Species at Risk Act
Management Plan Series

Management Plan for the Northern Map Turtle *(Graptemys geographica)* in Canada

Northern Map Turtle

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Government of Canada
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[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

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

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Northern Map Turtle and has prepared this management plan, as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with the governments of Ontario (Ministry of Natural Resources and Forestry) and Quebec (Ministère des Forêts, de la Faune et des Parcs) as per section 66(1) of SARA.

Success in the conservation 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 plan and will not be achieved by Environment and Climate Change Canada, the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Northern Map Turtle and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

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Acknowledgment and thanks are given to all other parties that provided advice and input used to help inform the development of this management plan including various Indigenous organizations and individual citizens, and stakeholders who provided input and/or participated in consultation meetings.

Executive Summary

The Northern Map Turtle (*Graptemys geographica*) is listed as Special Concern on Schedule 1 of the *Species at Risk Act* (SARA). It is a highly aquatic species that ventures onto land only to nest and bask. The species has a relatively rounded carapace[3] which is olive to brownish in colour with a pattern of light yellow lines. During the active season (spring to fall), the Northern Map Turtle is generally found in well oxygenated, large bodies of water such as rivers and lakes.

The species occurs throughout the northeastern United States and into southern Ontario and southern Quebec. Approximately 10% of the global range of Northern Map Turtle occurs in Canada.

The distribution and abundance of the Canadian population of Northern Map Turtle is not currently known but due to its life history traits and high number of potential threats, is suspected to be in decline. The Canadian adult population of Northern Map Turtle is estimated to be over 10,000 individuals. Although a range contraction of the Northern Map Turtle in Canada has not been documented, an analysis of recent data indicates a lack of species' observations since 1985 at 53% of sites containing historical occurrences. Some local populations show a trend toward an older age distribution, which may signal a population decline.

The main threats to the Canadian population of Northern Map Turtle are habitat loss and degradation from shoreline development, collisions with boats and fishing bycatch. Other threats that have been identified include mortality on roadways, water level management, illegal collection, human- subsidized predators[4], disturbance from human activities, exotic and invasive species, contamination and nutrient loading, and climate change. It should be noted that each of these threats has a cumulative effect. As individuals of this species have delayed sexual maturity and slow reproductive rates, the Northern Map Turtle is highly vulnerable to any increased rate of mortality in adults or older juveniles.

The management objective for the Northern Map Turtle is maintain and, if possible, increase the distribution and abundance of the Canadian population of Northern Map Turtle, by reducing the main threats to the species. The conservation measures recommended to achieve this objective are divided into six broad strategies: conserve individuals and habitat through the use of legal and administrative tools; reduce the risk of mortality, injury and harvesting; conserve, manage and restore habitat; carry out communication activities and establish or maintain partnerships; conduct surveys and carry out monitoring of Northern Map Turtle populations and habitats; and carry out research and acquire the knowledge necessary for management of Northern Map Turtle.

[3] Carapace is the upper part of the turtle's shell. It is formed from dermal bones fused to ribs and vertebrae (Harding 1997).

[4] Human-subsidized predators: Predators whose populations increase in response to low densities or absence of top predators and increased food availability from human sources (e.g., food handouts, garbage, crops).

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1. COSEWIC* Species Assessment Information

Date of Assessment: November 2012

Common Name (population): Northern Map Turtle

Scientific Name: *Graptemys geographica*

COSEWIC Status: Special Concern

Reason for Designation: There have been no quantitative, long-term studies of this species in Canada and, therefore, there is limited evidence of recent declines, range contraction or local extirpation of the species. However, the species' long-lived life history with delayed age of maturity and the potential threats to its habitat suggest that it is susceptible to population decline. Significant threats include direct mortality from collisions with motor boats and from commercial fisheries bycatch. Loss and degradation of shoreline habitat is another threat because this wary turtle is readily disturbed by human activity and boating, and shoreline developments interfere with the species' basking and nesting behaviour. Unnaturally high predation of nests by mammalian predators, especially raccoons, is another threat. If not ameliorated, these threats combined with the species' life history will cause the species to become Threatened in Canada.

Canadian Occurrence: Ontario and Québec

COSEWIC Status History: Designated Special Concern in May 2002. Status re-examined and confirmed in November 2012.

* COSEWIC – Committee on the Status of Endangered Wildlife in Canada

2. Species Status Information

The Northern Map Turtle is listed as a species of Special Concern[5] on Schedule 1 of the *Species at Risk Act* (SARA) (S.C. 2002, ch. 29). In Ontario, the species is listed as Special Concern[6] under the *Endangered Species Act*, *2007* (S.O. 2007, ch.6) (ESA) and is designated as a Specially Protected Reptile under the Ontario *Fish and Wildlife Conservation Act* (S.O. 1997, c.41). In Quebec, it has been listed as Vulnerable[7] under

[5] Special Concern (SARA): A wildlife species that may become a threatened or an endangered species, because of a combination of biological characteristics and identified threats.
[6] Special Concern (ESA): A species living in the wild in Ontario, which is not endangered or threatened, but may become threatened or endangered due to a combination of biological characteristics and identified threats .
[7] Vulnerable (ARTVS): A species for which survival is precarious even if extinction is not anticipated.

the *Act Respecting Threatened or Vulnerable Species* (ARTVS) since 2005 (C.Q.L.R., ch. E-12.01). The Northern Map Turtle is also listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2014).

The global rank for Northern Map Turtle is Secure (G5). It is considered Nationally Vulnerable (N3) in Canada and Nationally Secure in the United States (N5). In Quebec, the species is ranked as Imperiled (S2). In Ontario, it is Vulnerable (S3) (NatureServe 2013) (Appendix A). The International Union for Conservation of Nature (IUCN) lists the species as being of Least Concern[8] globally (IUCN 2014).

Approximately 10% of the global range of Northern Map Turtle is in Canada (Seburn 2007).

3. Species Information

3.1. Species Description

The Northern Map Turtle is a medium-sized, highly aquatic turtle, with a maximum shell length of 16 cm for males and 27.3 cm for females (Ernst and Lovich 2009). This species is sexually dimorphic[9]: the maximum adult female carapace[10] length greatly exceeds that of males, adult males are usually only 20% of the mass of adult females (Vogt 1980), and adult males have brighter postorbital[11] spots than adult females (Bulté et al. 2013). The species has a relatively rounded carapace with a medial keel (ridge). The carapace is olive to brownish in colour with a reticulate (resembles a net or network) pattern of light yellow lines that fade as the turtle ages. When first described, the pattern on the carapace of the Northern Map Turtle was thought to resemble a geographical map, hence the species' name. The plastron (bottom shell) is light yellow to cream in colour and is usually unmarked. Its head, neck, and limbs are olive to brown-black with yellow to greenish-yellow stripes. Northern Map Turtles may live over 20 years in the wild (Ernst and Lovich 2009).

3.2. Species Population and Distribution

The Northern Map Turtle's North American range extends from southern Ontario and southern Quebec in the north to Mississippi and Alabama in the south, west to Minnesota, Kansas, and Oklahoma and east to Virginia and North Carolina, with isolated populations in New York and Maryland (NatureServe 2013) (Figure 1).

[8] Species or lower taxa that is widespread and abundant.
[9] Sexually dimorphic: a condition in which the males and females in a species have different physical features (Carr 1952)
[10] Carapace: the upper part of the turtle's shell. It is formed from dermal bones fused to ribs and vertebrae (Harding 1997)
[11] Situated behind the eye socket.

In Canada, the species' range occurs mainly in the Great Lakes/St. Lawrence basin — from Lake St. Clair in Ontario to l'Île d'Orléans in Quebec (COSEWIC 2012).

The distribution and abundance of the Canadian population of the Northern Map Turtle is currently not fully known but due to its life history traits and high number of potential threats, is suspected to be in decline (COSEWIC 2012). In Ontario, Northern Map Turtle occurrences are scattered along the shores of Georgian Bay, Lake St. Clair, Lake Erie, and Lake Ontario, and along six major rivers. It is also widely distributed in the lakes, rivers, and waterways of the Canadian Shield in south-eastern and central Ontario (COSEWIC 2012). In Quebec, the species occurs along five major rivers, and four large lakes (Bonin 1998; REFERENCE REMOVED[12]; REFERENCE REMOVED; COSEWIC 2012). According to genetic sampling conducted by Bouchard et al. (2013), local populations in Quebec seem to be organized into metapopulations based on location.

The total abundance of Northern Map Turtles in Canada is unknown, but may be over 10,000 adults based on preliminary estimates at some locations (COSEWIC 2012). In one relatively small (788 ha) Ontario lake, the population has been estimated at over 1,500 turtles (Bulté et al. 2010), and there is potential for some other nearby lakes to hold similar or larger populations of Northern Map Turtles (COSEWIC 2012). A number of additional studies have resulted in abundance estimates for local populations of Northern Map Turtles. For example, the population around an island in eastern Ontario was estimated to consist of over 600 individuals (REFERENCE REMOVED). The populations at three sites (2 in Quebec, 1 in Ontario) along the Ontario-Quebec border likely consist of 500 to 1,000 individuals each (Bernier and Rouleau 2010; COSEWIC 2012).

Population trends are lacking for the Northern Map Turtle in Canada. However, it is suspected that the species may be in decline in some parts of its Canadian range due to a number of threats that increase mortality and decrease reproductive success (COSEWIC 2012).

The area of occupancy[13] of the Northern Map Turtle in Canada is estimated to be greater than 2,000 km² (COSEWIC 2012).

[12] Due to the vulnerability of turtle species to illegal collection, specific references providing sensitive information for some species have been removed from this version of the management plan. See *References* section.

[13] COSEWIC calculates area of occupancy (The area within "extent of occurrence" that is occupied by a taxon, excluding cases of vagrancy) using a grid with a cell size of 2kmX2km (Index of Area of Occupancy (COSEWIC 2009)).

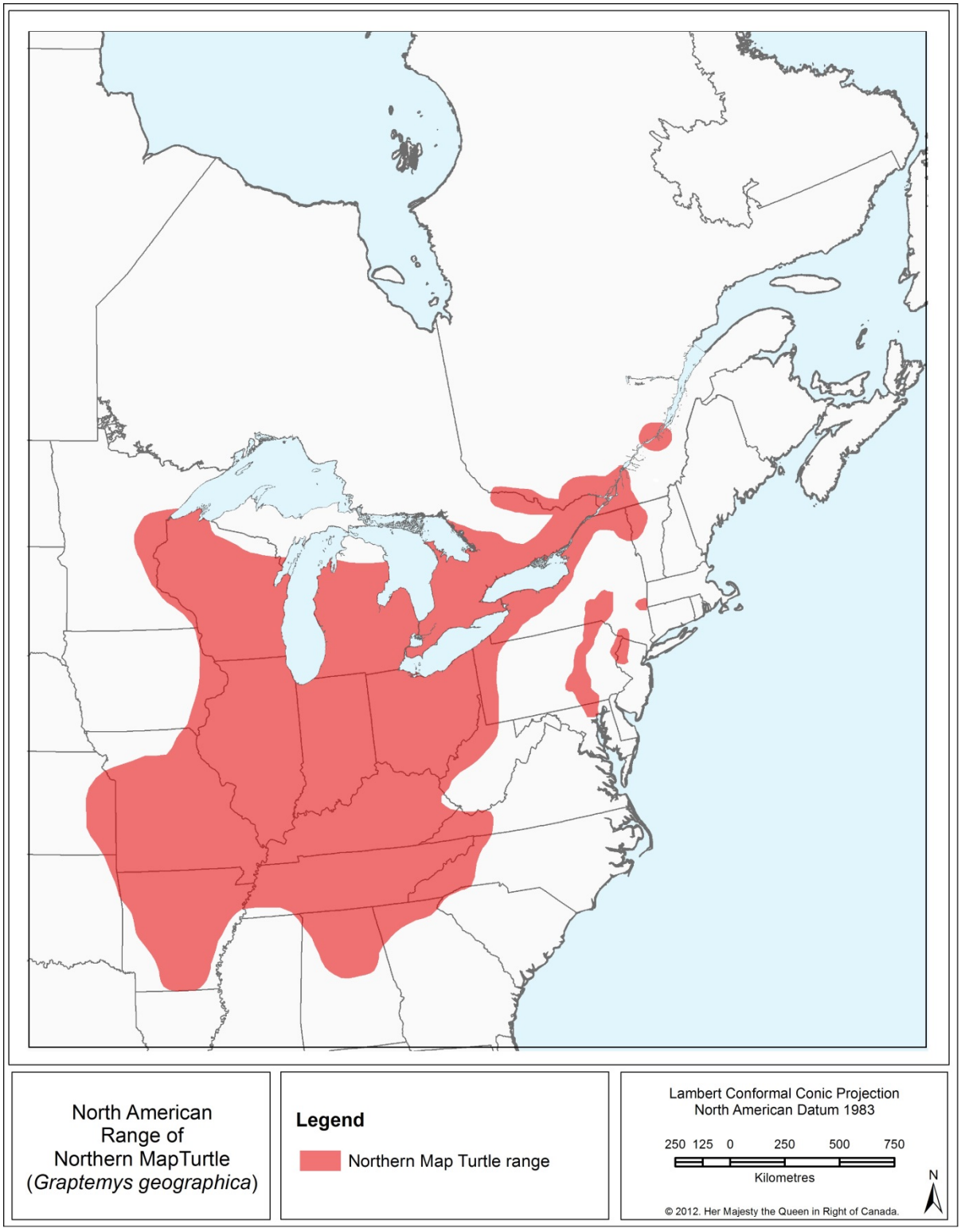

Figure 1. North American Range of the Northern Map Turtle (adapted from Royal Ontario Museum (ROM) 2012). This map represents the general range of the species, and does not depict detailed information on the presence and absence of observations within the range. Please refer to the text for further details on the distribution of the species in Ontario and Quebec.

3.3. Needs of the Northern Map Turtle

General Habitat Needs

The Northern Map Turtle relies primarily on aquatic habitat, and makes limited use of terrestrial habitat for nesting and basking. In the northern portion of their range, Northern Map Turtles typically inhabit well oxygenated bodies of water such as small to major rivers with slow to moderate flows, and lakes (COSEWIC 2012). Within lake habitats, the species tends to utilize areas with undeveloped shorelines or marshy habitats (REFERENCE REMOVED; REFERENCE REMOVED; Tran et al. 2007; Harrison 2011). In lakes occurring on the Canadian Shield, Northern Map Turtle utilizes rocky open shorelines and shoals, rock islands and substrates as well as muck substrate (Laverty pers. comm. 2012 in COSEWIC 2012). Within river habitats, the species tends to inhabit areas where moderate flow and turbidity are maintained (COSEWIC 2012). In most rivers, Northern Map Turtles tend to avoid areas where the water is less transparent (COSEWIC 2012). During the active season (April to October), individuals prefer shallow waters and generally avoid waters greater than 2.5 m deep (Tran et al. 2007; Bernier and Rouleau 2010; Carrière and Blouin-Demers 2010; COSEWIC 2012). Adult females have been observed passing through deep water more often than juveniles and males, possibly due to differences in diet and because their larger body size makes them better swimmers (Pluto and Bellis 1986; Carrière and Blouin-Demers 2010; Bernier and Rouleau 2010). The Northern Map Turtle requires suitable basking sites, such as partially submerged rocks and logs and exposed banks that are adjacent to deep water (COSEWIC 2012).

Northern Map Turtles favour natural shoreline environments and have home ranges primarily in shallow waters near shore; therefore, individuals of this species are sensitive to shoreline development and other activities that alter shoreline habitats (Carrière and Blouin-Demers 2010).

Overwintering

Overwintering sites for the Northern Map Turtle are typically deep, oxygen-rich lake or river bottoms that are sheltered from ice, with sand or gravel substrate and varied bottom features, such as exposed ledges, boulders, and tree trunks (Flaherty 1982; Bonin 1998; Graham et al. 2000; Ultsch 2006; Carrière 2007). Graham et al. (2000) describe the overwintering site at their study area as having very slow current; however, the presence of current has been observed at other overwintering sites (Bernier and Rouleau 2010). Northern Map Turtles have been recorded hibernating at depths between 0.3 m and 11.3 m (Bernier and Rouleau 2010; Harrison 2011; Rouleau and Bernier 2011). This species requires an oxygen-rich environment for over-wintering as they are relatively intolerant of anoxic[14] environments (Ultsch 2006).

Northern Map Turtles have been noted to hibernate both singly or communally with other Northern Map Turtles (Graham and Graham 1992; REFERENCE REMOVED;

[14] Anoxic: An environment with extremely low concentrations of oxygen.

Harrison 2011). Individual Northern Map Turtles have been known to congregate at the same overwintering sites year after year, which suggests they prefer overwintering site features that are not widely available throughout their home range, for example, sites that are well-oxygenated throughout the winter (Graham et al. 2000; Ultsch 2006; Carrière 2007).

Northern Map Turtles must survive exposure to subfreezing temperatures by supercooling[15], a strategy to avoid the freezing of body fluids (Baker et al. 2003). Northern Map Turtle hatchlings may overwinter within the nest (REFERENCE REMOVED; Baker et al. 2003; REFERENCE REMOVED; Nagle et al. 2004; Ernst and Lovich 2009; Fournier pers. comm. 2014). However, Nagle et al. (2004) report that overwintering is only possible for hatchlings, not for eggs or partially developed embryos; turtle embryos that fail to complete development before winter die in their nests.

Mating

Courtship and mating occur in the water, both in spring and autumn while the turtles are congregated at the overwintering site (COSEWIC 2002; Ernst and Lovich 2009). Individual females can store sperm from single mating events in the fall for later use should a spring mating event not take place (Miller and Dinkelacker 2007). A large proportion of clutches laid by female Northern Map Turtles have been found to be sired by multiple males, which indicates that, similar to other freshwater turtle species, promiscuity is a common reproductive strategy in this species (Banger et al. 2013).

According to Ernst and Lovich (2009), details of this turtle's maturation are unknown, but some reports suggest that females reach sexual maturity around 12 to 14 years of age or when they reach a carapace diameter of approximately 19 cm (Newman 1906; Vogt 1980; Bulté and Blouin-Demers 2009). A growth model based on captures from a lake in Ontario estimates maturity age to be 14 years for females and 4 years for males (Bulté and Blouin-Demers 2008).

Nesting

In Canada, the nesting period lasts anywhere from early May to early July (Gordon and MacCulloch 1980; REFERENCE REMOVED; REFERENCE REMOVED; Barrett Beehler 2007; REFERENCE REMOVED; Carrière 2007; Rouleau and Bernier 2011). Northern Map Turtle clutch size ranges from 3 to 22 eggs (REFERENCE REMOVED; Ryan and Linderman 2007), with an average between 9 to 17 eggs (Carr 1952; Gordon and MacCulloch 1980; REFERENCE REMOVED). Observations in Ontario have confirmed that females may lay two clutches during the active season (REFERENCE REMOVED). Hatchlings begin to emerge from the nest in early August and move to lake bottom sediments (REFERENCE REMOVED). Some hatchlings may overwinter in the nest and emerge the following spring between May and July

[15] Supercooling: chilling body fluids below freezing point, without them becoming solid. Cold-hardy reptiles are able to supercool only if they remain free of agents that would catalyze the freezing of their body fluids (such as soil particles, dust or ice-nucleating microorganisms) (Baker et al. 2003).

(REFERENCE REMOVED; Baker et al. 2003; REFERENCE REMOVED; Nagle et al. 2004; Ernst and Lovich 2009).

To lay their eggs, individual Northern Map Turtles seek areas near water, where the vegetation density and the slope are low (< 30°) and the substrate is most commonly composed of gravel or sand, but may also have large components of organic matter and clay (Flaherty and Bider 1984; Chabot et al. 1993; Nagle et al. 2004; Giguère et al. 2005; Barrett Beehler 2007). Northern Map Turtles prefer to nest in open locations receiving full sun (Nagle et al. 2004; Barrett Beehler 2007), and actively avoid wet sand during nesting (Vogt 1980). Nesting generally occurs within 3 to 35 m of the water's edge (REFERENCE REMOVED; Barrett Beehler 2007; Bernier and Rouleau 2010). Northern Map Turtles utilize a number of different nesting habitats, including (but not limited to) sand beaches and dunes (REFERENCE REMOVED; REFERENCE REMOVED), gravel piers and old quarries (Bernier and Rouleau 2010; Rouleau and Bernier 2011), rocky outcrops with thin soil deposits (Barrett Beehler 2007; Litzgus pers. comm. 2012 in COSEWIC 2012), as well as maintained sites (e.g. along highways containing fill material, gardens, and golf courses) (Baker et al. 2003; Nagle et al. 2004; Harrison 2011).

Baker et al. (2003) noted that Northern Map Turtles nested in close proximity to each other, and many returned to within a few metres of the same location each year. Carrière (2007) reported a high fidelity[16] to nesting sites, with some females traveling up to 5 km to nest.

Thermoregulation

Turtles regulate their body temperature using the surrounding environment: they are able to modify or maintain their temperature by varying their exposure to sun (known as basking), shade and water (Bulté and Blouin-Demers 2010a). Northern Map Turtles usually use stationary objects for basking, including fallen trees, exposed rocks, or areas such as exposed banks on land (Logier 1939, Gordon and MacCulloch 1980, Daigle et al. 1994, Bernier and Rouleau 2010) or mats of aquatic vegetation at the surface of the water (REFERENCE REMOVED; REFERENCE REMOVED; Bulté et al. 2010). Basking sites tend to be adjacent to water that is deeper than average for the area (Gordon and MacCulloch 1980). They typically have an easterly exposure but are not obviously protected from west winds (Gordon and MacCulloch 1980; Flaherty and Bider 1984; Ernst and Lovich 2009; Bernier and Rouleau 2010; Gillingwater pers. comm. 2012). This species often basks in groups (Gordon and MacCulloch 1980; Flaherty and Bider 1984; Ernst and Lovich 2009; Bernier and Rouleau 2010; Gillingwater pers. comm. 2012). Some studies have noted incidences of 10 – 60 turtles using the same basking site (Richards and Seigel 2009; Bernier and Rouleau 2010; Gooley et al. 2011; Chianucci 2013).

The Northern Map Turtle's basking activities tend to start in April, right after emerging from winter dormancy (Ernst and Lovich 2009). Gordon and MacCulloch (1980)

[16] Turtles were very likely to return to the same nesting site year after year (Carrière 2007).

reported the number of turtles observed basking in a lake in Quebec reached a peak in mid-May, and noted a large decrease starting in early July. In Canada, basking activity has been observed on warm sunny days until November (Beck pers. comm. 2011 in COSEWIC 2012; Kruschenske pers. comm. 2011 in COSEWIC 2012). There has been a noted difference in basking behavior between male and female Northern Map Turtles. Mature females tend to bask more frequently during and after the nesting season, compared to males and juvenile females (Gordon and MacCulloch 1980; Bulté 2009; Bulté and Blouin-Demers 2010b).

Foraging

The Northern Map Turtle is a specialized carnivore, feeding primarily on molluscs (bivalves, snails); insects and crayfish are also important food sources for the species (Ernst and Lovich 2009; COSEWIC 2012). Northern Map Turtles have been observed diving underwater and moving along vegetation to find snails and clams (Vogt 1981). Foraging habitat has been observed to be primarily in shallow water close to shore (Bulté et al. 2008). A study of one Lake Erie population of Northern Map Turtle found that females fed more heavily on molluscs and males fed more heavily on insects (Lindeman 2006). Multiple studies have found that the diet of juvenile females more closely resembles an adult male's diet, and that females prefer a more specialized diet as adults (Lindman 2006; Bulté et al. 2008; Richards-Dimitrie et al. 2013). In studies conducted in Canada and the United States, Lindeman (2006) and Bulté and Blouin-Demers (2008) reported adult female Northern Map Turtles preferring to feed almost exclusively on invasive Zebra (*Dreissena polymorpha*) and Quagga mussels (*Dreissena bugensis*), instead of a more varied diet. The invasive molluscs appear to have replaced not only native molluscs, but other non-molluscan taxa as well, in the diet of Northern Map Turtles.

Movement (commuting and dispersal)[17]

Northern Map Turtles regularly move between different aquatic habitat types to access regularly or seasonally required resources (e.g., nesting sites, overwintering sites, food sources). As a result, it is important that the different habitats Northern Map Turtles use are linked, or in reasonable proximity to one another, so that individuals can move between these habitats easily to meet their life cycle needs. The Northern Map Turtle will undertake seasonal migrations through water to find suitable habitats in response to seasonal changes in water current, depth and substrate (Gordon and MacCulloch 1980; Pluto and Bellis 1988; Laverty pers. comm. 2012 in COSEWIC 2012; Urquhart pers. comm. 2012 in COSEWIC 2012). Their movement patterns will vary depending on the availability of basking, nesting, overwintering, and foraging sites (COSEWIC 2002).

Home range sizes vary greatly between individuals, ranging between 20 to 385 ha (average 120 to 347 ha) for males and 47 to 1450 ha (average 160 to 1347 ha) for

[17] Movement habitat is the habitat (aquatic or terrestrial) that the species uses to move between habitats. Commuting here refers to short-distance movement within the home range in order to complete different life stages (e.g., mating, nesting), while dispersal refers to long-distance movement related to emigration of individuals.

females, and an average of 160 to 1037 ha for juvenile females (Carrière et al. 2009; Bernier and Rouleau 2010). Home range length has been noted to range from 2.2 to 24 km, with adult males having shorter home range lengths (3.5 to 7.8 km) than adult females (2.2 to 24 km) (Tessier and Lapointe 2009; Rouleau and Bernier 2011). This difference is thought to be due in part to the female's need to locate nesting habitat (Carrière 2007). It also appears that females have a high fidelity to their home ranges (Carrière 2007). Distance travelled throughout the active season differs according to the type of waterbody inhabited. In a lentic[18] environment, adult females have been noted to travel an average of 149 m/day while those in lotic[19] environments travel an average of 315 m/day (Carrière et al. 2009).

3.4 Biological Limiting Factors

Most turtles, including Northern Map Turtle, have certain common life history traits that can limit their ability to adapt to high levels of disturbance and that help explain their susceptibility to population declines (Congdon et al. 1993; Gibbons et al. 2000; Turtle Conservation Fund 2002). They have a reproductive strategy that depends on high adult survival rates to counterbalance the low recruitment rates because of:

1) short reproductive window due to late sexual maturity (12 to 14 years for females and life span (over 20 years);
2) high rate of natural predation on eggs and juveniles under the age of two;
3) dependence on environmental conditions for the internal development of eggs and external incubation of eggs without parental care.

As a consequence of these life history traits, turtle populations, including Northern Map Turtles, cannot adjust to an increase in adult mortality rates. Long-term studies indicate that high survival rates of adults (particularly adult females) are critical to the maintenance of turtle populations. Even a 2–3% increase in the annual adult mortality rate could result in population declines (Congdon et al. 1993, 1994; Cunnington and Brooks 1996).

The climatic range within which the Northern Map Turtle can survive limits its range in northern areas (Hutchinson et al. 1966; McKenney et al. 1998). Climate plays a vital role in recruitment, as this species relies on the external environment for incubation of eggs. Recruitment can vary from one year to the next depending on weather conditions, particularly during the summer. Sex determination for the Northern Map Turtle is temperature-dependent and occurs during incubation (Ernst and Lovich 2009). Some research indicates that males are produced when incubation temperatures are around 25°C, while females are produced at incubation temperatures of 30°C or greater (Bull and Vogt 1979); therefore, climate change could have an impact on the ratio of males and females recruited into the population.

[18] Lentic environment: a still water environment such as a lake or marsh
[19] Lotic environment: a flowing water environment such as a river or stream

In Canada, local populations of the Northern Map Turtle are at the northern limit of their range (Seburn and Seburn 2000). Because fewer heat-units[20] are available farther north, nesting and development periods become limited. This may be a limiting factor for this species (Brooks 2007).

3.5 Species Cultural Significance

Turtles play an important role in Indigenous spiritual beliefs and ceremonies. To the First Nations peoples, the turtle is a teacher, possessing a great wealth of knowledge. It plays an integral role in the Creation story, by allowing the Earth to be formed on its back. For this reason, most First Nations people traditionally call North America “Turtle Island”. Indigenous peoples also use the turtle shell to represent a lunar calendar, with the 13 scutes[21] representing the 13 full moons of the year. Turtle rattles, made from turtle shells are used in traditional ceremonies and often represent the turtle in the Creation story. Turtles also appear in other traditional stories including the Anishinaabe story “How the turtle got its shell” and the Haudenosaunee story “Turtle races with beaver” (Bell et al. 2010).

[20] Heat Units are the total amount of heat required for an organism to go through all stages in its life cycle. Therefore, the further north, the colder the average temperature, and the less opportunity there will be for a species to develop.
[21] Scutes: Broad, flat scales (Harding 1997)

4. Threats

Threats to the Northern Map Turtle may vary locally across its distribution within Canada. However the information presented in Table 1 is an overall assessment of threats to the Northern Map Turtle in Canada. Where information is known on the significance of a given threat at the local scale, additional information is provided in the threat description below Table 1.

4.1. Threat Assessment

The threats presented in Table 1 are in decreasing level of concern within each threat category.

Table 1. Threat Assessment Table

Threat	Level of Concern[a]	Extent	Occurrence	Frequency	Severity[b]	Causal Certainty[c]
	Threat Information					
Habitat Loss, Degradation, or Fragmentation						
Shoreline Development	High	Widespread	Historic & Current	Recurrent	High	High
Water Level Management	Medium/ High	Localized	Historic & Current	Recurrent	Moderate	Medium
Accidental Mortality						
Collisions with Boats	High	Widespread	Current	Seasonal	High	High
Fishing Bycatch	High	Localized	Current	Seasonal	High	High
Road Networks	High/ Medium	Widespread/ Localized	Historic & Current	Seasonal	Moderate	High/ Medium
Biological Resource Use						
Illegal Collection	Medium	Localized	Current	Recurrent	Moderate	Medium
Changes in Ecological Dynamics or Natural Processes						
Human-subsidized Predators	Medium	Localized	Current	Seasonal	Moderate	Medium
Disturbance or Harm						
Disturbance from Human Activities	Medium	Localized	Current	Seasonal	Unknown	Medium

Threat	Level of Concern[a]	Extent	Occurrence	Frequency	Severity[b]	Causal Certainty[c]
	Threat Information					
Exotic, Invasive, and Introduced Species						
Exotic and invasive species	Medium	Localized	Current & Anticipated	Continuous	Moderate	Medium
Pollution						
Contamination and Nutrient loading	Low	Localized	Historic & Current	Continuous/ Seasonal	Unknown	Low
Climate and Natural Disasters						
Climate Change	Unknown	Widespread	Current & Anticipated	Continuous	Unknown	Low

[a] ***Level of Concern****: signifies that managing the threat is of (high, medium or low) concern for the conservation of the species, consistent with the management objectives. This criterion considers the assessment of all the information in the table.*
[b] ***Severity:*** *reflects the global population-level effect (high: very large population-level effect, moderate, low, unknown).*
[c] ***Causal certainty****: reflects the degree of evidence that is known for the threat (high: available evidence strongly links the threat to stresses on population viability; medium: there is a correlation between the threat and population viability e.g., expert opinion; low: the threat is assumed or plausible).*
Note: *Provincial consideration: noted when an assessment differs between provinces (ON/QC in order).*

4.2. Description of Threats

This section highlights major threats outlined in Table 1, emphasizes key points, and provides additional information. Although threats are listed individually, an important concern is the long-term cumulative effect of a variety of threats posed on local Northern Map Turtle populations. It should be noted that some of these threats apply only during the active season because they lead to direct mortality, injury, or collection of individuals. Isolation through habitat loss and fragmentation is of particular concern, as it leads to a breakdown of metapopulation dynamics and limits the possibility of a rescue effect. Threats are listed in overall decreasing order of level of concern.

Habitat Loss and Degradation
Shoreline Development
In Canada, Northern Map Turtle resides in some of the most heavily populated areas and subject to the most intensive recreational, and urban development. Northern Map Turtle habitat has declined appreciably in both quantity and quality, with losses primarily due to conversion of wetlands, aquatic habitats (e.g., streams, water bodies, ponds) and associated riparian terrestrial habitats for recreational and urban development (Gordon and MacCulloch 1980). Throughout Ontario and Quebec, large portions of the species'

range are subject to cottage and urban development and maintenance (Blouin-Demers pers. comm. in COSEWIC 2012; McDonnell pers. comm. in COSEWIC 2012); park and recreational area development and maintenance(Tessier and Lapointe 2009; Rouleau and Bernier 2011); and increased boating activity (Tessier and Lapointe 2009). Shoreline habitat degradation reduces the availability of suitable nesting and basking sites (Carrière and Blouin-Demers 2010; COSEWIC 2012). Such habitat degradation can also reduce the number of overwintering sites and increase the number of predators (Ernst and Lovich 2009). In many areas, shorelines are reinforced to prevent erosion, often using metal, concrete walls or rip rap[22] (REFERENCE REMOVED). Even development of cottages and shoreline grooming can alter nesting habitat and remove key habitat requirements such as basking logs (McDonnell pers. comm. 2012 in COSEWIC 2012). By altering or eliminating shoreline habitat, Northern Map Turtles are no longer able to carry out critical life functions, such as nesting and basking, which will ultimately lead to a decline in the population. Construction activities associated with this type of development can also lead to direct turtle deaths. Individuals may be extracted from hibernacula by heavy equipment during land clearing/excavation or crushed by heavy equipment during the turtles' overland movements. This activity may also cause destruction or degradation of the aquatic plant communities which act as shelter and foraging habitat for the turtles.

Some techniques commonly used for the management of streams and riparian zones, such as reduction of snags/log jams, riparian draining, channelization, reduction of sandbars and beaches, and water impoundments may also negatively affect Northern Map Turtles (Bodie 2001). Northern Map Turtles are particularly affected by the removal or alteration of sandbars and beaches, which may reduce the availability of suitable nesting sites.

Accidental Mortality

Collisions with Boats

Map turtles will often bask at the surface of the water under floating vegetation mats with nothing but their head or nose visible from the surface. This behaviour puts Northern Map Turtles at significant risk of mortality or injury from motorboats and/or propellers while in the water (Burger and Garber 1995; Smith et al. 2006; REFERENCE REMOVED; Bulté et al. 2010). In Canada, deaths and injuries associated with motor boating and other water sports have been observed in Northern Map Turtles (Gillingwater pers. comm. 2005 in Seburn 2007; Carrière 2007; REFERENCE REMOVED; Bernier and Rouleau 2010; Bulté et al. 2010; Bennett and Litzgus 2014). Turtle deaths due to impacts with motorboats, even in water bodies with low to moderate (versus high) boat traffic may lead to a decline in the local freshwater turtle population (Bulté et al. 2010). Although accounts of propeller injuries are relatively common, the severity of the threat has been documented in only a few areas. A study of the impact of recreational motor boating on populations of Northern Map Turtles at two locations in Ontario found that populations were at significant risk as a result of collisions with boats. Overall, 8.3% and 3.8% of individuals at each of the two locations

[22] Rock or other material used to protect shorelines

included in the study, respectively, had propeller injuries; if over 10% of these collisions result in turtle death, rapid population extinction is plausible (Bulté et al. 2010). Boating-related injuries have also been reported in this species in Quebec (Bernier and Rouleau 2010). Studies have also found that female Northern Map Turtles were more likely to be found with a boat propeller injury than males which was likely due to the female's larger size (Bulté et al. 2010; Bennett and Litzgus 2014).

Fishing Bycatch

Bycatch in commercial and recreational freshwater fishing is believed to be a real, but underrated threat to turtles (Raby et al. 2011). Extensive research has been undertaken in eastern Ontario in recent years on the rates of turtle bycatch in commercial fishery nets; results show that the Northern Map Turtles are one of the most common turtle species caught (REFERENCE REMOVED; REFERENCE REMOVED; Midwood et al. 2014). Because nets are often not checked for several days, rates of drowning among turtles are high. Mortality rates are sufficient to cause extirpation of local turtle populations (Midwood et al. 2014). Since Northern Map Turtles commonly bask in groups, and often dive underwater when disturbed, a single disturbance could cause multiple turtles to retreat into the path of a nearby fishing net (Catrysse et al. 2015). Turtles that survive (i.e., do not drown) in nets can sustain injuries or exhibit behavioural changes that increases their risk of later mortality (REFERENCE REMOVED).

Studies conducted in eastern Ontario, and on the Mississippi River (United States) found that passive fishing techniques (e.g., fyke nets) can result in significant bycatch of turtles, in particular Northern Map Turtles (e.g., Barko et al. 2004; Carrière 2007; REFERENCE REMOVED). In 2005, 15 Northern Map Turtles drowned in underwater hoop-nets used for commercial fishing at a site in eastern Ontario (Carrière 2007). Even when care is taken to ensure that a portion of the trap remains above water, turtles tend to travel to the last compartment, which is sometimes anchored to the bottom and completely submerged (Thompson, pers. comm. 2005 in Seburn 2007).

In addition to the risk of by-catch in commercial fisheries' nets, turtles also risk injury and mortality from ingestion of recreational anglers' hooks. As turtles captured on fishing lines are often released by cutting the line, the hook remains in the turtle (REFERENCE REMOVED; REFERENCE REMOVED). The hook and nylon line can lead to serious lacerations in the digestive tract, and lead weights can cause poisoning (Borkowski 1997). Examples of Northern Map Turtle by-catch on fishing lines have been reported in Ontario (Johnson pers. comm. 2005 in Seburn 2007).

Accidental Mortality

Road Networks

Road mortality is a significant factor contributing to annual mortality in most of the turtle species found in North America, especially on roads that run through, or are located adjacent to wetlands (Beaudry et al. 2008; Litvaitis and Tash 2008) and is a growing concern in turtle studies (e.g., Andrews et al. 2006)Because the Northern Map Turtle species is highly aquatic, road mortality is thought to be of lesser concern for this species than for other freshwater turtles (Oldham pers. comm. 2012 in COSEWIC

2012). However, given their sensitivity to increased adult mortality, even low mortality rates can be detrimental to local populations.

In Ontario, the road network is developing rapidly, especially in the southern portion of the province, where the length of major roads has increased by 28,000 km within 60 years (Fenech et al. 2005). Road mortality is of high concern in this province and road sections with high mortality rates of freshwater turtles have been identified in many areas, including national and provincial parks (REFERENCE REMOVED; Crowley and Brooks 2005; Ontario Road Ecology Group 2010). One survey reported 25 Northern Map Turtle killed along a 3.6 km road stretch, which could represent an annual loss of up to 2% in this area (REFERENCE REMOVED). Another study in Ontario suggested that local populations were susceptible to population declines at locations where road density exceed 2 km of roads/km^2 and where traffic volume exceed 200 vehicles/lane/day, thresholds that are known to be exceeded in some areas (Gibbs and Shriver 2002).

Females tend to be at greater risk of road mortality because they travel overland during the nesting season (Haxton 2000), may use road shoulders to nest (e.g., Aresco 2005) and, as a result, are more frequently encountered on roads than males (Steen et al. 2006). This can lead to a decline in the population as there are fewer breeding/nesting females to help increase or maintain the population. Also, hatchlings emerging from nests located on road shoulders may be killed as they attempt to reach aquatic habitats. Mortality also may increase the likelihood of population decline due to reduced recruitment rates.

Maintenance of roads and trails can also pose a threat to individuals and nests when grading and vegetation removal/control is required throughout the summer, autumn and winter. The extent of the impact of road mortality on local populations of Northern Map Turtles requires further investigation.

Habitat Loss and Degradation

Water Level Management

Altering water levels in rivers and streams, lakes and impoundments through the operation of water control structures (e.g., hydroelectric dams, locks) has the potential to raise the water depth over hibernacula and reduce availability of nesting, basking, and foraging habitats.

Artificially lowering water levels may limit the availability of habitat (including overwintering) to turtles and, in the winter, may strand turtles in freezing temperatures and result in mortalities (Flaherty 1982; Ultsch 2006; Brownell pers. comm. in COSEWIC 2012;). A rapid increase in or drop in water levels is recognized as a threat to a number of freshwater turtle species including Northern Map Turtle due to the potential for flooding turtle nests (which may drown eggs or kill overwintering hatchlings) or the potential reduction in suitable nesting sites (Flaherty 1982). For example, by reducing the amount of exposed soil that is suitable for nesting as a result of natural flooding events (Seburn 2007; COSEWIC 2012), or altering sediment transport, thermal

properties, water levels, and oxygen concentrations, all of which can affect habitat suitability for turtles, especially during overwintering.

Water control structures can impede the movement of turtles in aquatic environments, thereby increasing habitat fragmentation (Bennett et al. 2010). This is of particular concern for highly aquatic turtle species, such as the Northern Map Turtle. In certain cases, dam and lock construction can contribute to isolation of Northern Map Turtle local populations (Bennett et al. 2010; COSEWIC 2012; Bouchard et al. 2013). For example, local populations along one major river in Ontario have low genetic diversity compared to other local populations analyzed. This could be the result of restricted movements and low habitat connectivity due to barriers along the river (Bouchard et al. 2013). Loss of genetic variation in small, isolated populations can in turn cause loss of population fitness and adaptability, and increase the risk of extinction in the wake of a catastrophic event or epidemic[23] (Frankham 1995; Reed and Frankham 2003). However, some Northern Map Turtle individuals have been found to cross dam and lock structures (Bennett et al. 2010; Bernier and Rouleau 2010; Gillingwater pers. comm. 2012), suggesting that these structures do not always prevent movement from occurring.

At some Northern Map Turtle locations, wetland creation or restoration may be required to improve the availability and quality of habitat and promote recovery of the species. In these cases, using water control structures to create or restore wetland habitats may contribute to improving the habitat for turtles and provide overall benefit to the species. Restoration activities such as this would need to be designed to minimize any adverse effects on Northern Map Turtles and other species at risk

Biological Resource Use

Illegal collection

Worldwide, many turtle species are impacted by both individual and large-scale systematic illegal collection of turtles for use as pets, food and traditional remedies (Bodie 2001; Moll and Moll 2004; REFERENCE REMOVED). The rate of export of freshwater turtles is high in the U.S. (Mali et al. 2014). For example, between 2003 and 2005, 511,520 map turtles (*Graptemys*) were legally exported from the United States, of which 10,365 individuals were declared as wild-caught (legally caught from the wild), with 3,672 Northern Map Turtles specifically exported (Senneke 2006 in COSEWIC 2012). The rate of illegal export can be expected to be high in Canada given lucrative trade demand. Reptile species are more likely to be involved in the international pet trade if they are categorized as at risk than if they are not considered at risk (Bush et al. 2014), which is consistent with a general demand for rare wildlife (Courchamp et al. 2006). Northern Map Turtles have similar features to multiple turtle species in the pet and food trade including: False Map Turtle (*Graptemys pseudogeographica*), Mississippi Map Turtles (*Graptemys kohnii*), painted turtles (*Chrysemys* spp.), cooters (*Pseudemys* spp.) and sliders (*Trachemys* spp.) (Conant and Collins 1991). Resemblance to many of these turtle species increases the risk of individual Northern

[23] Epidemic: A rapid spread of disease

Map Turtles being poached (COSEWIC 2012). Although it is unclear whether harvesting of turtles for food is a widespread practice in Canada, humans are known to consume a number of turtle species, including Northern Map Turtles (Thorbjarnarson et al. 2000; Moll and Moll 2004).

The illegal sale of Northern Map Turtles has been increasing through online websites such as Kijiji (Gillingwater pers. comm. 2011 in COSEWIC 2012). According to tips received by Ontario's Ministry of Natural Resources and Forestry, between 2010 and 2012, nine wild-caught Northern Map Turtles were advertised for sale online in Ontario (Gillingwater pers. comm. 2011 in COSEWIC 2012). Two cases of Northern Map Turtle harvesting were documented recently in Ontario (Cebek pers. comm. 2005; deSolla. 2005; de Solla pers. comm. 2005 in Seburn 2007).

Illegal collection of Northern Map Turtle may not directly cause mortality, but removes individuals, from all age classes, from the population which, given the species' reproductive strategy (extreme longevity, low recruitment rates), may greatly reduce recruitment (COSEWIC 2012). The annual removal of even just a few adults from a local population can have a significant impact (see section 3.4). The extent of illegal organized turtle harvest is poorly documented in Canada for the Northern Map Turtle.

Changes in Ecological Dynamics or Natural Processes

Human-subsidized Predators

Human activities such as agriculture, urban development and roads are known to increase the numbers of certain predators in Northern Map Turtle habitat. This leads to elevated rates of egg predation, which may cause declines in recruitment and alter the structure of populations. In many areas, the low density or absence of top predators and increased food availability from human sources (e.g., food handouts, garbage, crops) have led to a greater abundance of turtle predators than natural conditions would have historically supported (Mitchell and Klemens 2000). Main predators of Northern Map Turtle include Mink (*Neovison vison*), Raccoons (*Procyon lotor*), Red Fox (*Vulpes vulpes*), and Coyote (*Canis latrans*), while hatchlings are also known to be predated by Green Frogs (*Rana clamitans*), American Bullfrogs (*Lithobates catesbeianus*), Snapping Turtles (*Chelydra serpentina*), large fish, gulls, terns, and herons (Gillingwater pers. comm. 2011 in COSEWIC 2012). Several local populations of Northern Map Turtle experience high rates of nest predation. For example, a two-year study at a site on Lake Erie found that 75% of eggs were eaten by mammals (REFERENCE REMOVED). A study conducted (REFERENCE REMOVED) in Ontario found 63-100% of turtle nests were lost to predation, primarily by raccoons, while a second study (REFERENCE REMOVED) determined that the raccoon density in the study site was four times higher than the average for rural Ontario (REFERENCE REMOVED). Increased nest mortality in disturbed habitat was due primarily to greater raccoon densities overall rather than foraging efforts targeted toward turtle nests (REFERENCE REMOVED). Elevated predation by raccoons has been identified as a likely cause of low recruitment and a shifting size/age structure of turtle populations (REFERENCE REMOVED). In a study conducted in Quebec, Northern Map Turtle nesting sites has higher estimated predation

rates (between 55 – 95%) and greater predation rates from raccoons if the nesting sites were near human-modified landscapes (Bernier and Rouleau 2010).

Methods to deal with elevated predation rates have been developed (e.g. predator exclusion cages) and used with varying degrees of success (Seburn 2007; Riley and Litzgus 2013).

Disturbance or Harm

Disturbance from human activities

Human activity can affect Northern Map Turtles in many ways. Because they are so wary, simply approaching basking individuals can cause them to leave their basking sites and return to the water. The resulting heat loss, should the disturbance become repetitive, can delay the development of eggs in females, and affect other life cycle processes in both sexes and in all age classes (e.g., food metabolism, spring emergence) (Bulté and Blouin-Demers 2010b). Moreover, the presence of humans and/or boats can delay or interrupt nesting, and females may abandon their nests, making nests more susceptible to predation (Horne et al. 2003; Moore and Seigel 2006). Repeated disturbance at nesting sites may also force females to use lower quality nesting sites (Moore and Seigel 2006), which in turn can slow incubation and reduce the hatching rate (Horne et al. 2003). Recreational activities on nesting beaches (e.g. use of All-terrain Vehicles (ATVs)) can also lead to trampling of nests or turtles (REFERENCE REMOVED). Translocation of turtles (e.g. individuals collecting turtles and later returning them to the wild in a location other than where the individuals were originally captured) from one water body to another by humans may lead to increased stress and/or threats (e.g. road networks) when the turtle attempts to return to its area of origin or find habitats to meet its life cycle needs (e.g. for foraging or overwintering) (Gillingwater pers. comm. 2012). Turtle species have also been subject to deliberate harassment and persecution by humans, including throwing rocks, and shooting with firearms (e.g. Horne et al. 2003).

A study along one river in Ontario revealed that increased boat activity along with development of a public beach area resulted in a decrease in Northern Map Turtle observations in nearby bays and channels (Tessier and Lapointe 2009). The same study also noted a high level of disturbance to basking Northern Map Turtles by passing boats, indicated by sightings of turtles leaving the nest.

Exotic, and Invasive, and Introduced Species

Exotic and Invasive Species

The introduction of invasive, exotic plants can alter the availability and quality of the Northern Map Turtle habitats. In some areas, particularly around Lake Erie, Lake Huron, and Lake St. Clair, and along some major rivers, the non-native plant, Common Reed (*Phragmites australis*) has invaded wetlands, lakes and rivers, forming a monoculture[24] that has altered conditions and decreased habitat quality (Wilcox et al. 2003; Hudon et al. 2005; Gillingwater pers. comm. 2012). The expansion of road networks also

[24] An area that is dominated by a single plant species.

facilitates the spread of invasive plant species, especially in southern Ontario (Gelbard and Belnap 2003).

Turtles nest in open, unshaded areas receiving adequate solar heat. In a study conducted at a site on Lake Erie, Ontario, it was found that the non-native plant, Common Reed had reduced the amount of suitable nesting habitat for many turtle species because growth of the plant altered the microenvironment (particularly significant temperature reductions in nests) of turtle nests during the incubation period (Bolton and Brooks 2010). The loss of suitable nesting habitat for turtle species due to invasive plants including non-native Common Reed, Japanese Hops (*Humulus japonicas*), and Purple Loosestrife (*Lythrum salicaria*) have also been observed at many other locations throughout southern Ontario (Gillingwater pers. comm. 2012).

The introduction of non-native animal species can also have a negative effect on turtles. The release of exotic pet turtles (e.g., Red-eared Slider, *Trachemys scripta*) in natural environments following a period of captivity can result in the transmission of diseases to native populations and can create competition for basking and feeding sites (Cadi and Joly 2003, 2004). These turtles are known to occur in high numbers in some locations of Ontario and even breed (MNRF 2014, unpublished data; Seburn 2015). The Common Carp (*Cyprinus carpio*) is also a concern in many areas of southern Ontario, especially due to its abundance, active feeding habits, and strong ability to outcompete native species. When feeding, carp root around in the substrate, damaging or killing plants, and increasing siltation and turbidity in the water (Laird and Page 1996), which in turn, causes a whole range of ecological impacts, including loss of biodiversity (Kloskowski 2011). This affects the quality and quantity of suitable habitat available to Northern Map Turtle.

Pollution

Contamination and Nutrient Loading

Aquatic habitat of the Northern Map Turtle can be impacted by the degradation of water quality caused by the runoff of contaminated water from agricultural (nutrients and pesticides) and industrial zones (industrial waste), roads (e.g., de-icing salt), and urban areas (e.g., heavy metals) (Mitchell and Klemens 2000; Bishop et al. 2010). Northern Map Turtles could be vulnerable to contaminant accumulation in their body tissues. Individuals absorb contaminants in the environment through various physiological processes (e.g., feeding, breathing, and absorption through tissues or membranes such as eggshells). The Northern Map Turtle is more likely to be affected by contaminants than other turtle species because of its diet (i.e., molluscs, crayfish, and insects) (Lindeman 2006; Bulté and Blouin-Demers 2008) and the location of its habitats (St. Lawrence River and the Great Lakes drainage basins) (REFERENCE REMOVED). The Northern Map Turtle's ingestion of large numbers of zebra mussels from the Great Lakes basin (Bulté and Blouin-Demers 2008) could constitute a major source of exposure to contaminants (Hogan et al. 2007). Given that Northern Map Turtles prey on molluscs, degradation of water bodies that in turn reduces molluscan prey abundance would also be detrimental to Northern Map Turtle populations (COSEWIC 2012).

Recent studies indicate that there is little effect of reliance on benthic food chain on mercury accumulation in painted and musk turtles (REFERENCE REMOVED) and that concentration of mercury in blood and scutes does not affect parasitism level in Painted turtles (Slevan-Tremblay 2013). However, mercury exposure could be detrimental to the immune system by reducing the number of lymphocytes. Similar effects might be impacting Northern Map Turtles. Two studies, undertaken in the Great Lakes basin, detected several industrial-based contaminants in Snapping Turtle eggs. It was also noted that abnormal embryo development increased with exposure to polychlorinated aromatic hydrocarbons (Bishop et al. 1998; Van Meter et al. 2006). Although these studies focused on other species, the potential for similar effects on Northern Map Turtle exists as they share similar habitats and behaviours.

Inputs of sediments and organic matter through erosion and runoff can also alter water quality and habitat structure and threaten local populations of Northern Map Turtles. Siltation of deep pools has been linked to the decline of several turtle species (Bodie 2001), and could degrade Northern Map Turtle overwintering habitat by exposing individuals to freezing. The augmentation of nutrient loads associated with human activity can lead to blue-green algal blooms in waters frequented by turtles (Carpenter et al. 1998), and this can threaten turtles through ingestion of toxins from the algae. In addition, nutrient loading can lead to increased oxygen consumption by bacteria, which, in turn, can result in periods of low dissolved oxygen levels (hypoxia) or even a total absence of oxygen (anoxia) during winter. Northern Map Turtles are known to be intolerant of hypoxia during overwintering (Ultsch 2006); therefore, if they hibernate in areas where oxygen levels are decreased, they could be at risk of dying during overwintering due to hypoxia or anoxia.

Climate and Natural Disasters

Climate Change

Climate is the main limiting factor of the the distribution of turtles in the north. Given the effect of climate on recruitment rates, it seems likely that global climate change will have an impact on turtle populations. An increase in the annual average temperature in Ontario of 2.5 to 3.7ºC by 2050 (compared to 1961-1990) is expected, along with changes in seasonal precipitation patterns (Expert Panel on Climate Change Adaptation 2009).

The Northern Map Turtle exhibits temperature-dependent sex determination where higher temperatures lead to production of proportionately more females and lower temperatures lead to production of proportionately more males (Ernst and Lovich 2009). It has been hypothesized that climate change and the anticipated increase in average temperatures could have an impact on the sex ratio of turtle populations (through a female bias) (Janzen 1994; COSEWIC 2012) and on the development of embryos and hatchlings (Willette et al. 2005), which could threaten the viability of the species in the future (COSEWIC 2012). A climate modelling study in the Great Lakes regions suggests that 50-75% of known localities where Northern Map Turtle occurs in Canada and the United States are projected to remain climatically suitable for the species. Northern Map Turtle was deemed to be moderately sensitive to climate change compared to other

reptile species included in the study (King and Niiro 2013). Although climate change does appear to pose a threat to Northern Map Turtles in Canada, the level of concern remains difficult to project. Additional studies examining the impacts of climate change on Northern Map Turtle and other turtle species at risk would be beneficial.

5. Management Objective

The management objective for the Northern Map Turtle is to:

- Maintain, and, if possible, increase the distribution and abundance of the Canadian population of Northern Map Turtle by reducing the main threats to the species .

The Canadian distribution and abundance of the Northern Map Turtle is currently not fully known. The current area of occupancy of the Northern Map Turtle in Canada is ~ 2,000 km^2. Based on preliminary population estimates at some locations, the total abundance of Northern Map Turtles in Canada may be over 10,000 adults (COSEWIC 2012). There is little long term data on population trends for the species, however, COSEWIC (2012) indicated that the overall population is likely in decline due to increased adult mortality related to the numerous threats faced by the species. The objective of this management plan is to halt the potential population decline and maintain the overall population of the species in Canada (distribution and abundance) through addressing threats to the species.

Northern Map Turtles are affected by significant limiting factors (reproductive strategy and climatic constraints within its Canadian range), and the populations may therefore be very vulnerable to threats, particularly those that could lead to increased adult mortality (see section 3.4 – Limiting Factors). This long-lived species has specific ecological requirements, complex life cycle needs, and a limited ability to compensate for the loss of individuals through reproduction or through recruitment from adjacent local populations. As a result, to achieve this objective, it will be important to implement conservation strategies and general approaches on several fronts over a long period of time and sometimes on a large scale. It will be necessary to obtain baseline abundance data and trend information to determine whether the objective has been met and to provide further guidance for conservation measures. In addition, strategies to reduce and mitigate threats to individual turtles and habitat are required in order to maintain the Northern Map Turtle population in Canada. If we do not address the threats to this species, local populations will likely be unable to maintain their current size. Communication activities should be implemented and research activities undertaken to fill knowledge gaps, enhance understanding of Northern Map Turtle biology and ecology and better document the threats to the species in Canada.

6. Broad Strategies and Conservation Measures

6.1. Actions Already Completed or Currently Underway

At the national scale, the Canadian Herpetological Society (CHS) is the main non-profit organization devoted to the conservation of amphibians and reptiles, including turtles, and conducts the following activities: scientific investigations, public education programs and community projects, compilation and analysis of historical data and the undertaking of projects that support conservation or habitat restoration.

Since the Northern Map Turtle lives in association with other freshwater turtle species at risk in Canada (Eastern Musk Turtle [*Sternotherus odoratus*], Blanding's Turtle [*Emydoidea blandingii*], Spiny Softshell Turtle [*Apalone spinifera*], and Snapping Turtle [*Chelydra serpentina*), it has indirectly benefited from the many conservation measures implemented for these species (see the recovery planning documents for those species on the SARA Registry; www.registrelep-sararegistry.gc.ca).

Environment and Climate Change Canada has been funding projects related to Northern Map Turtle conservation throughout Quebec and Ontario through the Habitat Stewardship Program (HSP) and Aboriginal Fund for Species at Risk (AFSAR) since 2001 and the Interdepartmental Recovery Fund (IRF) since 2004. Projects have included activities such as undertaking targeted surveys for the species; identifying important habitat of local populations; studying the severity of and/or mitigating threats such as road mortality; soliciting observations/ encouraging public reporting of sightings; and educating landowners and/or the public on species identification, threats, and stewardship options.

Ontario

An Ontario Multi-Species Turtles at Risk Recovery Team was established in the early 2000s by a group of people interested in turtle recovery. This group has coordinated and initiated a number of recovery efforts, and was involved in preparing and reviewing an Ontario-based draft multi-turtle recovery strategy, which addressed five species of freshwater turtles, including Northern Map Turtle.

The Ministry of Natural Resources and Forestry[25] (MNRF) has funded numerous turtle conservation and stewardship projects across Ontario through the Ontario Species at Risk Stewardship Fund and other provincial funding programs. In 2010, they released the Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales (OMNR 2010) (The Stand and Site Guide). The Stand and Site Guide is one of a series of forest management guides used by forest managers when planning and implementing forest management operations. The stand and site guide includes

[25] Formerly known as Ontario Ministry of Natural Resources

standards, guidelines and best management practices for turtle species found in the Area of the Undertaking, including the Northern Map Turtle.

Since 2009, Ontario Nature has been coordinating the development of a new Ontario Reptile and Amphibian Atlas. By soliciting occurrence records from the public, researchers, government and non-government organizations, this project is improving our knowledge of the distribution and status of reptiles and amphibians, including the Northern Map Turtle, in Ontario (Crowley pers. comm. 2012; Ontario Nature 2012). Ontario Nature is working with the Natural Heritage and Information Centre, Ministry of Natural Resources and Forestry and other organizations to promote the new Ontario Reptile and Amphibian Atlas (http://www.ontarionature.org/atlas).

There are many organizations and agencies that offer outreach/ educational programs about turtle species at risk to school groups, First Nations, and the general public (e.g., Reptiles at Risk on the Road Project, Georgian Bay Reptile Awareness Program, Ontario Nature, Ministry of Natural Resources and Forestry, Ontario Parks, Kawartha Turtle Trauma Centre, Toronto Zoo, Upper Thames River Conservation Authority). In addition, the National Parks and Historic Canals provide opportunities to their visitors to learn about Northern Map Turtles and other at risk turtles across Ontario. The Toronto Zoo Adopt-A-Pond program (www.torontozoo.com/adoptapond) is one of several projects that have developed turtle conservation curricula for schools, while the Toronto Zoo Turtle Island Conservation program (http://www.torontozoo.com/conservation/tic.asp) promotes turtle conservation and awareness among First Nation and non-Indigenous groups. Turtle SHELL (Safety, Habitat, Education and Long Life), a charitable organization, has prepared booklets and installed turtle crossing signs. The Kawartha Turtle Trauma Centre rehabilitates and releases injured turtles. Efforts to secure the nests of turtle species at risk have also been undertaken.

Many projects are being carried out as a requirement under the Ontario *Endangered Species Act, 2007* that are directly benefiting Northern Map Turtle local populations. For example, turtle fencing and ecopassages are now incorporated into the design of most new highways whenever they bisect species at risk turtle habitat (Ontario Road Ecology Group 2010; OMNR 2013). Research is actively being conducted for species at risk turtles in Canada, many of which have been referenced throughout this recovery strategy and listed in section 8.

Quebec

The Quebec Turtles Recovery Team was created in 2005. One of its mandates was to develop and implement a recovery plan for five species of turtles: the Wood Turtle (*Glyptemys insculpta*), the Northern Map Turtle (*Graptemys geographica*), the Blanding's Turtle (*Emydoidea blandingii*), the Eastern Musk Turtle (*Sternotherus odoratus*) and the Spotted Turtle (*Clemmys guttata*) (ÉRCETQ 2005). This team merged in 2012 with the Spiny Softshell Recovery Team, thus including a sixth species of turtle. To ensure the implementation of the recovery actions, four Implementation Groups were established, each working on a specific turtle species or groups of

species. One of these groups is the Northern Map Turtle Implementation Group, and is made up of partners from many organizations and independent consultants, including (over the years) MFFP, Environment and Climate Change Canada, Éco-Nature, Biodôme de Montréal, Nature Conservancy of Canada, Ville de Montréal, Hydro-Québec, Nature-Action Québec, Zoo Ecomuseum / Société d'Histoire Naturelle de la Vallée du Saint-Laurent (SHNVSL), Université de Montréal, and Université d'Ottawa.

An amphibian and reptile database (Atlas des Amphibiens et des Reptiles du Québec - AARQ) exists and is managed by the SHNVSL . The Atlas des Amphibiens et des Reptiles du Québec has been a source database of the Centre de données sur le patrimoine naturel du Québec (CDPNQ) until 2014. As of 2014, the MFFP manages the Bank of Reptile and Amphibian Observations in Quebec (BORAQ). BORAQ is now a source database to the CDPNQ. The bank collects all the observational data submitted by the Ministry and its partners, including data recorded in AARQ before 2014.The CDPNQ is operated by the Ministère des Forêts, de la Faune et des Parcs (MFFP) for data on threatened or vulnerable wildlife species, including the Northern Map Turtle. In 2011, the CDPNQ mapped the element occurrences for Northern Map Turtle in Quebec.

Inventories and research on the ecology, genetics, habitat use, movements, impact of disturbances and road mortality have been conducted across the province by various organizations (e.g. MFFP, SHNVSL, Université de Montréal, Éco-Nature, Ville de Montréal, Nature Conservancy of Canada). A protocol on population monitoring has been developed and tested (Bernier and Mazerolle 2009).

A number of education and awareness programs that include Northern Map Turtles have been conducted by zoological institutions (e.g., Biodôme de Montréal, SHNVSL, Zoo de Granby), conservation organizations (e.g., Nature-Action Québec, Nature Conservancy of Canada, Éco-Nature), and parks. Many local conservation organizations and associations contribute to the conservation of the Northern Map Turtle and a Web vignette has been developed (MFFP website and Atlas des Amphibiens et des Reptiles du Québec (AARQ) website)[26]. The Nature Conservancy of Canada has developed a conservation plan for the Northern Map Turtle in the Lac des Deux Montagnes region. In addition, various educational brochures and posters have been distributed (Nature Conservancy of Canada, Éco-Nature, SHNVSL).

Several multi-partner projects were established to secure nests; to create and improve nesting sites; to install basking sites; to promote installation of road signs and navigation buoys in or adjacent to areas with high turtle densities to mitigate road and boating mortality, respectively; and to increase awareness about native species and how to prevent illegal turtle trade (Tessier et al. 2007, Éco-Nature/Parc de la Rivière-des-Mille-Îles, MFFP, SHNVSL, Ville de Montréal, Hydro-Quebec). There are also acquisition,

[26] MFFP website: http://www3.mffp.gouv.qc.ca/faune/especes/menacees/fiche.asp?noEsp=72
AARQ website: http://www.atlasamphibiensreptiles.qc.ca/

agreement, and stewardship programs to conserve turtle habitats in various regions of Quebec (e.g., Nature Conservancy of Canada, Nature-Action Québec, Éco-Nature, Canards Illimités, MFFP).

6.2 Broad Strategies

The broad strategies of this management plan are as follows:

1. Use legislative and administrative tools to conserve Northern Map Turtle individuals and habitat.
2. Reduce individual (adult and hatchling) mortality, injury and illegal collection across the range of the Northern Map Turtle in Canada.
3. Conserve, manage and restore habitat across the range of the Northern Map Turtle in Canada.
4. Conduct communication and outreach to promote efficient and collaborative management efforts across the range of Northern Map Turtle in Canada.
5. Survey and monitor Northern Map Turtle local populations, habitats and threats to provide baseline information and to monitor population trends and habitat use.
6. Conduct research on population demographics, habitat characterization and use, and threats/threat mitigation to fill knowledge gaps.

6.3 Conservation Measures

To work towards achieving the management objective, six broad strategies for recovery have been established. Conservation measures are recommended for each (Table 2). Threats/limitations in the third column are numbered as follows for concise presentation:

1. Shoreline development;
2. Collisions with Boats;
3. Fishing by-catch;
4. Road networks;
5. Water level management;
6. Illegal collection;
7. Human-subsidized predators;
8. Disturbance from human activities;
9. Exotic and invasive species;
10. Contamination and nutrient loading;
11. Climate change;
12. Lack of baseline information.

Table 2: Conservation Measures and Implementation Schedule

Conservation Measure	Priority[a]	Threat or Limitation Addressed	Timeline
1. Use legislative and administrative tools to conserve Northern Map Turtle individuals and habitat.			
1.1. Continue to promote compliance with existing provincial and federal legislation applicable to Northern Map Turtle individuals and their habitat.	High	1-6, 8-10	Ongoing
1.2. Promote the integration of approved Best Management Practices (BMPs) into the policies and practices of responsible agencies, jurisdictions, and industry.	Medium	1-10	Ongoing
1.3 Continue to encourage stewardship activities, including financial support through available funding programs.	Medium	1-11	Ongoing
2. Reduce individual mortality, injury and illegal collection across the range of the Northern Map Turtle in Canada.			
2.1. Continue to develop and encourage implementation of mitigation techniques (e.g., (BMPs) and alternatives to traditional development) to reduce individual mortality and injury, illegal collection, and exotic and invasive species. Examples of priority mitigations measures include:	High	1-10	2019-2029

Conservation Measure	Priority[a]	Threat or Limitation Addressed	Timeline
• Implement and evaluate techniques to reduce boating injury and mortality on areas with high to moderate boat traffic (e.g., cottage area) and to reduce turtle by-catch in commercial and recreational fisheries. • Implement and evaluate mitigation techniques to reduce road mortality rates (e.g., ecopassages). • Implement and evaluate techniques to control predator populations or restrain access to nesting habitats through direct and indirect measures (e.g., garbage removal, predator management, fencing). • Implement and evaluate stewardship activities to reduce disturbance of occupied nesting habitat and individuals (e.g., signposting, monitoring of off-road vehicle use on beaches).			
2.2. Promote the implementation of approved BMPs, development alternatives, and mitigation techniques to the general public, First Nations, landowners, land managers, and industry. This addresses priority threats through stewardship, funding and other techniques.	High	1-10	2019-2029
3. Conserve, manage and restore habitat across the range of the Northern Map Turtle in Canada.			
3.1 Conserve areas large enough to support habitat needs of local populations and increase connectivity by stewardship, development, promotion and implementation of BMPs and/or land conservation.	High	1-10	Ongoing
3.2 Prevent the establishment and control the spread of exotic and invasive species, and control or eliminate such species where they are detrimental to Northern Map Turtle local populations.	Medium	10	Ongoing
3.3 Assess habitat restoration needs at locations where habitat loss, degradation and fragmentation are threatening Northern Map Turtle local populations.	Medium	1, 4, 5, 9, 10	2019-2029
3.4 Develop, implement, and evaluate habitat restoration techniques where necessary to support local populations.	Medium	1, 4, 5, 9, 10	Ongoing
3.5 Where appropriate, restore or create suitable nesting habitat and monitor use by Northern Map Turtles.	Low	1, 4, 5, 10	Ongoing

Conservation Measure	Priority[a]	Threat or Limitation Addressed	Timeline
4 Conduct communication and outreach to favour efficient and collaborative management efforts across the range of Northern Map Turtle in Canada.			
4.1 Improve and maintain cooperation among stakeholders and First Nations (e.g., engage partners and promote collaborative work with multiple jurisdictions).	High	1-12	Ongoing
4.2 Develop and implement a communication and outreach strategy or continue implementing existing communication and outreach tools to help address threats to the species.	High	1-10	Ongoing
4.3 Encourage the transfer and archiving of information and tools, including Indigenous Knowledge (IK).	Medium	1-12	Ongoing
4.4 Promote and engage partners (e.g., academics, government, First Nations, non-government organizations) in research initiatives necessary to fill knowledge gaps.	Medium	12	Ongoing
5 Survey and monitor Northern Map Turtle local populations, habitat and threats to provide baseline information and trends.			
5.1 Identify nesting sites and overwintering sites of local populations for which information is not available or incomplete.	Medium	12	Ongoing
5.2 Encourage the submission of records for Northern Map Turtle to provincial herpetological atlases as well as provincial Conservation Data Centres.	Medium	12	Ongoing
5.3 Develop, and promote the appropriate use of standardized protocols for survey, monitoring and data bases (e.g., data collection, handling, marking).	Medium	12	Ongoing
5.4 Monitor local populations, habitat trends and threats to the species.	Medium	12	Ongoing
5.5 Prioritize sites with suitable habitat and historical or potential populations and conduct targeted surveys to document the presence of Northern Map Turtles, habitat use, abundance, and threats to the species.	Medium	12	2020

Conservation Measure	Priority[a]	Threat or Limitation Addressed	Timeline
6 Conduct research on population, habitat and threats to fill knowledge gaps.			
6.1 Conduct research on threat reduction and mitigation measures to document their efficiency and effects on local populations	Medium	12	Ongoing
6.2 Conduct demographic studies in selected sites across Northern Map Turtle's range, to expand knowledge on population size, age composition and sex ratios.	Medium	12	2019-2029
6.3 Document recruitment needs at locations where the Northern Map Turtle is declining and identify solutions adapted to causes of decline and site context.	Medium	1, 4, 5, 7-10	2019-2029
6.4 Refine knowledge on threats to Northern Map Turtle individuals and habitat to understand full range of effects and document severity, frequency, extent and casual certainty of threats.	Medium	12	Ongoing
6.5 Further characterize and define the habitats used by Northern Map Turtles at various life stages (e.g., overwintering, thermoregulation, foraging), particularly by hatchlings and juveniles.	Low	12	2019-2029

[a] *"Priority" reflects the degree to which the measure contributes directly to the conservation of the species or is an essential precursor to a measure that contributes to the conservation of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the management objective for the species. Medium priority measures may have a less immediate or less direct influence on reaching the management objective, but are still important for the management of the population. Low priority conservation measures will likely have an indirect or gradual influence on reaching the management objective, but are considered important contributions to the knowledge base and/or public involvement and acceptance of the species.*

6.4 Narrative to Support Conservation Measures and Implementation Schedule

Considering the Northern Map Turtle's reproduction strategy (see section 3.3 and 3.4), maintaining the highest possible adult survival rate, especially for females, remains the primary need of the species to achieve recovery. Unfortunately, some biological traits of the species (i.e., aquatic habits, nesting on beaches) make it particularly sensitive to many human activities (e.g., recreational boating, water sports, and recreational activities on beaches); therefore, a proactive integrated approach with landowners, First Nations, and land users to limit threats to adult Northern Map Turtles is required and deemed a high priority.

Such approaches should focus primarily on where and when most of the adult mortality occurs. Habitat conservation, as well as threat reduction and mitigation, are important in the management of local Northern Map Turtle populations because these measures will reduce adult mortality and provide suitable habitat for local populations to become self-sustaining. Population surveys and monitoring are also necessary to help gather information on the species in order to help inform further conservation efforts. These approaches must be implemented via an integrated approach engaging various parties (e.g., land owners, land users, land planners, non-government organizations, Indigenous communities, and governments). In order to inform these parties, as well as begin to mitigate specific threats (e.g. collisions with boats, and fishing by-catch), specific communication and outreach approaches need to be undertaken. It is also necessary to fill the knowledge gaps to help meet the management objective.

7. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the management objective. Every five years, success of management plan implementation will be measured against these performance indicators:

- Maintenance of or increase in the distribution (i.e., area of occupancy) of the Northern Map Turtle in Canada;
- The size of the population is stable or increasing in local Northern Map Turtle populations for which demographic data are available;
- Threats that may be causing population decline or reducing available suitable habitat have been reduced or mitigated throughout the Canadian range.

8. References

Due to the vulnerability of turtle species to illegal collection, specific references providing sensitive information for some species have been removed from this version of the management plan. To support protection of the species and its habitat, the exhaustive list of references may be requested on a need-to-know basis by contacting Environment and Climate Change Canada's Recovery Planning section at ec.planificationduretablissement-recoveryplanning.ec@canada.ca.

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Appendix A: Subnational Conservation Ranks of the Northern Map Turtle (*Graptemys geographica*) in Canada and the United States

Northern Map Turtle (*Graptemys geographica*)				
Global (G) Rank	**National (N) Rank (Canada)**	**Sub-national (S) Rank (Canada)**	**National (N) Rank (United States)**	**Sub-national (S) Rank (United States)**
G5	N3	Quebec (S2) Ontario (S3)	N5	Alabama (S3), Arkansas (S4), Georgia (S1), Illinois (S4), Indiana (S4), Iowa (S4), Kansas (S2), Maryland (S1), Michigan (S5), Minnesota (S5), Mississippi (SNR), Missouri (S5), New Jersey (SNA), New York (S3), North Carolina (S1), Ohio (SNR), Oklahoma (S1), Pennsylvania (S4), Tennessee (S5), Vermont (S3), Virginia (S3), West Virginia (S2), Wisconsin (S4S5),

(NatureServe 2013)

Rank Definitions (NatureServe 2013)

G5: Secure: At very low risk of extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.

S1: Critically Imperilled: At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.

S2: Imperilled: At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.

S2S3: Vulnerable/Imperilled: The risk of extirpation in the jurisdiction ranges from moderate to high due to a fairly restricted to restricted range, relatively few to few populations or occurrences, recent and widespread to steep declines, moderate to severe threats, or other factors.

N3/S3: Vulnerable: At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.

S4: Apparently Secure: At a fairly low risk of extirpation in the jurisdiction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.

S4S5: Secure/Apparently Secure: At no risk to fairly low risk of extirpation in the jurisdiction due to an extensive to very extensive range, abundant populations or occurrences, with little to some concern as a result of local recent declines, threats or other factors.

N5/S5: Secure: At very low risk of extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats).

SNA: Not applicable: A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.

SNR: Unranked: Subnational conservation status not yet assessed.

Appendix B: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[27]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[28] (FSDS) goals and targets.

Conservation planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of management plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the management plan itself, but are also summarized below in this statement.

Most activities undertaken to conserve the Northern Map Turtle individuals and their habitat will also be beneficial to other species that use similar habitat. The conservation of lakes and rivers as well as the adjacent riparian habitats will contribute to maintain the rich biodiversity supported by those habitats. Morever, threat reduction and mitigation measures targeting the Northern Map Turtle can contribute to reduce mortality in other animal species (e.g., use of ecopassages to reduce road mortality, managing predator populations, improvement of fishing techniques to reduce by-catch, efforts to eliminate pollution from aquatic environments). Some of these measures are likely to be found in other recovery documents, particularly those that deal with aquatic and riparian species. Table B-1 presents some examples of species that may benefit from management of the Northern Map Turtle population in Canada; other species not listed may also benefit from Northern Map Turtle management.

[27] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[28] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1

Table B-1. Some of the species at risk that may benefit from conservation and management of the habitats occupied by the Northern Map Turtle.

Common Name	Scientific Name	SARA Status
Eastern Foxsnake (Carolinian population)	*Pantherophis gloydi*	Endangered
Eastern Foxsnake (Great Lakes/St. Lawrence population)	*Pantherophis gloydi*	Endangered
Fowler's Toad	*Anaxyrus fowleri*	Endangered
King Rail	*Rallus elegans*	Endangered
Lake Erie Watersnake	*Nerodia sipedon insularum*	Endangered
Queensnake	*Regina septemvittata*	Endangered
Blanding's Turtle (Great Lakes/St. Lawrence population)	*Emydoidea blandingii*	Threatened
Least Bittern	*Ixobrychus exilis*	Threatened
Pugnose Shiner	*Notropis anogenus*	Threatened
Spiny Softshell	*Apalone spinifera*	Threatened
Eastern Musk Turtle	*Sternotherus odoratus*	Threatened
Eastern Sand Darter	*Ammocrypta pellucida*	Threatened
Snapping Turtle	*Chelydra serpentina*	Special Concern
Bridle Shiner	*Notropis bifrenatus*	Special Concern
Grass Pickerel	*Esox americanus vermiculatus*	Special Concern

Given that individual species have different life cycles and habitat requirements, along with other specific needs, management actions should recognize the potential for synergistic recovery actions. Wherever possible, natural ecosystem processes should be maintained and allowed to evolve without human interference, because these are the processes to which species are adapted.

The possibility that the present management plan inadvertently generates negative effects on the environment and on other species was considered. The majority of recommended actions are non-intrusive in nature, including surveys and outreach. The present management plan is unlikely to produce significant negative effects.