence, maintain the current range of occupancy and enhance connectivity of Eastern Foxsnake within both the Carolinian and Georgian Bay populations.

2.2 Protection and Recovery Objectives

Table 1. Protection and recovery objectives

<table>
<thead>
<tr>
<th>No.</th>
<th>Protection or Recovery Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Track the state of populations and recovery of the species</td>
</tr>
<tr>
<td>2</td>
<td>Improve knowledge of populations, habitat use and threats</td>
</tr>
<tr>
<td>3</td>
<td>Identify and protect habitat and habitat connections within the current distribution</td>
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<tr>
<td>4</td>
<td>Reduce mortality by minimizing the threats</td>
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<tr>
<td>5</td>
<td>Enhance, restore and reconnect populations</td>
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<tr>
<td>6</td>
<td>Promote protection of the species through legislation, policies and land use plans</td>
</tr>
</tbody>
</table>
2.3 Approaches to Recovery

Recovery action should focus attention at both local and landscape scales. At the local scale this should include: identifying and protecting hibernacula, habitat management, population surveys, habitat use determination and attempting to mitigate the impact of those roads where mortality is highest. At a broader scale, education and outreach needs to continue and expand, identifying and securing currently unprotected, important sites for the species and identifying where vegetation restoration is necessary to improve habitat linkages.

Table 2. Approaches to recovery of the Eastern Foxsnake in Ontario

<table>
<thead>
<tr>
<th>Relative Priority</th>
<th>Relative Timeframe</th>
<th>Recovery Theme</th>
<th>Approach to Recovery</th>
<th>Threats or Knowledge Gaps Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Track the state of populations and recovery of the species</td>
<td>Critical Short-term and Ongoing</td>
<td>Inventory, Monitoring and Assessment</td>
<td>1.1 Develop and implement a collaborative monitoring program across the species’ Ontario distribution that includes hibernacula population monitoring and coordinated road surveys • This program would provide information on population trends, severity of threats and effectiveness of recovery actions and threat mitigation • In depth monitoring should be undertaken at priority sites</td>
<td>Knowledge gaps: Distribution, abundance and population trends</td>
</tr>
<tr>
<td></td>
<td>Beneficial Long-term</td>
<td>Inventory, Monitoring and Assessment</td>
<td>1.2 Given the large amount of genetic structure (DiLeo et al. in press) found in the Carolinian population, this population should be sampled periodically to ensure inbreeding does not become a problem in the future and that populations are not becoming increasingly fragmented</td>
<td>Threats: Habitat loss, degradation and fragmentation</td>
</tr>
</tbody>
</table>
### Recovery Strategy for the Eastern Foxsnake (Carolinian and Georgian Bay populations) in Ontario

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<tr>
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<th>Threats or Knowledge Gaps Addressed</th>
</tr>
</thead>
</table>
| Critical          | Short-term        | Research       | 2.1 Update knowledge of distribution  
• Continue province wide compilation of records through MNR District Offices, the NHIC and Ontario Nature’s new herpetofaunal atlas  
• Identify detailed distribution pattern outside of protected areas  
• Continue and expand data recording in protected areas  
• Conduct surveys of public and professionals to collect Eastern Foxsnake presence-absence data  
• Conduct strategic field surveys to refine knowledge of distribution (e.g., Elgin County shoreline, north of Key River)  
• Conduct GIS analyses to evaluate current distribution, population connectivity and habitat use. Map known hibernacula | • Knowledge gaps: Distribution, abundance and population trends |
| Critical          | Medium-term       | Research       | 2.2 Increase knowledge of the species’ ecology and genetics  
• Conduct research on juvenile snakes to determine their ecological needs and investigate juvenile dispersal  
• Determine how much habitat is required to support a self-sustaining population of Eastern Foxsnakes in southwestern Ontario | • Knowledge gaps: Species biology and ecology |
| Beneficial        | Long-term         | Research       | 2.3 Conduct comprehensive health and disease screening  
• Determine if egg parasitism is a significant factor in egg survival | • Knowledge gaps: Threats to survival and recovery |
Recovery Strategy for the Eastern Foxsnake (Carolinian and Georgian Bay populations) in Ontario

<table>
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</tr>
</thead>
</table>
| Beneficial        | Long-term         | Research       | **2.4** Investigate impacts of pesticides and other contaminants on individuals and populations  
• Identify toxicological effects on individuals in Point Pelee National Park and Hillman Marsh Conservation Area  
• Determine if contaminants are affecting the health of other Eastern Foxsnake populations | • Knowledge gaps: Threats to survival and recovery |
| Beneficial        | Long-term         | Research       | **2.5** Investigate the scale and significance of illegal collection | • Threat: collection |
| Critical          | Short-term        | Inventory, Monitoring and Assessment | **3.1** Describe and map habitat and corridors used by Georgian Bay and Carolinian populations  
• Develop a list of priority areas (based on proximity to occupied sites or potential development) to investigate for potential Eastern Foxsnake habitat  
• Define habitat features associated with specific life history stages  
• Describe and map habitat and assess spatial needs  
• Assess the probable long-term viability of habitats from both natural and human influences  
• Determine population level habitat requirements and conditions that allow for population viability  
• Assess whether further spatial analysis of existing radio-telemetry datasets (e.g., Point Pelee National Park and Pelee Island) would yield information useful for habitat identification for those sites or inform identification at other sites | • Threats: Habitat loss and degradation  
• Knowledge gaps: Habitat needs |
## Recovery Strategy for the Eastern Foxsnake (Carolinian and Georgian Bay populations) in Ontario

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</tr>
</thead>
</table>
| Necessary        | Long-term          | Research       | 3.2 Conduct radio-telemetry studies to improve knowledge of habitat use and identify hibernacula  
• Investigate relationship between sub-populations that occur within (or partly within) protected areas and sub-populations occupying surrounding unprotected lands  
• Priority studies should include populations/systems that are representative of other populations | Knowledge gaps: Distribution, abundance, population trends; Habitat needs |
| Critical         | Short-term         | Protection     | 3.3 Identify and investigate opportunities for securing lands for conservation purposes  
• Identify landowners of key Eastern Foxsnake habitat  
• Conserve habitat through stewardship or land acquisition processes | Threat: Habitat loss and degradation |
| Critical         | Short-term         | Protection     | 3.4 Develop habitat protection guidelines  
• Ensure confidentiality of hibernacula, oviposition sites and Eastern Foxsnake concentrations  
• Develop and promote best management practices [especially with respect to development of linear facilities (e.g., roads, utility lines)] for Eastern Foxsnake. Promote the use of these guidelines by landowners and municipal planners  
• Develop guidelines for Environmental Impact Studies to ensure that Eastern Foxsnake habitat is adequately considered and addressed where development proposals occur within their range  
• Promote inclusion of habitat in Official Plans | Threat: Habitat loss and degradation; Accidental kills related to infrastructure development, upgrades or repairs |
## Recovery Strategy for the Eastern Foxsnake (Carolinian and Georgian Bay populations) in Ontario

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<th>Threats or Knowledge Gaps Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Necessary</td>
<td>Long-term</td>
<td>Protection; Management</td>
<td>3.5 Develop management actions to improve or maintain priority parcels or networks</td>
<td>Threat: Habitat degradation</td>
</tr>
<tr>
<td>Necessary</td>
<td>Long-term</td>
<td>Inventory, Monitoring and Assessment</td>
<td>3.6 Conduct research to identify hibernacula for populations where hibernacula have not been monitored or identified in the past 10 years or where locations of the significant hibernacula are unknown</td>
<td>Knowledge gap: Distribution, Threat: Habitat loss</td>
</tr>
</tbody>
</table>

### 4. Reduce mortality by minimizing threats

<table>
<thead>
<tr>
<th>Critical</th>
<th>Short-term</th>
<th>Research</th>
<th>4.1 Investigate significance of causes of mortality</th>
<th>Knowledge gaps: Threats to survival</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>• Conduct a study that examines variables associated with road mortality (e.g., Point Pelee National park, Rondeau, Long Point)</td>
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<td>• Investigate off road mortality</td>
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<td>• Investigate incidence of mortality from nets or mesh (erosion control structures, chicken wire, garden netting)</td>
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<td></td>
<td>• Investigate extent of human induced mortality in aquatic habitats and potential mitigation strategies</td>
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<td>• Investigate impact of subsidized predators (e.g., raccoons, cats, wild turkeys) on adults, neonates and eggs</td>
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<td></td>
<td></td>
<td></td>
<td>• Determine significance of each mortality factor across range and within populations</td>
<td></td>
</tr>
<tr>
<td>Critical</td>
<td>Short-term</td>
<td>Stewardship; Protection; Management</td>
<td>4.2 Develop, implement and evaluate mitigation measures for various human caused impacts and mortality</td>
<td>Threats: Road mortality, Human persecution and Accidental mortality</td>
</tr>
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<td></td>
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<td></td>
<td>• Erect signage along known areas of high road mortality</td>
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<td>• Encourage temporary road closures in protected areas during periods of high mortality</td>
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</tbody>
</table>
### Recovery Strategy for the Eastern Foxsnake (Carolinian and Georgian Bay populations) in Ontario

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<th>Approach to Recovery</th>
<th>Threats or Knowledge Gaps Addressed</th>
</tr>
</thead>
</table>
| Critical          | Short-term         | Protection; management; stewardship | **4.3** Identify locations of hibernacula and other significant habitat that are inside and outside of protected areas  
- Focus on areas where new development projects or decommissioning projects (e.g., building demolition, well decommissioning) are proposed  
- Acquire detailed site-specific information  
- Increase awareness of the presence of Eastern Foxsnakes particularly where activities could contravene section 9 and 10 of the ESA 2007 (e.g., municipal departments, utility companies)  
- Identify a chain of custody or protocol to be used if hibernating Eastern Foxsnakes are accidentally unearthed | All Threats |
| Necessary         | Short-term         | Communications, Education and Outreach | **4.4** Identify organizations involved in recovery and integrate communications with existing programs  
- All Threats |
| Necessary         | Short-term         | Communications, Education and Outreach | **4.5** Evaluate effectiveness of existing outreach programs to identify gaps and make improvements  
- All Threats |
| Necessary         | Short-term         | Communications, Education and Outreach | **4.6** Promote Eastern Foxsnake (and other species at risk) as an integral part of the interpretation programs at parks where Eastern Foxsnakes occur  
- All Threats |
## Recovery Strategy for the Eastern Foxsnake (Carolinian and Georgian Bay populations) in Ontario

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</tr>
</thead>
<tbody>
<tr>
<td>Beneficial</td>
<td>Short-term</td>
<td>Communications, Education and Outreach</td>
<td>4.7 Plan and create resource presentation materials for adult audiences to be used by outreach extension volunteers</td>
<td>All Threats</td>
</tr>
<tr>
<td>Necessary</td>
<td>Short-term</td>
<td>Communications, Education and Outreach</td>
<td>4.8 Conduct outreach to farm workers and rural residents in areas where Eastern Foxsnakes are likely to be encountered</td>
<td>All Threats</td>
</tr>
<tr>
<td>Beneficial</td>
<td>Short-term</td>
<td>Communications, Education and Outreach</td>
<td>4.9 Develop, promote and implement citizen science program (e.g., road mortality survey)</td>
<td>All Threats &amp; Knowledge gaps: Distribution, abundance and population trends</td>
</tr>
</tbody>
</table>

### 5. Enhance, restore and reconnect populations

<table>
<thead>
<tr>
<th>Necessary</th>
<th>Long-term</th>
<th>Stewardship; Management</th>
<th>5.1 Restore habitat</th>
<th>Threats: Habitat degradation &amp; Knowledge gaps: Threats to survival</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>• Review and summarize all potentially useful restoration practices (e.g., artificial nesting sites, artificial hibernacula, habitat manipulation techniques, ecological restoration)</td>
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<td>• Identify potential locations where habitat restoration would improve or increase habitat</td>
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<td>• Implement restoration practices in a strategic manner, including site-specific monitoring</td>
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<td></td>
<td>• Explore opportunities to restore habitat linkages between isolated populations in southwestern Ontario</td>
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<td>• Identify potential partners, including other species recovery teams, as the recovery of several species at risk may be involved</td>
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<td>Relative Priority</td>
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<td>Recovery Theme</td>
<td>Approach to Recovery</td>
<td>Threats or Knowledge Gaps Addressed</td>
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<td>Beneficial</td>
<td>Long-term</td>
<td>Research</td>
<td>5.2 Experimentally evaluate restoration practices</td>
<td>• Threats: Habitat loss and degradation</td>
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| Beneficial       | Long-term         | Management; Stewardship | 5.3 Based on results of experimental evaluation of restoration practices and research into threats and ecology, develop and implement a strategy to enhance, restore and/or reconnect populations  
• Evaluate monitoring results and adjust management practices accordingly | • All Threats |
| 6. Promote protection of the species through legislation, policies and land use plans |                    |                          |                                                                                      |                                     |
| Critical         | Short-term        | Protection              | 6.1 Inform specific landowners of legal protection given to hibernacula and oviposition sites through letters or outreach | • All Threats |
| Critical         | Short-term        | Protection              | 6.2 Develop and deliver training workshops and materials to engage wildlife officers    | • All Threats |
Narrative to Support Approaches to Recovery

**Approach 1.1**
Monitoring protocols and methods for identifying hibernacula should be tested.

Trends in range occupation should be compared every five years. If possible, populations at selected communal hibernacula should be monitored over the long term as a measure of comparison.

The status of Eastern Foxsnakes on the Long Point peninsula should be assessed and, if a decline is found, the cause should be determined.

**Approach 1.2**
A recent comprehensive genetic study quantified the genetic population across southwestern Ontario (DiLeo et al. in press). Across Essex, Chatham-Kent and Lambton counties there was a significant amount of genetic structure. Across this relatively small area there were approximately five genetic clusters with very little gene flow between the clusters. For most clusters it appears that cluster size is large enough to avoid problems with inbreeding. However, this approach proposes monitoring to ensure inbreeding and further fragmentation do not become problems.

**Approach 2.1**
Field Surveys and/or questionnaires to determine where potentially viable populations occur in Eastern Georgian Bay and southwestern Ontario outside of protected areas are needed. Areas where infrequent observations have been reported should be investigated further. Any reported observations should be correlated to habitat conditions and ground truthed. This will help determine limits of range and investigate apparent occurrence gaps where habitat should be protected. These studies should be completed within the next three to five years.

**Approach 3.1**
It appears that in southwestern Ontario Eastern Foxsnakes are dependent on a landscape that includes a mosaic of features that provide the essential components to support their life cycle. They survive in relatively open habitats but likely need a critical minimal amount (i.e., percentage of the landscape) of natural vegetation that can provide sites for hibernation, oviposition, foraging and movement corridors. Presumably there is a critical minimum amount of wetland and habitat linkage, beyond which the Eastern Foxsnakes will not survive. Radio-telemetry data from the few sites available should to be superimposed on detailed vegetation maps so that movement patterns can be realized in the context of a given landscape mosaic. Further radio-telemetry studies are recommended because data from Point Pelee National Park and Pelee Island are not representative of most of the Eastern Foxsnake’s range of occupancy in southwestern Ontario, since those areas contain relatively large core blocks of habitat. Other populations occur in landscapes where required habitat features may be very fragmented. A series of studies to define habitat and examine issues is recommended over the next five years.
Radio-telemetry studies are expensive, time consuming and difficult to conduct outside of protected areas due to the need to obtain access permission from multiple landowners. An analysis of landscape features associated with reliable observation records compiled by the NHIC (e.g., distance to shorelines, distance to wetlands) should be conducted to evaluate the data’s potential to inform habitat identification in areas lacking detailed data instead of conducting a radio-telemetry study. This work should be completed in the next three to five years.

**Approach 3.2**

The priority for radio-telemetry based studies should be Eastern Foxsnake populations/systems in southern Ontario that can reasonably be considered the most representative of other southern Ontario populations. Because some sites will have wider applicability, and because it is not realistic to consider studying all populations, strategically locating studies will be an important first step. For example, studies at Long Point (Provincial Park and National Wildlife Area) and/or Rondeau Provincial Park have the potential to provide spatial data that would best represent “sand-spit” populations, whereas radio-telemetry studies conducted further inland would provide better inference to sites with similar landscape characteristics (e.g., agricultural land bordered by hedgerows).

Hibernacula are critically important habitat features since a significant portion of a local population could congregate there during winter months. From a protection perspective, identifying hibernacula is a challenge that is best accomplished by labour-intensive radio-telemetry studies. This may limit the ability to effectively protect some populations outside of protected areas and needs to be weighed against the potential losses of individuals resulting from such a study. Clearly, radio telemetry will not be possible in most areas of Eastern Foxsnake range occupancy, which emphasizes the need to protect sizeable blocks of habitat outside of existing protected areas.

**Approach 3.4**

In order to alleviate threats, government agencies, land resource managers, municipal planners, land developers, landowners and the public should become much more aware of and take into consideration the species’ ecological requirements. In short, rural landscapes should be used in ways compatible with the needs of snake populations.

**Approach 5.1**

In southwestern Ontario, habitat connectivity will probably need to be actively restored (e.g., linkages between habitat patches reconnected) so that Eastern Foxsnakes can move through the landscape in relative safety. Otherwise isolated populations may not be viable in the long term. By contrast, sensitive land-use management and restrained land development may be sufficient to maintain large tracts of quality habitat and healthy, interacting populations along Georgian Bay. However, it is important to ensure that habitats are not fragmented and bisected with roads and that habitat connectivity is maintained, as development pressures are mounting.
Recovery efforts should be coordinated with existing landscape conservation initiatives. Substantial wetland restoration in southwestern Ontario would not only help Eastern Foxsnakes, but also many other species at risk. Participation with organizations such as the North American Wetland Conservation Council (Canada), Eastern Habitat Joint Venture, Nature Conservancy Canada and Ontario Stewardship could play a big role.

2.4 Area for Consideration in Developing a Habitat Regulation

Under the ESA 2007, a recovery strategy must include a recommendation to the Minister of Natural Resources on the area that should be considered in developing a habitat regulation. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below by the recovery team will be one of many sources considered by the Minister when developing the habitat regulation for this species.

Given the high fidelity of Eastern Foxsnakes to their hibernacula, and the communal nature of hibernacula, and given the communal nature and repeated use of oviposition sites and their importance to reproductive success, it is recommended that these sites be prescribed as habitat in a habitat regulation for the species. These sites are essential to ensure a population’s persistence in a given area or region.

Hibernation Habitats
Because of the high site fidelity that Eastern Foxsnakes show to hibernacula, as well as the communal nature of these microhabitats, destruction of this type of habitat could have a catastrophic impact on local population viability. Hence, these habitat features should be considered the most important to protect. All identified hibernacula, including natural and anthropogenic sites, should be prescribed as habitat in a habitat regulation. Natural hibernacula that are structurally stable should be protected indefinitely, whereas anthropogenic sites, which can degrade to an unusable state faster than geological or bedrock-based features, should be protected while they still have the potential to function as hibernation habitat for the species.

Data collected from known hibernacula indicate that the subterranean portion of these habitats can extend several metres laterally from the entrance/exit, which is often an inconspicuous hole or fissure in the substrate. It is therefore recommended that the area within 100 metres of the known or suspected entrance/exit be identified as habitat in a habitat regulation. If there are multiple known or suspected entrances/ exits, then the identified area should be generated accordingly. The 100 metre area should extend from the perimeter of a known hibernaculum or from a known or suspected entrance to a hibernaculum where the exact location of the hibernaculum itself has not been identified. It is the expert opinion of the recovery team that this approach would ensure that all components of a hibernaculum remain functional, including any basking or staging areas used by foxnakes in the days/weeks before entering hibernation in the fall and emerging in the spring.
Recovery Strategy for the Eastern Foxsnake (Carolinian and Georgian Bay populations) in Ontario

**Georgian Bay population:** Within the area of occurrence of the Georgian Bay population, all known hibernation sites are located within 100 metres of the high-water mark, excluding one unique limestone outlier in the Port Severn area, and generally occur within, but are not limited to, areas with vertical structure (R. Willson pers. comm. 2004, Lawson 2005, MacKinnon 2005, J. Rouse pers. comm. 2005). The recovery team, through expert study and opinion, estimates that less than five percent of the hibernation sites are known, because hibernation sites are difficult to identify due in part to the subterranean nature and the lack of persons in the areas to observe Eastern Foxsnakes during egress and ingress which occur in early spring and fall. Thus, as a precautionary approach to protect undetected hibernacula, the recovery team recommends that the area within 100 metres of the high-water mark be protected until such time as it has been determined that Eastern Foxsnake hibernacula do not occur in the specific area.

**Carolinian population:** The vast majority of hibernation sites have not been identified across the Carolinian region. Given that virtually any structure that extends below the frost line could comprise a hibernaculum, any probable hibernacula within the current occupied range of the Carolinian population should be prescribed as habitat within a habitat regulation. It is the opinion of the recovery team that a probable hibernaculum is any natural or anthropogenic structure that extends below the frost line within 1500 metres of an area where one or more Eastern Foxsnakes have been observed in the past ten years. Row et al. (in prep.) found that the average maximum distance from hibernation for Eastern Foxsnakes radio-tracked at Point Pelee National Park and Hillman Marsh Conservation Area was 1500 metres. The ten year period is recommended as a precautionary approach due to the normal life span of Eastern Foxsnakes, the subterranean nature of hibernacula, the lack of long-term intensive radio-telemetry work on these populations, the number of private landowners, lack of permission to access private property and the lack of persons in the areas to observe Eastern Foxsnakes during egress and ingress which occur in early spring and fall. Since all of the communal hibernation sites identified through radio telemetry from 2007 to 2009 appeared to be in man-made structures, including sites in parks and protected areas (J. Row pers. comm. 2009), this protection should apply to both natural and anthropogenic features.

**Oviposition Habitats**
Oviposition occurs in rock crevices, dune slopes, manure piles, compost piles, rotting logs and masses of dead vegetation. Oviposition sites are often communal and females bask near the chosen oviposition site for several days or more prior to, during and after oviposition (J. Row pers. comm. 2009). It is suspected that neonates remain near the nest site up to several weeks after hatching (J. Row pers. comm. 2009). Once an oviposition site is identified, an area 30 metres surrounding it should be prescribed as habitat in a habitat regulation. It is the recovery team’s expert opinion that 30 metres (average tree height) will ensure that the themoregulatory properties of the site are maintained and will encompass nearby basking/resting sites and travel corridors around the oviposition site.
It is recommended that the features prescribed as habitat in a habitat regulation include both natural and artificial oviposition sites. With the exception of oviposition sites that occur within fractures in the bedrock or under large table rocks, the physical characteristics of sites functioning as nests are ephemeral and are often suitable for oviposition for a few years. The vegetative components of the site continue to decompose until the conditions are no longer selected for oviposition. It is recommended that oviposition sites that naturally decompose (e.g., large rotting trees) be prescribed as habitat until two years after the last known use of the site and the feature can no longer support conditions required for nest survival. Structurally stable oviposition sites should be protected indefinitely. For man-made oviposition structures (e.g., compost piles, wood piles) the duration should be for the time period when the snakes could be occupying the habitat (usually July through October for oviposition sites).

It is recommended that any feature (natural or man-made) that appears to have the physical characteristics necessary to function as an oviposition site be included in the regulation if Eastern Foxsnakes have been observed within 30 metres of the feature during the oviposition period regardless of whether eggs are found.

Georgian Bay population: In the range of the Georgian Bay population, it is recommended that all potential oviposition structures in appropriate habitat within 100 metres of the high-water mark (or in the exception area in Port Severn) should be prescribed as habitat in a habitat regulation for the duration of the structure’s natural life: for geological formations that are structurally stable rock-based sites that is indefinitely, while for sites that naturally decompose (e.g., large rotting trees) the duration would be less.

Carolinian population: Most oviposition areas have not been identified for this species. Due to the ephemeral nature of the oviposition sites used by the Carolinian population, it is the expert opinion of the recovery team that all potential natural oviposition features that are consistent in composition with, and which occur within 1 kilometre of known occupied oviposition sites (natural, anthropogenic or artificial), should also be prescribed as habitat in a habitat regulation for the duration of the feature’s natural life. This recommendation is based on the rationale that females can move one kilometre or more to nest sites.

Other Habitat Areas
In addition to sites for hibernation and oviposition, Eastern Foxsnakes require habitat areas for foraging, mating, thermoregulation, shedding and movement corridors.

Georgian Bay population: It is recommended that the area along Georgian Bay including the water between the shoreline and the outer islands and all lands (i.e., terrestrial and aquatic) and islands within 1 kilometre from the high-water mark be prescribed as habitat for Eastern Foxsnakes in a habitat regulation. The distance was established from two extensive research projects (Lawson 2005, MacKinnon 2005), NHIC and local MNR Eastern Foxsnake distribution data. This area extends from the
north side of the French River mouth to north side of the Severn River mouth and the eastern side of the Penetanguishene Peninsula, excluding established developed urban areas (e.g., Town of Parry Sound). In these urban areas, 100 metres from the high-water mark should be prescribed as habitat in a habitat regulation. A distance of 100 metres is recommended in these areas because the density of roads and loss of natural inland habitat has essentially excluded Eastern Foxsnakes from these areas (J. Rouse pers. comm. 2010). Additionally, the geological limestone outlier in the Port Severn area (which is more than 1 kilometre from the shoreline and is the only known hibernation complex further than 100 metres from high-water mark) and the lands one kilometre [related to the distance Eastern Foxsnakes travel from this hibernation site (R. Willson pers. comm. 2004, MacKinnon 2005)] out from the base of the geological limestone outlier and/or east to the four-lane Highway 400 should also be prescribed as habitat.

Within the Georgian Bay range, Eastern Foxsnakes have been found to congregate at shedding sites and use them in successive years (A. Lawson pers. comm. 2004). These traditionally used communal shedding sites should also be prescribed as habitat in a habitat regulation.

Carolinian Population: It is recommended that the marsh and prairie habitat within the current occupied range of the Carolinian population be prescribed as habitat in a habitat regulation to preserve ecosystem function (e.g., prey abundance).

For the Carolinian population, it is recommended that old fields, habitat bordering sewage lagoons, woodlands, natural and restored prairie habitat, and patches of habitat (riparian, grass, or hedgerow) along drainage ditches, creeks, roads and railway tracks be considered for inclusion in the area prescribed as habitat in a habitat regulation.

Upland hedgerows between riparian features or other core habitat areas and vegetated bluffs associated with the Lake Erie shoreline or ravines can be very important to Eastern Foxsnakes in this highly fragmented region (Gould pers. comm. 2010, Woodliffe pers. comm. 2010). These vegetation features provide important movement corridors between larger contiguous habitat patches and can contain specific habitat features such as compost piles and rotting logs for oviposition, vegetation suitable for shedding, foraging areas and rock or debris piles for thermoregulation (Gould pers. comm. 2010, Woodliffe pers. comm. 2010). Some of these features will be more significant to the species than others. Due to knowledge gaps regarding Eastern Foxsnake distribution in much of its Carolinian range, individual vegetation patches or features may need to be assessed to determine if they represent important habitat for the species. Considering that several new Eastern Foxsnake locations are documented within the Carolinian zone each year (Gould pers. comm. 2010) it may be more practical to evaluate habitat areas and features on a site specific basis. It is recommended that any vegetation patch or specific feature that is known to provide habitat for Eastern Foxsnakes, from existing information or through future evaluation, be prescribed as habitat in a habitat regulation.
GLOSSARY

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee responsible for assessing and classifying species at risk in Canada.

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

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

1 = critically imperilled
2 = imperilled
3 = vulnerable
4 = apparently secure
5 = secure

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

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

*Species at Risk Act (SARA)*: The federal legislation that provides protection to species at risk in Canada. This act establishes Schedule 1 as the legal list of wildlife species at risk to which the SARA provisions apply. Schedules 2 and 3 contain lists of species that at the time the act came into force needed to be reassessed. After species on Schedule 2 and 3 are reassessed and found to be at risk, they undergo the SARA listing process to be included in Schedule 1.

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


Row, J.R., G. Blouin-Demers, and S.C. Lougheed. in prep. Effects of habitat loss and fragmentation on movement and habitat use of eastern foxsnakes (*Mintonius gloydi*) at three spatial scales.


## Recovery Strategy Development Team Members

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation and Location</th>
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<tr>
<td><strong>Recovery Strategy Development Team</strong></td>
<td></td>
</tr>
<tr>
<td>Gary Allen (Co-Chair)</td>
<td>Parks Canada</td>
</tr>
<tr>
<td>Jeremy Rouse (Co-Chair)</td>
<td>Ontario Ministry of Natural Resources, Parry Sound District</td>
</tr>
<tr>
<td>Ryan Bolton</td>
<td>University of Guelph</td>
</tr>
<tr>
<td>Ron Brooks</td>
<td>University of Guelph</td>
</tr>
<tr>
<td>Graham Cameron</td>
<td>Ontario Ministry of Natural Resources, Bancroft District</td>
</tr>
<tr>
<td>Glenn Cunnington</td>
<td>Carleton University</td>
</tr>
<tr>
<td>Sandy Dobbyn</td>
<td>Ontario Ministry of Natural Resources, Ontario Parks, Southwest Zone</td>
</tr>
<tr>
<td>Todd Farrell</td>
<td>The Nature Conservancy of Canada</td>
</tr>
<tr>
<td>Scott Gillingwater</td>
<td>Upper Thames River Conservation Authority</td>
</tr>
<tr>
<td>Ron Gould</td>
<td>Ontario Ministry of Natural Resources, Aylmer District</td>
</tr>
<tr>
<td>James Kamstra</td>
<td>AECOM</td>
</tr>
<tr>
<td>Burke Korol</td>
<td>Ontario Ministry of Natural Resources, Ontario Parks, Central Zone</td>
</tr>
<tr>
<td>Anna Lawson</td>
<td>Formerly Ontario Ministry of Natural Resources, Southern Region Planning Unit</td>
</tr>
<tr>
<td>Andrew Lentini</td>
<td>Toronto Zoo</td>
</tr>
<tr>
<td>Stephen Lougheed</td>
<td>Queens University</td>
</tr>
<tr>
<td>Alistair MacKenzie</td>
<td>Ontario Ministry of Natural Resources, Ontario Parks, Pinery Provincial Park</td>
</tr>
<tr>
<td>Carrie MacKinnon</td>
<td>Independent</td>
</tr>
<tr>
<td>Angela McConnell</td>
<td>Environment Canada, Canadian Wildlife Service – Ontario</td>
</tr>
<tr>
<td>Vicki M’Kay</td>
<td>Parks Canada, Point Pelee National Park</td>
</tr>
<tr>
<td>Andrew Promaine</td>
<td>Parks Canada, Georgian Bay Islands National Park</td>
</tr>
<tr>
<td>Jeff Row</td>
<td>Queens University</td>
</tr>
<tr>
<td>Roxanne St. Martin</td>
<td>Ontario Ministry of Natural Resources, Southern Region Planning Unit</td>
</tr>
<tr>
<td>Rob Willson</td>
<td>Riverstone Environmental Solutions</td>
</tr>
<tr>
<td><strong>Advisors, Associate Members and Additional Contacts</strong></td>
<td></td>
</tr>
<tr>
<td>Gabriel Blouin-Demers</td>
<td>University of Ottawa</td>
</tr>
<tr>
<td>Ron Black</td>
<td>Ontario Ministry of Natural Resources, Parry Sound District</td>
</tr>
<tr>
<td>NAME</td>
<td>AFFILIATION and LOCATION</td>
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</tr>
<tr>
<td>Peter Carson</td>
<td>Norfolk Field Naturalists</td>
</tr>
<tr>
<td>Joe Cebek</td>
<td>Trent University</td>
</tr>
<tr>
<td>Glenda Clayton</td>
<td>Georgian Bay Biosphere Reserve</td>
</tr>
<tr>
<td>Mary Gartshore</td>
<td>Norfolk Field Naturalists</td>
</tr>
<tr>
<td>Angie Horner</td>
<td>Environmental Services Professional</td>
</tr>
<tr>
<td>Briar Howes</td>
<td>Parks Canada</td>
</tr>
<tr>
<td>Deb Jacobs</td>
<td>Formerly Ontario Ministry of Natural Resources, current Ontario Ministry of the Environment</td>
</tr>
<tr>
<td>Bob Johnson</td>
<td>Toronto Zoo, University of Toronto</td>
</tr>
<tr>
<td>Talena Kraus</td>
<td>Artemis Eco-Works</td>
</tr>
<tr>
<td>Jan McDonnell</td>
<td>Ontario Ministry of Natural Resources, Parry Sound District</td>
</tr>
<tr>
<td>Michael Oldham</td>
<td>Ontario Ministry of Natural Resources, Natural Heritage Information Centre</td>
</tr>
<tr>
<td>John Osmok</td>
<td>Ontario Ministry of Natural Resources, Midhurst District</td>
</tr>
<tr>
<td>Paul Pratt</td>
<td>Ojibway Nature Centre</td>
</tr>
<tr>
<td>Kent Prior</td>
<td>Parks Canada</td>
</tr>
<tr>
<td>Don Rivard</td>
<td>Parks Canada</td>
</tr>
<tr>
<td>Regina Varrin</td>
<td>Ontario Ministry of Natural Resources, Biodiversity Section</td>
</tr>
<tr>
<td>Allen Woodliffe</td>
<td>Ontario Ministry of Natural Resources, Aylmer District</td>
</tr>
</tbody>
</table>