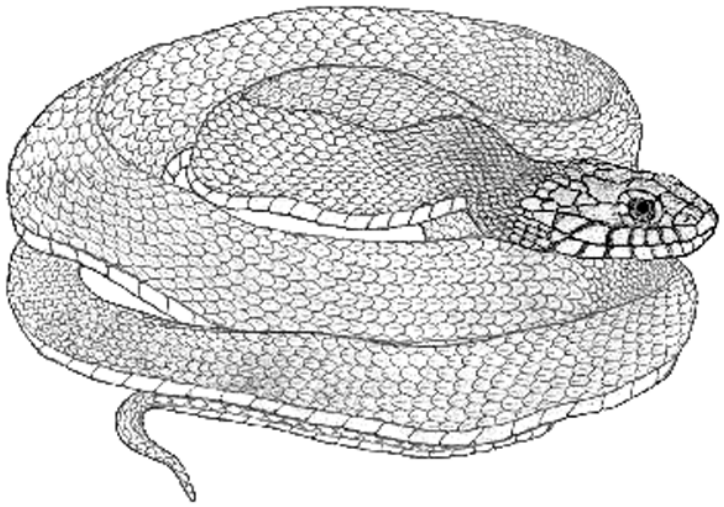
COSEWIC
Assessment and Update Status Report

on the

Lake Erie Watersnake
Nerodia sipedon insularum

in Canada



ENDANGERED
2006

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION
DES ESPÈCES EN PÉRIL
AU CANADA

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

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COSEWIC would like to acknowledge Ryan M. Bolton for writing the update status report on the Lake Erie watersnake *Nerodia sipedon insularum* in Canada, prepared under contract with Environment Canada, overseen and edited by Ron Brooks, Co-chair (Reptiles) of the COSEWIC Amphibians and Reptiles Species Specialist Subcommittee.

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COSEWIC
Assessment Summary

Assessment Summary – April 2006

Common name
Lake Erie Watersnake

Scientific name
Nerodia sipedon insularum

Status
Endangered

Reason for designation
It has a small population, likely fewer than 1000 adults, confined to four small Canadian islands in western Lake Erie. Threats, which include loss of its shoreline habitats, mortality on roads, and destruction of hibernacula by quarries and construction, are increasing. Although persecution by people may be levelling off, it is still a significant threat to these snakes.

Occurrence
Ontario

Status history
Designated Endangered in April 1991 and in April 2006. Last assessment based on an update status report.

COSEWIC
Executive Summary

Lake Erie Watersnake
Nerodia sipedon insularum

Species information

The Lake Erie Watersnake, *Nerodia sipedon insularum*, is one of two subspecies of the Northern Watersnake, *Nerodia sipedon* (family Colubridae), found in Canada. Lake Erie Watersnakes range in colour from being regularly patterned with dark dorsal and lateral blotches to a uniform gray (often a drab greenish or brownish) without pattern. The colour of the ventral scales is generally white or yellowish white, often with dark speckling. The Lake Erie Watersnake is moderately heavy-bodied. The head is large and covered with broad, smooth scales and the body scales are “keeled” with a ridge down the middle. The Lake Erie Watersnake is non-venomous but readily bites when handled. Adult males average between 59 and 71 cm mean snout to vent length (SVL) and adult females average between 80 and 88 cm mean SVL.

Distribution

The Lake Erie Watersnake has one of the smallest distributions of any snake in North America. In its Canadian range, the Lake Erie Watersnake is known to occur only on four small islands in the western basin of Lake Erie (East Sister, Hen, Middle, and Pelee Islands). In the United States, the Lake Erie Watersnake occurs in a small shoreline area of the Ohio mainland and on 11 Ohio islands in the western end of Lake Erie.

Habitat

During the active season, the Lake Erie Watersnake occupies rocky or sandy shorelines, and limestone or dolomite shelves and ledges with cracks and varying levels of vegetation. Natural and human-made rock berms are also utilized. The snakes feed in the water but rarely go more than 50 m from shore while foraging. Watersnakes are rarely found more than 100 m inland during the active season and distance travelled inland is dependent on availability of cover and prey, presence of predators, and suitable basking and escape areas. Inland locations are also used by Lake Erie Watersnakes for hibernation. The hibernation sites are usually cavities and crevices, and are typically composed of soil and rock substrates.

Biology

The Lake Erie Watersnake can live up to 12 years in the wild. Females reach sexual maturity at 3 years of age and males mature at 2 years. Courtship involves scramble competition in which several males court one female simultaneously. Some females reproduce annually. Females give birth to live young and litter size averages 23 and is positively related to the female's size. The Lake Erie Watersnake's previous prey of logperch (*Percina* caprodes) and other darters has been largely replaced with the round goby (*Neogobius melanostomus*) which has recently invaded Lake Erie.

Population sizes and trends

Lake Erie Watersnakes were reported in great numbers on several islands of western Lake Erie from the early 1800s and up to the early 1960s. Subsequently, populations have decreased sharply throughout their range. The restricted range of the Lake Erie Watersnake on the islands of western Lake Erie and a low rate of inter-island dispersal make populations vulnerable to stochastic events. The growing number of human inhabitants on these islands increases mortality due to roadkill, persecution and increased loss of habitat.

Limiting factors and threats

The Lake Erie Watersnake's extremely small geographic range, its restriction to islands and its limited population size amplify the threats that are also affecting many other reptiles in Canada. Increasingly, shoreline and inland development on islands for recreation, summer homes, and tourism is destroying and degrading the snakes' habitat. Although roadkill and predators contribute to watersnake mortality, the main threat to watersnake populations may still be human persecution. Current studies are examining contaminant concentrations and their effects on Lake Erie Watersnakes. Contaminant levels may be an issue for this snake because its diet largely consists of round gobies that feed on filter-feeding Zebra and Quagga mussels (*Dreissena polymorpha* and *Dreissena bugensis*, respectively), which occur in the contaminated waters of western Lake Erie.

Special significance of the species

The Lake Erie Watersnake possesses a colour pattern polymorphism that has provided a rare illustration of microevolutionary change involving effects of selection, gene flow, inheritance, and population history. The subspecies displays local adaptations to living in island habitats that have reduced vegetative cover. Hence, it is genetically and ecologically different from the Northern Watersnake (*N. s. sipedon*).

Existing protection

Globally, NatureServe lists the Lake Erie Watersnake taxon as imperilled (global rank is G5T2). NatureServe lists the Lake Erie Watersnake as imperilled (S2) in

Ontario. The IUCN has not evaluated *N. s. insularum*. In Canada, *N. s. insularum* was assessed as Endangered by COSEWIC in 1991. In Ontario, it is a regulated species under the Ontario Endangered Species Act and is a specially protected reptile under the Ontario Fish and Wildlife Conservation Act. In the United States, this species is listed as Threatened under the Federal List of Endangered and Threatened Wildlife, and Endangered by the state of Ohio and the Ohio Division of Parks and Recreation.

COSEWIC HISTORY

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

COSEWIC MANDATE

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

COSEWIC MEMBERSHIP

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

DEFINITIONS (2006)

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

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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Canada

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

Update
COSEWIC Status Report

on the

Lake Erie Watersnake
Nerodia sipedon insularum

in Canada

2006

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SPECIES INFORMATION

Name and classification

Nerodia sipedon insularum (Lake Erie Watersnake / Couleuvre d'eau du lac Érié) was designated as a distinct taxon by Conant and Clay (1937). *Nerodia s. insularum* is one of two subspecies of the Northern Watersnake (*Nerodia sipedon*) in Canada, the other being the Northern Watersnake (*Nerodia sipedon sipedon;* Crother *et al*. 2000, Crother *et al*.2001).

Morphological description

Dorsal patterns of the Lake Erie Watersnake are highly variable among individuals, ranging from uniformly gray, drab greenish, or brownish yellow and unpatterned or blotchless to regularly patterned with dorsal and lateral blotches (Conant and Clay 1937; Conant and Clay 1963; King 1986, 1998; King and Lawson 1995, 1997). The relative size and position of pattern elements remain fixed over the life of the snake (King 1993a as cited in USFWS 2003). The ventral surface tends to be white or yellowish white (often with dark speckling) with the bases of ventral scales the same colour as the dorsum (Conant and Clay 1937). The body scales are keeled, that is, each scale has a ridge down the middle. The snake has a single anal plate.

The Lake Erie Watersnake is non-venomous but can become aggressive if threatened. Its defensive posture is to flatten the head and body and attempt to strike. The Lake Erie Watersnake is a large snake reaching lengths at maturity of 43-125 cm snout-to-vent length (SVL) (King 1986). On Pelee and Middle Islands, mature males are between 59.1 and 71.6 cm SVL, and adult females measure between 80.2 and 88.2 cm SVL (King 1986; King 1998). Similar average sizes were found in 1999 on Pelee Island where gravid females ranged between 68 and 95 cm SVL (Bishop and Rouse unpubl. data 1999).

The Lake Erie Watersnake differs from other watersnakes by being more grayish in colouration and by having a partial or complete lack of blotches or banding (Conant and Clay 1937), whereas the Northern Watersnake has a regular, strongly-banded pattern. The Lake Erie Watersnake also lives almost exclusively on the islands of western Lake Erie (Conant and Clay 1963), whereas the Northern Watersnake is found on the mainland in Ohio and many other central and eastern states in the U.S. and in Ontario and Quebec in Canada. The habitat of Lake Erie Watersnakes is largely composed of rocky shorelines, or limestone or dolomite shelves and ledges with cracks and sparse vegetation, whereas Northern Watersnakes occur in more thickly vegetated habitats with mud, soil, or clay substrate (Conant 1951). The Lake Erie Watersnake also differs from the Northern Watersnake in diet and morphology (shorter tail and larger adult body size) (Conant 1951; Langlois 1964; King 1986, 1989, 1993a).

Genetic description

Populations on the islands of western Lake Erie are separated from the Ohio and Ontario mainland populations by 5 to 14 km of water which acts as a natural barrier (USFWS 2003). In addition to unpatterned individuals, both intermediate and regularly patterned individuals are found on the islands. This variation suggests that mainland Northern Watersnakes and the island-dwelling Lake Erie Watersnakes still intergrade. Gene flow is created by movement among and between islands and the mainland, thereby increasing genetic variation more than if the populations were completely isolated (King and Lawson 1997). However, inter-island movements appear to be rare and have only been documented twice (King 2002, D. Jacobs pers. comm. July 2005). Genetic analysis of allozyme variation suggests that 0.08% - 1% of island populations (*N. s. insularum*) are replaced by mainland (*N. s. sipedon*) individuals per generation (King and Lawson 1995, 1997). Frequency of the various colour patterns seems to have been stable from 1980 to the present suggesting that selection and gene flow have also remained stable over this period (King 2004a). Reduced and intermediate patterns appear to be favoured on islands because reduced patterning is more cryptic against the bare, rocky shorelines (King 1992, 1993b, 1993c, King and Lawson 1995; King *et al*. 1997).

DISTRIBUTION

Global range

The Lake Erie Watersnake has one of the smallest distributions of any snake on the continent (Campbell *et al.* 1991), having a global range of less than 40 km in diameter (King 1998) (Fig. 1). The Lake Erie Watersnake is only found on islands in the western end of Lake Erie between Catawba/Marblehead Peninsula in Ohio and Point Pelee in Ontario. Historically, *N. s. insularum* had a range that included 22 or more offshore islands and rock outcrops of western Lake Erie (USFWS 2003). Reports dating back to 1893 suggest that the Lake Erie Watersnake was observed on all islands in western Lake Erie (King 1998). Recently, Lake Erie Watersnakes have been observed on Ballast, Gibraltar, Gull, Green, Kelleys, Middle Bass, North Bass, Rattlesnake, South Bass, Starve, and Sugar Islands in the U.S. (USFWS 2003). Excluding Starve and Gull islands (reportedly too small to provide hibernacula), the U.S. islands in the western end of Lake Erie provide approximately 68 km of critical shoreline habitat (King 1998).

Figure 1. Global distribution of the Lake Erie watersnake (*Nerodia sipedon insularum*) (indicated with a tiny arrow).

Canadian range

In Canada, the Lake Erie Watersnake has been observed on the following nine islands: Big Chicken, Chick, East Sister, Hen, Little Chicken, Middle, Middle Sister, North Harbour, and Pelee (USFWS 2003; Figs 1, 2). All nine islands are located in Ontario in the western end of Lake Erie near the U.S. border (Fig. 1). Although historical evidence indicates Lake Erie Watersnakes once existed on all nine islands, only six of the islands (East Sister, Hen, Middle, Middle Sister, North Harbour, and Pelee) have been extensively or casually surveyed since the early 1980s (King 1987a; King *et al*. 1997). Lack of observation of watersnakes during recent short searches suggests that watersnakes no longer exist on North Harbour and Middle Sister Island (King *et al.* 1997). However, since researchers have been denied access to North Harbour and Middle Sister Islands (they are privately owned), these observations are based on only one or a few visits and the absence or presumed extirpation of the Lake Erie Watersnake on these islands is not conclusive. The last observation records for North Harbour and Middle Sister Islands, the two most westerly Canadian islands, were in 1939 and 1941, respectively (King *et al.* 1997). The Ontario islands account for 41 km (or approximately 38%) of the global 109 km of critical shoreline habitat (King 1998). Pelee Island is the largest island (47 km^2/4091 ha) in the Lake Erie Watersnake's range and also supports the largest population in Canada (Campbell *et al.* 1991; NatureServe 2005).

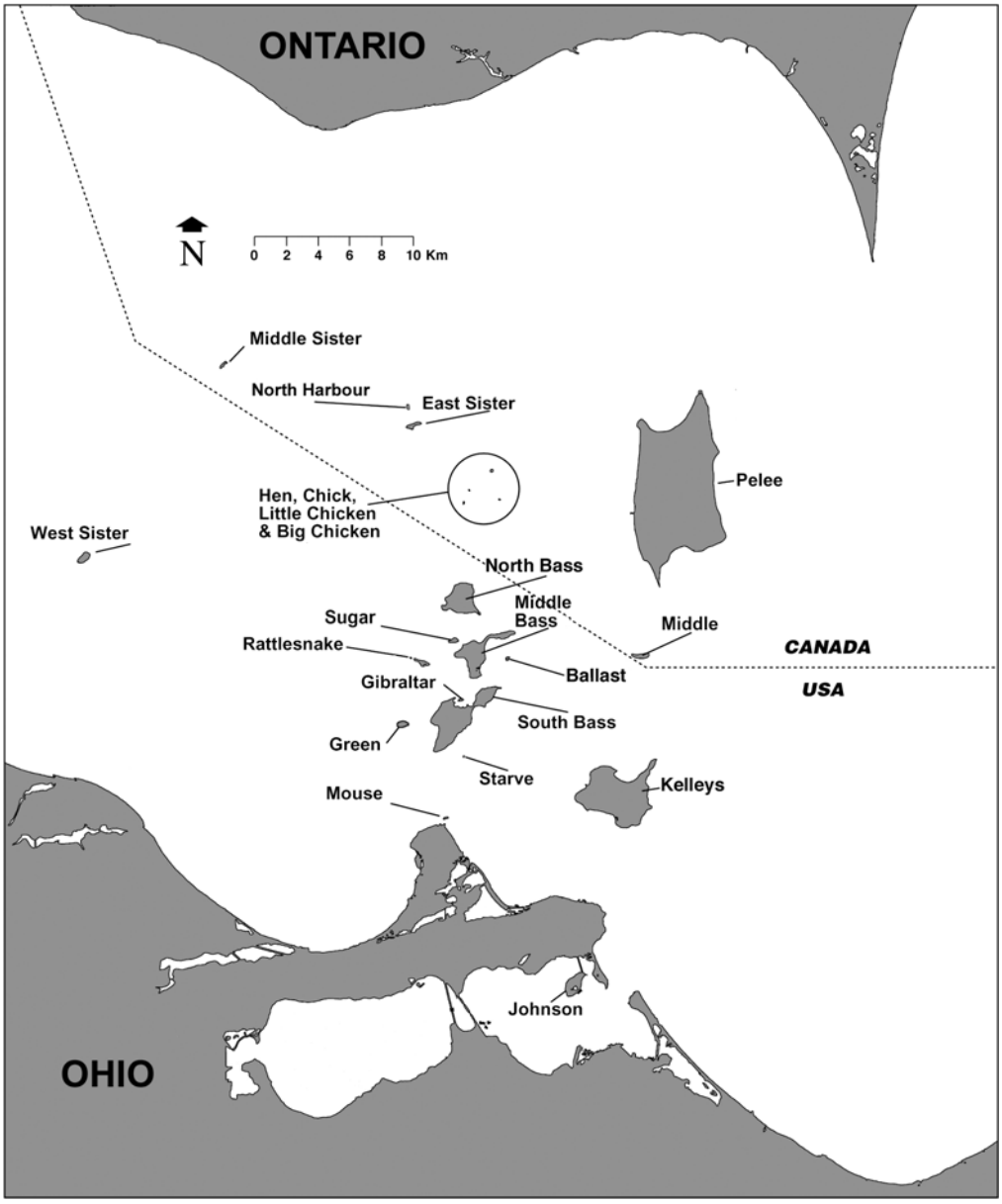

Figure 2. The island region of western Lake Erie, showing the four islands (East Sister, Hen, Middle, and Pelee Island) where the Lake Erie watersnake (*Nerodia sipedon insularum*) is known to be extant in Canada.

The extent of occurrence of the Lake Erie Watersnake in Canada is estimated to be 188 km^2. The area of occupancy of the Lake Erie Watersnake in Canada is estimated to be 24 km^2. The area of occupancy accounts for all shoreline habitat and possible hibernacula on the four islands in Canada (East Sister, Hen, Middle, and Pelee) where Lake Erie Watersnakes are known to be extant.

HABITAT

Habitat requirements

Lake Erie Watersnakes require specific habitat during the active season to forage, bask, court, mate, and give birth to young; they also require suitable habitat for hibernation. Essential summer habitat is composed of rocky shorelines or those made of limestone or dolomite shelves and ledges with cracks and some sparse vegetation (King 1987; King 1989; USFWS 2003). Summer habitat in Canada also includes sandy areas with associated debris or vegetation as well as cobblestone beaches and berms (D. Jacobs pers. comm. June 2005). Lake Erie Watersnakes also use areas with gravel, bare sand and/or exposed bedrock (King 1986, 1989; NatureServe 2005). Plants, loose rocks, and limestone shelves provide cover, and utilization of these structures depends on vegetation density, proximity to the shoreline and availability of basking areas (USFWS 2003). Logs and anthropogenic debris (e.g. metal sheets, cardboard, etc.) can also provide cover for Lake Erie Watersnakes (M.J. Oldham pers. comm. October 2005).

In all habitats, King (1986, 2003) reported 75% of observations of Lake Erie Watersnakes to be within 13 m of the water's edge on Ohio islands. Similar shoreline habitat occurs on Pelee, East Sister, and Middle Islands in Ontario, although Pelee Island does have sandy beaches that do not occur on the other Islands and are not as attractive to the watersnakes as rocky shorelines (D. Jacobs pers.comm. September 2005). However, actual distance from the water's edge was dependent on availability of cover such as vegetation or fallen debris, rather than a fixed distance (D. Jacobs pers. comm. November 2004). Nevertheless, this species is rarely found more than 100 m inland (King 2003). Availability of prey, presence of predators, and suitable basking and escape areas influence whether Lake Erie Watersnakes will use interior portions of islands (USFWS 2003; King 2004a). Ponds and wetlands found in the interior of islands are used by a small number of individuals during the summer active season. Similarly, flooded quarries and drainage ditches in the interior of the islands are used by Lake Erie Watersnakes during the summer active season (M.J. Oldham pers. comm. October 2005).

Lake Erie Watersnakes also use inland locations as hibernation sites (King 2003; D. Jacobs pers. comm. November 2004). Lake Erie Watersnakes may hibernate in natural areas or human-made structures. These sites usually contain soil and rock substrates and possess openings or fissures, which can include cracks in bedrock, rock piles, tree root masses, animal burrows (King 2003), abandoned and active quarries (Campbell *et al.* 1991; King 2004a; D. Jacobs pers. comm. November 2004), rock-filled timber, or steel crib docks and riprap (broken stones used for a foundation) (USFWS 2003). In Canada, radiotelemetry studies indicate that there is a significant amount of communal hibernation, whereas this has not been observed to any great extent on the U.S. islands (D. Jacobs pers. comm. September 2005).

Habitat trends

Inland habitat is infrequently used during the summer active season, but is important for hibernation sites (King 1998, 2003; D. Jacobs pers. comm. November 2004), suggesting that Lake Erie Watersnakes use a full range of island habitat and that all areas are potential snake habitat (King 1998, 2003). Increasing shoreline development, such as construction of homes, roads, docks, marinas, and structures for erosion protection on these islands threaten the Lake Erie Watersnake's survival (USFWS 2003). Although snakes can use some human-made structures, other construction such as sheet steel docks and poured concrete for erosion control are not utilized by snakes and decrease suitable habitat (USFWS 2003). Watersnakes may adapt to some human development, but King (1998) found a higher proportion of snakes in more extensively vegetated areas. These sites had relatively less gravel, sand, and bare soil and more debris, suggesting that locations with greater onshore cover are preferred and that areas with a lower degree of human disturbance are more attractive (King 1998).

Habitat protection/ownership

In 1991, the Lake Erie Watersnake was added to Ontario's Endangered Species Act, which protects the snake's habitat from willful destruction or interference. Under the Conservation Land Tax Incentive Program, the Ontario Ministry of Natural Resources (OMNR) offers tax rebates to landowners who possess at least 0.2 ha of endangered species habitat (such as Lake Erie Watersnake shoreline habitat) (OMNR 2004; D. Jacobs pers. comm. September 2005). In 1999, the Nature Conservancy of Canada successfully bid for the purchase of Middle Island (15 ha) and then turned it over to Parks Canada in 2001, with the island becoming part of Point Pelee National Park (it is now managed as a Zone 1 Special Preservation Area – the highest level of protection in the National Parks system) (D. Jacobs pers. comm. September 2005, V. McKay pers. comm. October 2005). East Sister Island is protected as a Provincial Nature Reserve (D. Jacobs pers. comm. September 2005).

Pelee Island contains three nature reserves: Fish Point and Lighthouse Point (combined 114 ha), established and managed by the Ontario Ministry of Natural Resources, and Stone Road Alvar, owned by the Nature Conservancy of Canada, Ontario Nature, and Essex Region Conservation Authority. A small portion of Mill Point (1.5-2 km of shoreline habitat) is also under the protection of the Essex Region Conservation Authority and Ontario Nature (B. Porchuk pers. comm. November 2004; D. Jacobs pers. comm. September 2005).

Although additional islands and island habitat deemed critical for Lake Erie Watersnakes are privately owned and zoned for environmental protection, experience has shown that designating legal habitat protection often reduces cooperation by landowners, who deny researchers access to properties (USFWS 1999; King 2004a). In 2003, OMNR researchers attempted to confirm the presence/absence of the Lake Erie Watersnake on three privately owned Canadian islands (Hen, Middle Sister, and

North Harbour) but were refused access by the landowners (in one case, the refusal was specifically due to concerns over potential restriction of activities) (D. Jacobs pers. comm. September 2005).

BIOLOGY

Life cycle and reproduction

The longevity of the Lake Erie Watersnake is up to 12 years in the wild (USFWS 2004). Females reach sexual maturity at 3 years of age, whereas males become sexually mature at 2 years. Typically, females reach sexual maturity at 60 cm SVL and males at about 44 cm SVL (King 1986).

Courtship and mating occurs from early May to early June and, as in other natricine snakes, involves scramble competition (several males court one female simultaneously), resulting in a large aggregation of snakes (King 1986; USFWS 1999, 2003). Some females reproduce annually and the frequency of reproduction is size dependent with larger females being more likely to reproduce annually than smaller females (King 1986; Bishop and Rouse unpubl. data 1999).

Parturition occurs in late August and early September. Litter size ranges from 9 to 50 with an average of 23 neonates (NatureServe 2005). On Pelee Island, Bishop and Rouse (unpubl. data 1999) found litter sizes ranging between 13-46 with a mean of 27 neonates. Litter size is positively correlated to female size with larger females not only producing more young but also larger neonates (King 1986). Average neonate size is 18.1 cm SVL and 4.8 g (King 1986). Neonates do not grow much prior to entering hibernation and often emerge at the same size at which they entered (USFWS 1999, 2003).

Predation

Predators of the Lake Erie Watersnake have not been well documented. Known predators include the Herring Gull (*Larus argentatus*), Great Blue Heron (*Ardea herodias*), American Robin (*Turdus migratorius*), raccoon (*Procyon lotor*), red fox (*Vulpes vulpes*), Blue Racer (*Coluber constrictor*), and domestic animals such as cats and dogs (King 1986; USFWS 2003). Dead Lake Erie Watersnakes with wounds from bird attacks have been found on islands inhabited by Double-Crested Cormorants (*Phalacrocorax auritus*) (D. Jacobs pers. comm. November 2004), but it is not known if cormorants killed the snakes. Neonates and juveniles are more likely to be preyed upon than are adult snakes; however, predation has apparently not contributed greatly to the species' population decline (USFWS 2003).

Physiology

Female Lake Erie Watersnakes feed over a longer portion of the active season than do males. Females grow faster than males at 0.014 versus 0.012 cm/day,

respectively, and females attain a larger body size (82.1 cm mean SVL) than males (62.4 cm mean SVL) (King 1986).

Similar to many reptiles, Lake Erie Watersnake activity depends heavily on seasonal and local weather conditions. Lake Erie Watersnakes have been observed entering water in the first week of May when water temperatures were approximately 5°C (King 1986). However, emergence from hibernation typically starts when the mean maximum daily air temperature rises to 12.8°C (April/May) and entrance into hibernation commences when the mean minimum daily air temperature drops to 15.5°C (September/October) **(**King 2003).

Dispersal/Migration

Lake Erie Watersnakes have been known to travel several kilometres from island to island, or island to mainland; however, movements over such distances are rare (King 1987a). Individuals rarely move more than 50 m off shore during the active season (King 2003; D. Jacobs pers. comm. November 2004). King (2003) estimated that 50% of all aquatic movements occurred within 8 m of shore, 75% were within 13 m, 90% were less than 21 m, and only 1% ranged more than 47 m from shore. Maximum extent of shoreline used by an adult Lake Erie Watersnake in Ohio ranges from 30-1360 m, averaging 252 m among individuals (King 2003). King (2003) found 50% of the watersnake population hibernated within 27 m of the shore, 75% within 69 m, 90% within 161 m and 99% hibernated within 700 m of shore. In Canada, radiotelemetry studies show that the distance of hibernation sites from shore ranged from 13-105 m and averaged 53 m; with 50% of the hibernation sites within 56 m of the shore, 75% within 69 m, and 90% within 95 m of shore (D. Jacobs pers. comm. September 2005).

Although migration between islands and from island to mainland is rare, one Lake Erie Watersnake was determined to have travelled a straight-line distance of 11 km to Middle Island from Kelleys Island in 2002 (D. Jacobs unpubl. data 2002/2003). However, less than 3% of adults move even among sites on a given island and movements between islands occur much less often (King 1987a). Migration may occur between islands and the mainland in Ontario at an estimated rate of nine snakes in each generation (King and Lawson 1995). Small home range and short distance movement of the Lake Erie Watersnake are mirrored in distinct and local geographic variation in contamination levels found in samples taken from watersnakes along 34 km of shoreline on Pelee Island (Bishop and Rouse unpubl. data 1999).

Interspecific interactions

Lake Erie Watersnakes now feed almost exclusively on the round goby that has recently invaded Lake Erie (King 2004a). It is not known what effect this shift in diet has had on the Lake Erie Watersnake's former prey of logperch (*Percina caprodes*) and other darters. Conant (1951) mentions that watersnakes may scavenge for fish that have washed up onto the beach.

Adaptability

Lake Erie Watersnakes appear to adapt somewhat to modification of shoreline habitat. Kelleys Island supports the most dense concentration of Lake Erie Watersnakes in Ohio despite the fact that this island is the most heavily developed of the islands in the watersnake's U.S. range (USFWS 2003). Lake Erie Watersnakes have been documented using anthropogenic structures such as riprap, rock-filled timber or steel crib docks for basking and resting habitat (King 2001, 2003; USFWS 2003). However, sheet steel docks and poured concrete for erosion control are not used by snakes and destroy what would otherwise be suitable watersnake habitat (USFWS 2003). In the U.S. and Canada, radiotelemetry studies demonstrate that individual Lake Erie Watersnakes show fidelity to hibernation sites and specific stretches of shoreline for summer habitat (D. Jacobs pers. comm. September 2005). It is not known how adaptable individuals are to being displaced by habitat development/destruction from their preferred sites.

Lake Erie Watersnakes feed almost exclusively on aquatic prey (King 1986, 1998). The previous COSEWIC report (Campbell *et al.* 1991) noted that fish comprised over 50% of the watersnake's diet on Pelee Island and that half of that percentage consisted of logperch and other darters. Since the early 1990s, the round goby has invaded feeding areas of the Lake Erie Watersnake (Jude *et al*. 1992) and are now the dominant bottom-dwelling fish in the island region (King 2003). In 1998, gobies represented 24% of the Lake Erie Watersnake's diet (King *et al*. 1999) and by 2003, gobies made up over 92% of the Lake Erie Watersnake's diet (King 2004a). The effects of this change in diet may be significant. King (2004a) found that watersnakes of all size and age classes consumed gobies, and watersnakes less than one year old had a larger body size after the invasion of gobies compared to before the increase in gobies as prey. The same results were found for body size of adult snakes, with higher growth rates after gobies became a large portion of the diet.

POPULATION SIZES AND TRENDS

Search effort and abundance

Records show that Lake Erie Watersnakes were found in abundance in the early 1800s and up to the early 1960s around the Lake Erie islands in the U.S. and Canada near the west end of Lake Erie (Ballou 1878; McDermott 1947; Wright and Wright 1957; Langlois 1964). Searches of Middle Island were conducted from 2001-2005 in 25 visits (D. Jacobs pers. comm. July 2005). Between 2001 and 2005, OMNR personnel visited East Sister Island 17 times to search for Lake Erie Watersnakes (D. Jacobs pers. comm. July 2005). King focused most of his work in the U.S. Islands, but also sampled in some years on Canadian Islands (King 1986, 1987a, 1987b, 1989, 2002).

Pelee Island

Surveys in the mid-1900s found Lake Erie Watersnakes to be numerous on Pelee Island (Fetherston 1949; Watts 1951). Fetherston (1949) collected 27 watersnakes in one afternoon on the east shore of Fish Point. However, by the 1970s, the numbers of specimens collected had declined. Campbell (1977) (cited in Campbell *et al.* 1991) reconsidered his opinion that the Lake Erie Watersnake was not endangered in the early 1970s and decided it was declining and probably endangered. King (1986) estimated the population of Lake Erie Watersnakes along 4.8 km of shoreline on Pelee Island to be 489 adults (95% confidence intervals between 205 and 1547 adults) and capture rate and density to be 0.87 adult snakes per hour or 102 per km respectively. Mark-recapture surveys along 4.65 km of shoreline on Pelee Island between 1988-1992 estimated that the population had decreased to 391 adults from 467 adults estimated between 1980-1985 (King 2002). The 4.6-4.8 km of shoreline sampled were in protected areas and likely had higher densities than most of Pelee's shoreline. Sampling has become more difficult in many parts of Pelee Island because permission is needed to access many of the shoreline areas (D. Jacobs pers. comm. July 2005).

Middle Island

Thomas (1949) believed that a large number of mature individuals observed on Middle Island in 1945 represented the population size attained when the snakes were left undisturbed, because humans had not inhabited the island since 1933. Seven members of the Ohio Herpetological Society collected several hundred specimens, 254 of which were adults, in April 1949 (Camin *et al*. 1954). In 1957, Camin and Ehrlich (1958) found only 21 additional new adults. A search in early June 1958 yielded 84 adults captured by four people in two days, but killing of snakes began again once humans started returning to Middle Island during the summer months (Ehrlich and Camin 1960). Between 2001-2005, during a search for suitable watersnakes to be fitted with radio transmitters, a total of 54 adult Lake Erie Watersnakes were found on Middle Island (D. Jacobs unpubl. data; D. Jacobs pers. comm. September 2005). In 2002, the minimum number of known adults on Middle Island was 43 (assuming no immigration) (D. Jacobs pers. comm. September 2005).

East Sister Island

During 1980 and 1983, East Sister Island was surveyed four times. King (1986) found 0.21 adult snakes per hour over 1 km of shoreline and a mean population estimate of 25 adults for the entire island. From 1988-1992, the population density estimate was 52 adults per km, and King (2002) estimated 109 adults as the total population. Searches for snakes for a telemetry study during 2001-2005 on East Sister Island found only 30 adult Lake Erie Watersnakes (D. Jacobs unpubl. data; D. Jacobs pers. comm. November 2004). In 2002, the minimum number of known adults on East Sister Island was 19 (assuming no immigration) (D. Jacobs pers. comm. September 2005).

Hen Island

There have been no new published reports on numbers of Lake Erie Watersnakes on Hen Island since the last COSEWIC report (Campbell *et al.* 1991). The 1991 report notes that in 35 minutes in May 1990, 10 to 15 watersnakes were seen along the shoreline. OMNR researchers have attempted to gain access to this island, but permission has been refused by the landowner, though Lake Erie Watersnakes are still believed to occur on Hen Island (D. Jacobs pers. comm. July 2005).

Fluctuations and trends

The restricted range of the Lake Erie Watersnake on islands of western Lake Erie creates a population that is vulnerable to stochastic events and increasing human activities. Historically, as the number of people inhabiting islands in the watersnake's range increased, persecution by humans likely became a major cause of the watersnake's decline. The local abundance of snakes, their moderately large size, and their propensity to bite made them a target for extermination. In the past, Lake Erie Watersnakes occurred on 22 offshore islands and rock outcrops between mainland Ohio and Ontario within the western portion of Lake Erie. There are now only 11 U.S. and four Canadian islands where the Lake Erie Watersnake is believed to be extant. Persecution of watersnakes by humans is still apparent today and may still be the number one cause of the watersnake's decline (USFWS 2003). However, populations are also declining due to increasing residential and commercial development, resulting in loss of suitable habitat and increased road mortality (Willson *et al*. 2002). Other events, such as changing water levels (and subsequent mortality due to flooding of communal hibernacula), prey availability (should there be an event that affects current prey availability), predation, and possible inbreeding depression (Frankham 1998; Madsen *et al.* 1996) are concerns given the fragmented nature of the Lake Erie Watersnake's geographic range and limited population size.

King (2002) summarized his research and surveys covering 36 sites on nine U.S. and three Canadian (East Sister, Middle, and Pelee) islands for one or more periods between 1980 and 2002. For U.S. populations from 1980-1985 to 1988-1992, King (2002) estimated that the watersnake populations declined by 33 adults per km of shoreline at three sites. From 1988-1992 to 1996-1998, they declined a further 13 adults per km of shoreline at four sites (see Tables 3 and 4 in King 2002). However, from 1988-1992 to 2000-2002, numbers increased from 23-88 adults per km of shoreline, depending on site and time period. These increases coincide with efforts of the Ohio Division of Wildlife and the USFWS to halt persecution of snakes and with increases in densities of round gobies (King 2002).

From 1980-1985 to 1988-1992, the average adult density on the three Canadian islands declined by 48.6 snakes per km of shoreline (from a total of 8.7 km sampled). However, this decline largely reflects a decline on one site (Fish Point south) on Pelee; the other sites remained more or less unchanged (Table 4 in King 2002). The decline at Fish Point may have resulted from the inadvertent destruction of a known communal

hibernaculum that was located immediately adjacent to Fish Point (D. Jacobs pers. comm. June 2005).

Rescue effect

There is evidence that watersnakes may occasionally move among islands and also from the mainland to island. Therefore, immigration is possible, but long-distance movement is rare (King 2001; Bishop and Rouse unpubl. data 1999). In 2002, a PIT tagged Lake Erie Watersnake was located during surveys on Middle Island. It was later confirmed that this animal was originally captured and marked on the south shore of Kelleys Island in Ohio. The watersnake had travelled a straight-line distance of 11 km (Jacobs unpubl. data. 2002/2003). However, King (1987b) noted that movement among islands occurs at very low rates. Thus, immigration of individuals between U.S. and Canadian islands is possible, though it is unknown whether this would have any positive effect on maintaining the viable population threshold for continued survival in Canada.

LIMITING FACTORS AND THREATS

Similar to many reptiles in Canada, Lake Erie Watersnakes are declining as a result of habitat loss, human persecution, mortality on roads and predation. Contamination is not currently a demonstrated factor in decline; however, it may be a potential threat to the Lake Erie Watersnake. These threats are amplified because of the watersnake's extremely small geographic range on islands, their high visibility, aggressive defensive behaviour, and limited population size.

Habitat Loss/fragmentation

The islands in the western portion of Lake Erie are becoming increasingly popular for recreation and tourism. These activities are focused on shoreline development for cottages, retirement homes, and tourist accommodations. Loss and degradation of suitable and critical shoreline habitat due to development have detrimental effects on watersnakes, although there is evidence that watersnakes have adapted well to some anthropogenic structures (King 2001; USFWS 2003). Inland habitat, used for hibernation by some watersnakes, is similarly threatened by increasing development, particularly construction of homes, roads, commercial structures, and the infrastructure that accompanies community development.

Road Mortality

Increasing tourism-based development leads to more road construction and human usage resulting in higher road mortality rates of snakes. Although Lake Erie Watersnakes travel only short distances over land on islands, they are still affected by road mortality (King 1998; Willson *et al.* 2002). Although there are no roads on three of the Canadian islands where Lake Erie Watersnakes occur; there are a large number of roads on Pelee Island, some of which run parallel to most of the shoreline.

Furthermore, more human inhabitants increase the likelihood of snakes being killed by other machines, such as boats and lawn mowers (USFWS 2003). A survey of road mortality of reptiles on Pelee Island in the mid-1990s showed that the roads that run parallel and close to the entire island's shoreline take a high toll on Lake Erie Watersnakes (Willson *et al*. 2002). In 1993 and 1994 combined a total of 81 Lake Erie Watersnakes were recorded dead on the road. In 1998 and 1999, only 22 were found dead despite increased traffic, which may indicate that numbers of snakes had declined.

Persecution

The most significant factor in watersnake population decline may still be persecution by people (USFWS 2003). In the past, people have attempted to rid their islands of watersnakes through "campaigns of extermination" (King 1998; USFWS 2003). Since the Lake Erie Watersnake's designation by the Fish and Wildlife Service (1999) and the Ontario Endangered Species Act (1977), watersnakes have been protected by legislation from persecution in some areas. However, such designations have been known to reduce private landowner cooperation (USFWS 1999) and some researchers have experienced a lack of cooperation and have been denied access onto certain properties (King 2003; D. Jacobs pers. comm. November 2004; R. Brooks pers. comm. May 2005).

Contamination

The threat of contamination in Lake Erie Watersnakes has increased with the dietary switch to round gobies as their primary food source. Gobies feed on Zebra and Quagga mussels, both of which are filter feeders, having the potential to bioaccumulate toxins. Hence, there may be a greater likelihood of bioaccumulation of toxins in present watersnake populations than in the past (King 2004a). Comparative analyses of blood samples taken from Lake Erie Watersnakes (pre- and post-goby invasion) are currently underway in order to establish levels of PCBs and related toxic compounds (King 2004a), though preliminary analyses suggest that contaminants in Lake Erie Watersnakes have not increased as a result of consuming round gobies (USFWS 2005).

Predators

Certain predators of watersnakes, such as raccoons and foxes, thrive close to human activity. Additionally, domestic and feral cats and dogs frequently kill watersnakes (USFWS 2003). Furthermore, some of the western Lake Erie islands are now occupied by large colonies of Double-crested Cormorants and there is evidence of mortality caused by these birds (D. Jacobs pers. comm. November 2004).

SPECIAL SIGNIFICANCE OF THE SPECIES

Lake Erie Watersnakes are discussed in the scientific literature (Camin and Ehrlich 1958; Ehrlich and Camin 1960). The colour pattern polymorphism found in Lake Erie Watersnakes is a classic example of microevolutionary change in which effects of

selection, gene flow, inheritance, and population history are well understood (King 1987b, 1992, 1993b; King and Lawson 1995, 1997; Hendry *et al*. 2001).

Selection favours the reduced patterning of Lake Erie Watersnakes on the Lake Erie islands because the unbanded variants are more cryptic against the limestone and dolomite shorelines, and therefore visual predators such as gulls, herons, and raptors are less successful in detecting these watersnakes as prey (King 1987a, 1993a; King and Lawson 1995, 1997; Hendry *et al*. 2001; USFWS 2003). Regularly banded, mainland Northern Watersnakes are cryptic in their more heavily vegetated habitat (King and Lawson 1995, 1997; USFWS 2003).

King and Lawson (1995, 1997) found significant genetic variation in colour patterns in Lake Erie Watersnakes and patterns are heritable. Positive genetic correlations indicate that one major locus is responsible for influencing colour pattern because of the variation in morphs within watersnake families.

King (1987b) predicts that, as Lake Erie Watersnake populations decline, the effect of selection for unbanded snakes will be overwhelmed by increased gene flow due to immigration from mainland (banded *N. s. sipedon*) snakes and future island populations will possess mainly banded morphs. Therefore, population size is an important factor in maintaining the unbanded Lake Erie Watersnake subspecies.

Although microevolutionary changes of colour patterns in watersnakes are well understood, data on the processes influencing differentiation are still incomplete because expected differences between island and mainland watersnakes exceed those observed (King and Lawson 1997). Lake Erie Watersnakes provide insight on multiple evolutionary processes that influence patterns of variation in many other organisms.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

NatureServe (2005) lists the Lake Erie Watersnake's global status as G5T2 (demonstrably widespread, abundant and secure, but taxon is imperiled). The U.S. National status is N2 (imperiled) and the Canadian National status is NNR (or unranked). The IUCN (2004) has not evaluated *N. s. insularum*.

In Canada, the Lake Erie Watersnake was assessed as Endangered by COSEWIC in 1991. In Ontario, it is listed as endangered and regulated under the Ontario Endangered Species Act and is a specially protected reptile under the Ontario Fish and Wildlife Conservation Act. The Nature Conservancy of Canada, Ontario Ministry of Natural Resources, Ontario Nature, Parks Canada, and the Essex Region Conservation Authority have set up several nature reserves on islands in the Lake Erie Watersnake's range. Since the 1991 Lake Erie Watersnake designation of Endangered by COSEWIC, a national recovery team has been established, and a recovery strategy for the species was drafted in 2005 (D. Jacobs pers. comm. September 2005). According to NatureServe (2005), the Ontario rank of the Lake Erie Watersnake is S2 (imperiled).

In the U.S., the Lake Erie Watersnake is listed as Threatened under the Federal List of Endangered and Threatened Wildlife. The Lake Erie Watersnake has a status of Endangered assigned by the state of Ohio. The Ohio Division of Parks and Recreation and Division of Natural Areas and Preserves owns and manages portions of U.S. islands including one for watersnake conservation and protection (USFWS 2003). NatureServe (2005) lists the rank in Ohio as S2 (imperiled).

TECHNICAL SUMMARY

Nerodia sipedon insularum
Lake Erie watersnake couleuvre d'eau du lac Érié
Range of Occurrence in Canada: Ontario

Extent and Area Information	
• *Extent of occurrence (EO)(km²)* **Calculation based on data from King *et al.* (1997)**	188 km²
• *Specify trend in EO*	Declined from historical records
• *Are there extreme fluctuations in EO?*	No
• *Area of occupancy (AO) (km²)* **Calculation based on data from King *et al.* (1997)**	24 km²
• *Specify trend in AO*	Declining from historical records
• *Are there extreme fluctuations in AO?*	No
• *Number of known or inferred current locations*	Current locations restricted to four islands in western Lake Erie
• *Specify trend in #*	Declining, but may have stabilized
• *Are there extreme fluctuations in number of locations?*	No
• *Specify trend in area, extent or quality of habitat*	Declining quality and extent
Population Information	
• *Generation time (average age of parents in the population)*	6+ years
• *Number of mature individuals*	Range 365-1665
• *Total population trend:*	Declining from historic population
• *% decline over the last/next 10 years or 3 generations.*	Unknown
• *Are there extreme fluctuations in number of mature individuals?*	No
• *Is the total population severely fragmented?*	Yes
• *Specify trend in number of populations*	Declining (from 6 to 4 islands and also declined within islands)
• *Are there extreme fluctuations in number of populations?*	No
• List populations with number of mature individuals in each: • Ontario: 4 populations; • Pelee Island ~410 (95%CI = 200-1500) individuals • Middle Island ~ 50 individuals • Hen Island < 15 individuals • East Sister Island ~ 100 individuals • Total mean population ~ 565	

Threats (actual or imminent threats to populations or habitats)	
• Loss of habitat due to shoreline and inland development and quarrying • Increased rates of road mortality due to expanding tourism-based development (increased road construction and usage by human inhabitants) • Increased predator populations with the increase in human activity (raccoons) • Persecution by people • Potential threat due to bioaccumulation of environmental contaminants (PCBs and other organochlorines) • Small populations that are more susceptible to demographic and ecological stochasticity	
Rescue Effect (immigration from an outside source)	
• *Status of outside population(s)?* **USA:** • Listed as **threatened** under the Federal List of Endangered and Threatened Wildlife • Listed as **endangered** by the state of Ohio and the Ohio Division of Parks and Recreation	
• *Is immigration known or possible?*	Known but infrequent
• *Would immigrants be adapted to survive in Canada?*	Yes
• *Is there sufficient habitat for immigrants in Canada?*	Yes
• ***Is rescue from outside populations likely?***	Not likely to be important
Current Status COSEWIC: Endangered 1991, Endangered 2006 Ontario: Endangered-regulated Ohio: Endangered	

Status and Reasons for Designation

Status: Endangered	**Alpha-numeric code**: B 1 ab(iii,iii,v) + 2 ab(ii,iii,v). C2a(i**)**
Reasons for Designation: It has a small population, likely fewer than 1000 adults, confined to four small islands in western Lake Erie. Threats, which include loss of its shoreline habitats, mortality on roads, and destruction of hibernacula by quarries and construction, are increasing. Although persecution by people may be levelling off, it is still a significant threat to these snakes.	
Applicability of Criteria **Criterion A**: (Declining Total Population): Not applicable **Criterion B**: (Small Distribution, and Decline or Fluctuation): The EO(B1) and AO(B2) are both well below the threshold for Endangered. There are only 4 known populations (a) and there is decline in b(ii,iii,v). **Criterion C**: (Small Total Population Size and Decline): Qualifies as Endangered (C2a(i)) **Criterion D**: (Very Small Population or Restricted Distribution): Qualifies as Threatened (D1) **Criterion E**: (Quantitative Analysis): NA	

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