PROPOSED

Species at Risk Act
Management Plan Series

Management Plan for the Snapping Turtle (*Chelydra serpentina*) in Canada

Snapping Turtle

2016

Government of Canada
Gouvernement du Canada

Canada

Recommended citation:

Environment and Climate Change Canada. 2016. Management Plan for the Snapping Turtle (*Chelydra serpentina*) in Canada [Proposed]. *Species at Risk Act* Management Plan Series. Ottawa, Environment and Climate Change Canada, Ottawa, iv + 39 p.

For copies of the management plan, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry.[1]

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Également disponible en français sous le titre
« Plan de gestion de la tortue serpentine (*Chelydra serpentina*) au Canada [Proposition] »

ISBN
Catalogue no.

[1] http://www.registrelep-sararegistry.gc.ca

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 Canada and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Snapping Turtle and has prepared this management plan as per section 65 of SARA. To the extent possible, the management plan has been prepared in cooperation with the governments of Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick and Nova Scotia 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 Snapping 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] http://registrelep-sararegistry.gc.ca/default.asp?lang=En&n=6B319869-1%20

Acknowledgements

The first drafts of this document were prepared by Alain Branchaud and Marie-José Ribeyron (Environment and Climate Change Canada, Canadian Wildlife Service – Quebec Region). The contributions of Sylvain Giguère and Pierre-André Bernier (Environment and Climate Change Canada, Canadian Wildlife Service – Quebec Region), Samara Eaton, Karen Potter and Andrew Boyne (Environment and Climate Change Canada, Canadian Wildlife Service – Atlantic Region), Jeff Robinson, Bruna Peloso, Angela McConnell, Shane de Solla and Lee Voisin (Environment and Climate Change Canada, Canadian Wildlife Service – Ontario Region), Andrew Didiuk (Environment and Climate Change Canada, Canadian Wildlife Service – Prairies and Northern Region), Manon Dubé and Véronique Brondex (Environment and Climate Change Canada, Canadian Wildlife Service – National Capital Region), Joanne Tuckwell (Parks Canada), Diane Amirault-Langlais and Éric Tremblay (Kouchibouguac National Park of Canada), Megan Crowley (Kejimkujik National Park of Canada), Maria Papoulias and Leonardo Cabrera (Rouge National Urban Park), Lisa Hagar (Industry Canada), Jocelyne Jacob (National Capital Commission), Simon Pelletier, Yohann Dubois and Isabelle Gauthier (Quebec Department of Forests, Wildlife and Parks), Maureen Toner (New Brunswick Department of Natural Resources), and Mark Elderkin (Nova Scotia Department of Natural Resources), as well as Joe Crowley, Amelia Argue, Julia Holder, Terese McIntosh, Alan Dextrase, Jay Fitzsimmons, Vivian Brownell, Patrick Hubert and Glenn Desy (Ontario Ministry of Natural Resources and Forestry) and Rachel McDonald (Department of National Defence) are also acknowledged and appreciated.

Executive Summary

The Snapping Turtle (*Chelydra serpentina*) was assessed as Special Concern by COSEWIC in 2008, and was listed as Special Concern under Schedule 1 of the *Species at Risk Act* in 2011. It is one of the largest freshwater turtles in Canada. It has a keeled carapace, exposed limbs, hooked jaw, long neck and long tail. Snapping Turtles occupy a wide range of habitats but prefer aquatic habitats characterized by slow-moving water with a soft muddy bottom and dense aquatic vegetation. They also use adjacent terrestrial habitats.

The Canadian range of the Snapping Turtle extends from southeastern Saskatchewan to Nova Scotia. Although data on Canadian population trends are very limited, long-term studies have shown that some populations are declining and that local populations are highly vulnerable to increases in adult mortality. Certain characteristics of the species' reproductive strategy (life history characterized by delayed maturity, extended longevity and low recruitment) make local populations very sensitive to increases in mortality associated with anthropogenic threats.

The main threats to the Canadian population of Snapping Turtles are conversion of aquatic or riparian habitats for agriculture and urban development purposes incompatible with the species' needs, the road network, legal and illegal harvesting, persecution, human-subsidized predators, and fishing bycatch. Other threats that have been identified include chemical contamination, water level management, dredging, and collisions with boats. It should be noted that each of these threats has a cumulative effect.

The management objective for the Snapping Turtle is to maintain and, if possible, increase the index of area of occupancy of the Snapping Turtle in Canada (~ 858,000 km^2) and to maintain and, if possible, increase Snapping Turtle abundance in Canada, by reducing the main threats to the species, particularly those affecting adult Snapping Turtles.

The conservation measures recommended in order to achieve this objective are divided into six broad strategies: protect 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 Snapping Turtle populations and habitats; and carry out research and acquire the knowledge necessary for management of the Snapping Turtle.

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1. COSEWIC* Species Assessment

Date of Assessment: November 2008

Common Name: Snapping Turtle

Scientific Name: *Chelydra serpentina*

COSEWIC Status: Special Concern

Reason for Designation: Although this species is widespread and still somewhat abundant, its life history (late maturity, great longevity, low recruitment, lack of density-dependent responses) and its dependence on long, warm summers to complete incubation successfully make it unusually susceptible to anthropogenic threats. When these threats cause even apparently minor increases in the mortality of adults, populations are likely to decline as long as these mortality increases persist. There are several such threats and their impacts are additive. Aboriginal Traditional Knowledge generally supports the declining trend and population figures in the COSEWIC report.

Canadian occurrence: Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick and Nova Scotia

COSEWIC Status History: Designated Special Concern in November 2008.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

2. Species Status Information

The Canadian range of the Snapping Turtle (*Chelydra serpentina*) represents approximately 10% of its global range. In Canada, the species has been listed as Special Concern on Schedule 1 of the *Species at Risk Act* (S.C. 2002, c. 29) since 2011. It has been listed as a special concern species under the Ontario *Endangered Species Act*, *2007* (S.O. 2007, c. 6) since 2009, as a species of special concern under the New Brunswick *Species at Risk Act* (S.N.B. 2012, c. 6) since 2011, and as a vulnerable species under the Nova Scotia *Endangered Species Act* (S.N.S. 1998, c. 11, s. 1) since 2013. The Snapping Turtle has not been legally designated as a species at risk in Saskatchewan, Manitoba or Quebec.

The Snapping Turtle has a global conservation status rank of G5 (secure) and a national status rank of N5 (secure) in Canada and the United States. The species has a status rank of S5 (secure) in Nova Scotia, S4 (apparently secure) in Quebec and New Brunswick, and S3 (vulnerable) in Saskatchewan, Manitoba and Ontario (see Appendix A of the present document; [NatureServe, 2015]).

In 2010, the International Union for the Conservation of Nature (IUCN) ranked the Snapping Turtle as least concern (IUCN, 2015). The species is not protected by the

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). In Canada, the Snapping Turtle is not governed by the *Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act* (S.C. 1992, c. 52).

3. Species Information

3.1. Species Description

The Snapping Turtle is one of the largest freshwater turtles in Canada (maximum carapace length = 49.4 cm; [Ernst and Lovich, 2009]). It has a brown, black or olive keeled carapace[3] (the keels are more prominent on young turtles), with deeply serrated posterior marginal scutes. The Snapping Turtle has a cross-shaped plastron,[4] which is much reduced compared with that of other Canadian freshwater turtles, leaving the limbs exposed. It has a very large head with a hooked upper jaw, a long neck and a long tail with elongate scales, giving it a saw-toothed appearance (Harding, 1997; Ernst and Lovich, 2009). Males can attain a carapace size of 49.4 cm, compared with a maximum of 36.6 cm for females (Gibbons and Lovich, 1990). In males, the linear distance from the cloaca to the posterior tip of the plastron is more than 120% greater than the length of the posterior lobe[5] of the plastron, whereas in females, this ratio is generally smaller than 110% (Mosimann and Bider, 1960; Ernst and Lovich, 2009). In Ontario, males can reach an average mass of 18 kg and females an average mass of 9 kg (R. Brooks, unpublished data cited in COSEWIC, 2008). However, it appears that wild individuals of the species can reach a mass of 34 kg (Harding, 1997). For more descriptive details on the species, see the COSEWIC Status Report (2008).

[3] Upper (dorsal) shell.
[4] Lower (ventral) shell.
[5] Rounded part of plastron located near tail.

3.2. Populations and Distribution

The Snapping Turtle ranges across the United States east of the 105th meridian and southward to southern Texas. Approximately 10% of the species' range is in Canada, where it encompasses southeastern Saskatchewan, southern Manitoba, western, central and southern Ontario, central and southern Quebec, southern New Brunswick and mainland Nova Scotia (Figure 1; [COSEWIC, 2008]).

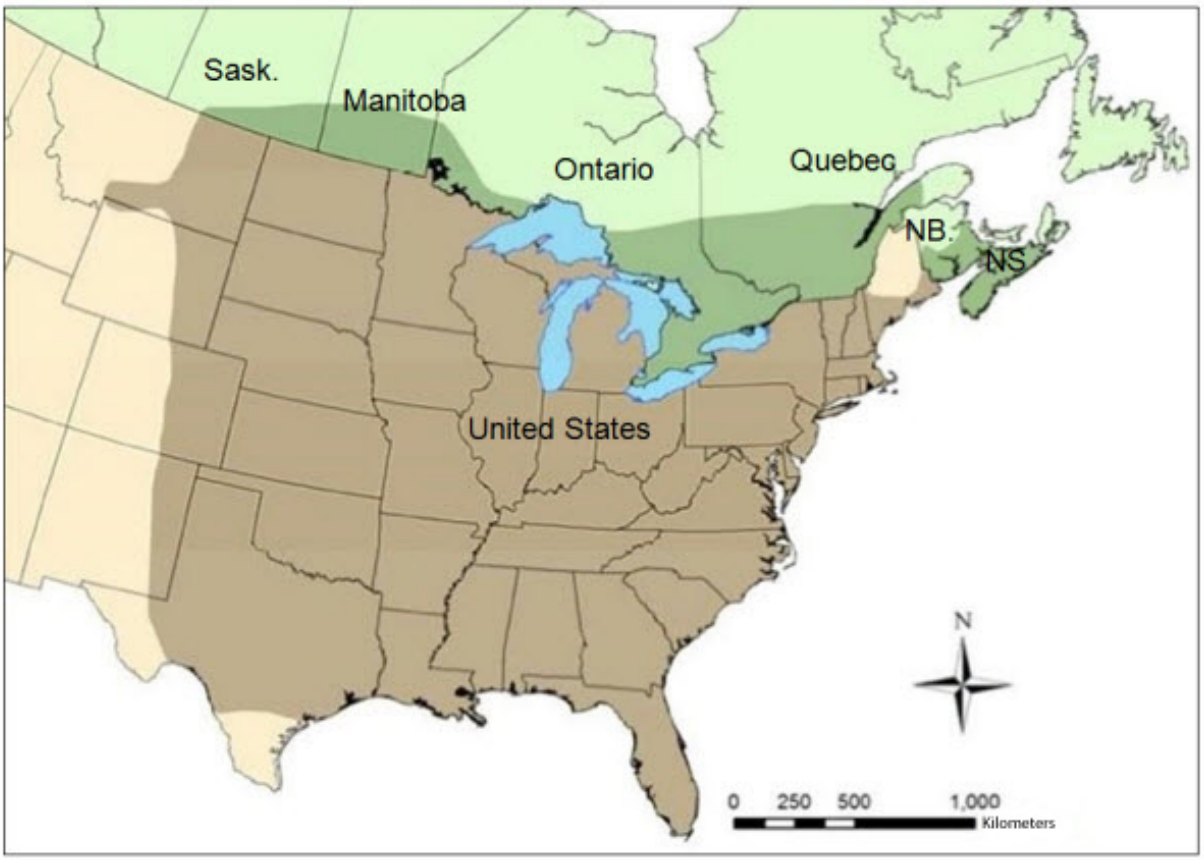

Figure 1. Distribution of the Snapping Turtle (adapted from COSEWIC, 2008). The species' range is indicated by the shaded areas.

Most of the available data on Snapping Turtle numbers in Canada come from incidental observations or non-targeted surveys. In Ontario, long-term mark-recapture studies have also been conducted (in Algonquin Provincial Park [e.g., Brooks et al., 1988; Brooks et al., 1991; Galbraith et al., 1988], Point Pelee National Park [e.g., Browne, 2003; Browne and Hecnar, 2007], and Hamilton [unpublished data from S. de Solla; Galbraith et al., 1988]). In Saskatchewan, the Snapping Turtle occurs in the southeastern part of the province, although unconfirmed reports suggest that the species may also be present in southwestern Saskatchewan (COSEWIC, 2008). In Manitoba, it has been reported in most of the regions in the southern part of the province (Central Plains, Eastman, Interlake, Northern, Parkland, Pembina Valley,

Westman, Winnipeg Capital Region), and according to unconfirmed reports, the species' range may extend as far north as The Pas (Preston, 1982; COSEWIC, 2008). The Snapping Turtle is distributed throughout Ontario south of a line from approximately Wawa to Kirkland Lake, and there are reports of its presence in western Ontario, along the Ontario–Minnesota border (COSEWIC, 2008). In Quebec, the Snapping Turtle occurs in the watersheds of almost all the rivers located south of the 49th parallel, and its abundance decreases with increasing latitude (Y. Dubois, pers. com., 2014; AARQ, 2015). In New Brunswick, it is found in all counties of the province, except Restigouche in the north. The species is also present throughout mainland Nova Scotia (COSEWIC, 2008). While the occurrence of Snapping Turtles has been reported on Cape Breton Island, these specimens likely represent released captives (Cape Breton Highlands National Park, 2009).

Although the size of the Canadian Snapping Turtle population is unknown, these turtles are estimated to number in the thousands (COSEWIC, 2008). The Snapping Turtle remains relatively abundant in eastern Canada, but is less often encountered in Saskatchewan and Manitoba (COSEWIC, 2008). Little is known about the population trend in Canada. Long-term studies conducted in Ontario have nonetheless shown that certain populations are declining and that local populations are vulnerable to increases in adult mortality (see section *3.4 – Limiting Factors* as well as other details concerning these local populations in the COSEWIC Status Report [2008]). Given this limiting factor, local population declines are likely to occur within the Canadian range wherever anthropogenic threats result in an increase in adult mortality.

The extent of occurrence[6] of the Snapping Turtle in Canada has been estimated to be about 1,455,000 km^2 and the index of area of occupancy[7] approximately 858,000 km^2 (COSEWIC, 2008). The species' extent of occurrence has declined and is still declining owing to a significant reduction in habitat quantity and quality (see the subsection entitled *Conversion of aquatic or riparian habitats for agriculture and urban development purposes incompatible with the species' needs*, in section 4.2).

3.3. Needs of the Snapping Turtle

General habitat needs

Although Snapping Turtles occupy a wide variety of habitats, the preferred habitat for this species is characterized by slow-moving water with a soft mud bottom and dense aquatic vegetation. Established populations are most often found in ponds, marshes, swamps, peat bogs, shallow bays, river and lake edges, and slow-moving streams (Harding, 1997; Ernst and Lovich, 2009; Paterson et al., 2012). Although individual turtles may persist in developed areas (e.g., golf course ponds, irrigation canals) and environments with heavily polluted water (e.g., some port areas), it is unlikely that local populations will persist in such habitats, since environmental contamination is known to

[6] The area included in a polygon without concave angles that encompasses the geographic distribution of all known populations of a wildlife species (COSEWIC, 2010).
[7] The area within 'extent of occurrence' that is occupied by the species (COSEWIC, 2010).

severely compromise reproductive success (Bishop et al., 1998; de Solla et al., 1998; COSEWIC, 2008; Rowe, 2008).

Hibernation

Snapping Turtles seek out hibernation sites in the aquatic environment in order to keep from freezing during the winter. These may include lotic[8], lentic[9] and mud[10] environments (Brown and Brooks, 1994; Paterson et al., 2012). Within these habitats, the turtles appear to prefer the following characteristics for their hibernacula: water shallow enough to let the turtle reach the surface to breathe, but deep enough so the water will not freeze to the bottom; a location that is likely to freeze over later in the season and thaw earlier in the spring; a thick layer of mud in which the turtle can bury itself; and additional submerged cover, such as a floating mat of vegetation, roots, stumps, branches or logs, a muskrat dwelling or an overhanging bank (Meeks and Ultsch, 1990). Snapping Turtles tolerate anoxic[11] conditions (Reese et al., 2002); their overwintering sites have been found to vary greatly in their dissolved oxygen levels (Paterson et al., 2012). It appears that these turtles select overwintering sites characterized by lower water temperatures than the surrounding habitat, probably to reduce the metabolic costs of hibernation (Paterson et al., 2012). During hibernation, the turtles can lower their body temperature to 1°C or 2°C, but if the temperature drops further they will freeze to death (R. Brooks, pers. comm., cited in Ernst and Lovich, 2009). In the Great Lakes region, Snapping Turtles generally hibernate from October to April (Harding, 1997; Brown and Brooks, 1993). They may hibernate in groups (Meeks and Ultsch, 1990), and other species of turtles may join them at the overwintering site (Ernst and Lovich, 2009). Snapping Turtles appear to show fidelity to their hibernation site, with many adults migrating annually up to 3.9 km to return to their previous year's hibernacula (Brown and Brooks, 1994).

Reproduction

Mating of Snapping Turtles may occur throughout the active season (Ernst and Lovich, 2009), but it more commonly occurs in the spring and fall (Harding, 1997). In Canada, females generally lay their eggs between late May and late June (Harding, 1997; Desroches and Rodrigue, 2004). Across the species' global range, clutch size varies between 4 and 109 eggs, but a typical clutch contains 25 to 45 eggs (Ernst and Lovich, 2009). The eggs are generally laid on sand or gravel banks near the water, in locations where vegetation is absent or sparse. Although a wide range of other sites that are easy to dig into are also used, including beaver and muskrat lodges, roadsides, artificial dam and railway embankments, cracks in rocky banks, sawdust piles, disturbed soil, gardens, lawns, forest clearings and farm fields, nesting success at these sites is unknown (Obbard and Brooks, 1980; Congdon et al., 2008; Ernst and Lovich, 2009). Females exhibit strong nesting site fidelity, returning to the same site year after year (Loncke and Obbard, 1977; Obbard and Brooks, 1980).

[8] Freshwater ecosystems with continuously flowing water (e.g., rivers and streams).
[9] Relating to lakes.
[10] With soft waterlogged soil (muddy, swampy).
[11] Environment containing little or no oxygen.

In Snapping Turtles, sex is determined by incubation temperature. Research has shown that an incubation temperature of 20°C produces only females, temperatures of between 23°C and 24°C, only males, and temperatures of between 29°C and 31°C, only females. Intermediate or unstable incubation temperatures appear to produce mixed sex ratios (Yntema, 1976; Dimond, 1983; Crews et al., 1989; Bobyn and Brooks, 1994, Freedberg et al., 2001; 2011). Eggs generally hatch 65 to 95 days after they are laid (Harding, 1997), that is, between late August and late October; eggs laid at more northerly latitudes take longer to hatch (Ernst and Lovich, 2009). Hatchlings can overwinter in the nest but the rate of hatchling survival in populations in the northern part of the range is low (Obbard and Brooks, 1981b; Parren and Rice, 2004). Upon emerging from the nest, hatchlings usually move to water, after which they bury themselves under leaf debris or other material (Ernst and Lovich, 2009). Little is known about the habitat preferences of juveniles, but they appear to favour shallower portions of aquatic habitats with less vegetation in comparison with adults (Congdon et al., 1992).

Thermoregulation

To regulate their body temperature, Snapping Turtles often bask by floating at the water's surface or remaining stationary in shallow water (e.g., head of bay). They sometimes bask on logs and rocks, beaver or muskrat lodges or on stream banks (Obbard and Brooks, 1979; Brown et al., 1990; Ernst and Lovich, 2009), generally near the surface of the water. Snapping Turtles bask less often than other turtle species. In a study carried out in Ontario, Brown et al. (1990) showed that in some cases the body temperature of Snapping Turtles (22.7°C) was lower than the temperature considered optimal (28–30°C), even though these turtles are able to increase their body temperature through thermoregulation. Other factors such as home range structure and foraging tactics could explain why the turtles do not take advantage of opportunities to maintain an optimum body temperature (Brown et al., 1990).

Snapping Turtles generally become dormant when the water temperature drops below 5°C (Ernst and Lovich, 2009) and become active when the water temperature is about 7.5°C (Obbard and Brooks, 1981a). However, they do not feed at temperatures below 15°C (Obbard and Brooks, 1981a).

Foraging

The Snapping Turtle is omnivorous and opportunistic. Its diet may include algae and vascular plants (fruits, leaves and stems; Ernst and Lovich, 2009; Pell, 1941), mollusks (bivalves, snails), arthropods (crayfish, insects), fish (adults, eggs), amphibians (salamanders, anurans), reptiles (small turtles, snakes), birds (particularly waterbirds and shorebirds) and small mammals (Ernst and Lovich, 2009). Snapping Turtles usually consume larger amounts of plant material than animal matter (Lagler, 1940). They may actively forage for food, or they may lie in wait to ambush prey (Ernst and Lovich, 2009). Snapping Turtles consume both live prey and carrion (Schneider, 1998).

Movement
Snapping Turtles are capable of swimming through deep water but prefer to remain on the periphery of water bodies (within 5 m of shore) at depths of less than 2 m (Brown, 1992). Although the Snapping Turtle is one of the most aquatic freshwater turtle species in Canada, it uses terrestrial habitats as movement corridors, particularly when local water conditions are unfavourable (Steen et al., 2010). Obbard and Brooks (1980) reported that some Snapping Turtles had travelled more than 500 m overland from one body of water to another. They may also use streams in early spring as a means of travelling between bodies of water (Brown and Brooks, 1993).

In Ontario, the Snapping Turtle's home range size has been estimated to range from a few hectares (Obbard and Brooks, 1981a; Pettit et al., 1995) to a few dozen hectares (Paterson et al., 2012). Depending on the populations concerned, males and females may have a similar home range (e.g., 3.21 ha for males and 3.79 ha for females; Obbard and Brooks, 1981a) or females may have a larger home range (e.g., 2.2–3.4 ha on average for males and 8.6–9.7 ha for females [Pettit et al., 1995]; ± 17.5 ha for males and ± 30 ha for females; [Paterson et al., 2012]). It appears, moreover, that females travel greater distances than males, particularly during the nesting season. Pettit et al. (1995) reported that females travelled up to 2.02 km between their residence and a nesting area, whereas Obbard and Brooks (1980) found that the maximum round trip distance travelled between home range and nesting site was 16 km. In addition, Brown and Brooks (1994) showed that some individuals travelled up to 4 km (1 km on average) away from their summer home range to return to a hibernation site. In a study conducted in Algonquin Provincial Park, Paterson et al. (2012) showed that home range size was approximately the same for males and females in the pre-nesting season and the nesting season (about a dozen hectares), but that females had a larger home range size in the post-nesting season (possibly due to increased foraging activity).

3.4. Limiting Factors

The maintenance of Snapping Turtle populations depends on high adult survival rates to counterbalance low recruitment rates, which are mainly due to the species' reproductive strategy and climatic constraints.

Reproductive strategy
Most turtles, including the Snapping 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., 1994; Gibbons et al., 2000; Turtle Conservation Fund, 2002).

Snapping Turtles have a relatively short time to reproduce owing to their delayed sexual maturity. In Ontario, it is estimated that females nest for the first time between 17 and 19 years of age (Galbraith et al., 1989; Galbraith, 1994). Sexual maturity is reached at an earlier age in more southerly populations, such as those in Florida (4–8 years; [Aresco et al., 2006]), Iowa (4–7 years; [Christiansen and Burken, 1979]) and Michigan

(12 years; [Congdon et al., 1987]). In Ontario, it is estimated that males reach sexual maturity between 15 and 20 years of age (R. Brooks, unpublished data cited in COSEWIC, 2008). The lifespan of Snapping Turtles in the wild has been estimated to be nearly 40 years (Galbraith and Brooks, 1989; Harding, 1997), and unpublished data and anecdotal reports suggest that Snapping Turtles can often reach ages greater than 50 years (COSEWIC, 2008). Long-term studies indicate that high survival rates of adults (particularly females) are critical to the maintenance of turtle populations. An increase of just 2% or 3% in the adult mortality rate can result in a severe decline in the turtle population (Congdon et al., 1993; 1994; Cunnington and Brooks, 1996). Life-history models indicate that a slight increase (+ 0.1%) in the annual mortality rate of turtles over 15 years of age (due to road mortality or harvesting, for example) would halve the number of adults in the local population in less than 20 years (Congdon et al., 1994). Adult survivorship is therefore of critical importance for the persistence of local Snapping Turtle populations. Episodes of predation on adults have been reported and can have a long-term impact on local populations. For example, Brooks et al. (1991) reported that 31 adult Snapping Turtles were killed during their winter hibernation by river otters (*Lontra canadensis*) over a three-year period, reducing the minimum number of adult residents in the lake under study from 47 to 16.

Local Snapping Turtle populations also experience a high rate of predation on eggs. Nest predation rates ranging from 59% to 94% have been reported (Hammer, 1969; Petokas and Alexander, 1980; Congdon et al., 1987, cited by Wirsing et al., 2012). This naturally high rate of predation is exacerbated by the activity of human-subsidized predators[12] (see the threat *Human-subsidized predators* in section 4). Although the hatchling survival rate is low, survivorship increases as the turtles mature (and increase in size). The survival rate is only 6.4% to 23.0% for hatchlings, but reaches 67.8% to 75.4% for juveniles, and 93.0% to 96.6% for mature individuals (Heppel, 1998).

Climatic constraints

Local Snapping Turtle populations are also dependent on environmental conditions which influence the duration of hibernation and the internal development of eggs and external incubation of eggs without parental care. Canadian Snapping Turtle populations are at the northern limit of the species' range (Seburn and Seburn, 2000; Ernst and Lovich, 2009). Since a smaller number of heat units[13] are available in more northerly regions, the likelihood of completion of egg incubation and embryo development decreases with increasing latitude (Yntema, 1976; Holt, 2000; Ewert, 2008). Furthermore, recruitment can vary from one year to the next depending on weather conditions, particularly during the summer (R. Brooks, pers. comm., cited in COSEWIC, 2008).

[12] Human-subsidized predation: appreciable increase in predation by animal species whose populations flourish as a result of close association with humans and human-altered habitats (Boarman, 1997).
[13] Heat units represent the total amount of heat that an organism needs to complete all its life cycle stages. Therefore, the mean temperature decreases and so does a species' potential development with increasing latitude.

In Snapping Turtles, sex determination is temperature-dependent at certain stages of embryo development (Janzen, 1992; Rhen and Lang, 1998; see the subsection entitled *Nesting* in section *3.3 – Needs of the Snapping Turtle*). Consequently, weather conditions could have an impact on the proportion of males and females recruited into the population.

3.5. Species Cultural Significance

Turtles feature prominently in the beliefs and ceremonies of many First Nations peoples. For some First Nations communities, the turtle is a teacher, possessing a great wealth of knowledge. It plays a vital role in creating the world by allowing the Earth to be created on its back. For this reason, many First Nations peoples call North America "Turtle Island," and First Nations communities view the Turtle's back as a sort of calendar, with its pattern of thirteen large scutes standing for the thirteen moons of each 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 the legends of some First Nations, such as the Anishinaabe ("How the Turtle Got its Shell") and the Hauenosaunee ("Turtle Races with Beaver") (Bell et al., 2010).

4. Threats

The threats to the Snapping Turtle may vary regionally and locally throughout its range in Canada. The information presented in Table 1 is an overall assessment of the threats to the species in Canada.

4.1. Threat Assessment

Threats are presented in Table 1 in overall decreasing order of concern within each main threat category.

Table 1. Threat Assessment Table

Threat	Level of Concern[a]	Extent	Occurrence	Frequency	Severity[b]	Causal certainty[c]
Habitat loss and degradation						
Conversion of aquatic or riparian habitats for agriculture and urban development purposes incompatible with the species' needs	High	Widespread	Current	Continuous	High	High
Water level management	Low	Localized	Current	Recurrent	Unknown	Low
Dredging	Low	Localized	Current	Recurrent	Unknown	Low
Accidental mortality						
Road network	High	Widespread	Current	Seasonal	High	High
Fishing bycatch	Medium	Widespread	Current	Seasonal	Moderate/Low	High
Collisions with boats	Low	Localized	Current	Seasonal	Low	Low
Biological resource use						
Legal and illegal harvesting	Medium	Widespread	Current	Seasonal	High	Medium
Pollution						
Chemical contamination	Medium/Low	Localized	Current	Continuous	Moderate/Low	Medium
Disturbance or harm						
Persecution	Medium	Widespread	Current	Recurrent	Unknown	Medium
Changes in ecological dynamics or natural processes						
Human-subsidized predators[d]	Medium	Widespread	Current	Seasonal	Moderate	Medium

[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 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).

4.2. Description of Threats

This section describes the major threats outlined in Table 1, emphasizes key elements, and provides additional information. Although threats are listed individually, an important concern is the long-term cumulative effect of a variety of threats to local Snapping Turtle populations. It should be noted that some of these threats apply only during the active season since they lead to direct mortality, injury or capture of individuals. Moreover, exposure to threats increases during periods of increased Snapping Turtle movements (e.g., nesting); some females move several kilometres between their overwintering and nesting sites in the spring. Among the mechanisms by which threats can impact Snapping Turtle populations, isolation through habitat loss is of special concern, as it can lead to fragmentation of local populations by interfering with dynamics and limiting the possibility of rescue effect[14]. The threats to the Snapping Turtle are presented below in order of decreasing level of concern.

Conversion of aquatic or riparian habitats for agriculture and urban development purposes incompatible with the species' needs

The Snapping Turtle is confined to the more southern parts of Canada, which are the most heavily populated areas and subject to the most intensive agricultural operations. Snapping 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 agriculture and urban development (COSEWIC, 2008). Conversion can make all or parts of habitats partially or entirely unusable for certain stages of the species' life cycle (e.g., riprap or concrete walls installed along shorelines can reduce nest site availability and act as a barrier to movement) or destroy them outright (e.g., filling of a wetland for agriculture or urban development reduces the area of habitat available for all life stages). It should be noted that the reduction in availability of suitable nesting sites caused by degradation and conversion of riparian habitat is especially problematic given the turtles' nest site fidelity (see the subsection entitled *Reproduction* in section *3.3 – Needs of the Snapping Turtle*).

In Canada, more than 80% of aquatic habitats located near large urban centres have been converted to agriculture or urban development. Agriculture has claimed 71% of wetlands in southern Ontario and 70% of wetlands in the Prairies (Natural Resources Canada, 2004). Since the Snapping Turtle occupies the most populated regions of the country, it has suffered considerable habitat loss and continues to do so. A study by Freedberg et al. (2011) indicates that conversion of aquatic habitats for agriculture can also indirectly affect the Snapping Turtle population by altering the sex ratio. The study showed that females frequently chose to nest in agricultural fields rather than in natural sand prairie nesting habitat. These field sites, albeit open and sparsely vegetated at the start of the nesting season, soon become covered by rapidly growing crop plants (e.g., corn, soybean, sunflower) which are present during most of the embryo development period. The resulting temperature conditions favour male-biased sex ratios (up to 100%

[14] Rescue effect is the process by which a wildlife species may move through its range in such a way that it mitigates a Canadian extirpation or population decline.

male offspring). Such a strong bias in favour of males could lead to a population decline.

Furthermore, at the local scale, an increase in human density in the species' area of occupancy may boost the numbers of human-subsidized predators (see subsection entitled *Human-subsidized predators*), increase the risk of persecution (see subsection entitled *Persecution*) and of legal and illegal harvesting (see subsection *Legal and illegal harvesting*) and lead to an expansion of the road network (see subsection entitled *Road network*).

Road network

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). In some locations, dozens of Snapping Turtles are killed on roads every year (e.g., Ashley and Robinson, 1996). Modelling studies show that local freshwater turtle populations experience annual traffic mortality rates that may exceed 5% in areas with high road densities (Gibbs and Shriver, 2002), which reduces the likelihood of the long-term persistence of local populations in areas with high road densities (see section *3.4 – Limiting Factors*; and subsection entitled *Persecution* which deals with the issue of turtles being deliberately driven over). Crowley (2006) showed that the extirpation of several reptile populations in Ontario was associated with regions of high road density. Snapping Turtles are particularly vulnerable to road mortality during nesting, because females in search of nesting sites are more likely to cross roads and because soft gravel road shoulders make attractive nesting sites (Haxton, 2000; Aresco, 2005). Given the limiting factors associated with the species' reproductive strategy (see section *3.4 – Limiting Factors*), the negative impact of an increase in the mortality of mature females that nest on road shoulders greatly exceeds the potential increase in the recruitment rate associated with the use of such sites. In areas with higher road densities, turtle population sex ratios could become increasingly skewed towards males as a result of increased mortality of females (Aresco, 2005). If a female does manage to complete a roadside nest, the hatchlings are often killed as they leave the nest or the eggs fail to hatch due to compaction of the nest chamber, desiccation or increased access to mammalian predators (COSEWIC, 2008). Roadside nests may also be destroyed or damaged during routine road maintenance such as grading (R. Brooks, unpublished data cited in COSEWIC, 2008). Roadside nest sites can therefore be considered ecological traps. Lastly, major roads with heavy traffic (e.g., highways) or roads built in such a way as to make it impossible for turtles to cross can be considered barriers to their movement (NatureServe, 2015).

Legal and illegal harvesting

Hunting of Snapping Turtles is prohibited in Manitoba, Quebec, New Brunswick and Nova Scotia. Hunting of these turtles for personal use is permitted in Saskatchewan, and a fishing licence (not specific to the Snapping Turtle) is required in Ontario, where reporting of turtle harvests has been mandatory since 2012. Ontario has a daily bag limit of two turtles per person per day (MNRF, 2015). The legal harvesting period runs

from July 15 to September 15 in southern Ontario, and year-round in northern Ontario (MNRF, 2015). In 2012, four people, who took a total of 13 Snapping Turtles, reported their take to the Government of Ontario (Environmental Commissioner of Ontario, 2013).

Trade in turtles for food, medicine, recreational (such as pets) and decorative (such as trinkets) purposes affects the Snapping Turtle at all life stages. Whereas adults are mainly exploited for food, juveniles and hatchlings are exploited as pets (COSEWIC, 2008; Mali et al., 2014). Harvesting of Snapping Turtles in the natural environment and captive rearing of these turtles on farms for export to East Asia have increased substantially in recent years in the United States, where the number of turtles reported as being exported annually (including both wild and captive-reared turtles) has risen from 10,000 in 1999 to more than 300,000 over the past few years (van Dijk, 2012). Between 2002 and 2012, at least 126 million turtles (including more than 4 million turtles in the genus *Chelydra*) were exported from the United States (Mali et al., 2014). Very little information exists on exports of turtles from Canada (COSEWIC, 2008; WWF, 2015). Illegal trade appears to be on the rise in Canada, particularly in large cosmopolitan centres (e.g., Toronto and Montreal; [COSEWIC, 2008]).

Considering the reproductive strategy of the Snapping Turtle (i.e., delayed sexual maturity, high embryo mortality, extended adult longevity; see section *3.4 – Limiting Factors*), harvesting (legal or illegal) of adults and older juveniles is especially harmful for wild populations. Van Dijk (2012) reported that in some areas at the northern limit of the Snapping Turtle's range, harvesting of these turtles has resulted in significant declines in local populations.

Persecution

The Snapping Turtle has a largely undeserved but widespread reputation as an aggressive animal that preys on waterfowl and fish species (these animals make up only a small proportion of its diet; see subsection entitled *Foraging* in section *3.3 – Needs of the Snapping Turtle*) that are sought after by hunters and fishermen. For this reason and because of their large size and defensive behaviour when on land, they are often the target of illegal acts of abuse. They have been found deliberately starved to death, nailed to trees, shot, beaten or dismembered, and deliberately driven over by automobiles (R. Bolton, R. Brooks and S. Gillingwater, pers. comm. cited in COSEWIC, 2008). In a study conducted on the periphery of a national wildlife area, Ashley et al. (2007) showed that 1.8% of drivers deliberately drive over turtles. Depending on the volume of vehicle traffic and the presence of roads through turtle habitat, this threat may have a very important effect at the scale of a local population, especially since mature females (whose survival is necessary to maintain local populations – see section *3.4 - Limiting Factors*) use roadside areas for nesting (see subsection entitled *Road network*).

Little is currently known about the effects of persecution on local Snapping Turtle populations. The available information is more qualitative in nature, as it is based primarily on expert opinions (see COSEWIC, 2008).

Human-subsidized predators

Human activities such as agriculture, housing development and road development boost the numbers of certain predators in Snapping Turtle habitat (COSEWIC, 2008; Riley and Litzgus, 2014). In several regions of southern Canada, predation of Snapping Turtle eggs is exacerbated by high populations of Racoons [*Procyon lotor*], Striped Skunks ([*Mephitis mephitis*], Red Foxes [*Vulpes vulpes*], Opossums [*Didelphis virginiana*] and Coyotes [*Canis latrans*] (COSEWIC, 2008; Riley and Litzgus, 2014). Unusually high rates of nest predation have been well documented in several Ontario parks, such as Point Pelee National Park, where 83.8% of Snapping Turtle nests (Wirsing et al., 2012) and 100% of roadside nests of Snapping Turtles and Painted Turtles (*Chrysemys picta*) were depredated (Browne, 2003). At this site, the predation rate in anthropogenically disturbed areas (95%) was higher than in undisturbed areas (60%) (Wirsing et al., 2012). These elevated rates of egg predation are believed to have caused a decline in recruitment and a consequent shift in population structure (Browne and Hecnar, 2007). Unnaturally high densities of certain mammals are the primary cause of nest failure in the southern part of the species' range in Canada and, given that the human population in southern Canada is stable or growing, it is unlikely that predator densities will decrease in the future (COSEWIC, 2008). Egg predation may occur predominantly within the first few days after nest establishment in some cases (e.g., Wirsing et al., 2012), as well as throughout the incubation period (e.g., Riley and Litzgus, 2014). In some cases, this threat can be mitigated by using predator exclusion devices (Riley and Litzgus, 2013) or by reducing the abundance of predator populations (Christiansen and Gallaway, 1984; Spencer, 2002).

In addition, the rate of egg predation could be higher for Snapping Turtles than for other turtle species, particularly since their nests are likely more visible (greater soil disturbance around their nests), and contain a large number of eggs (Wirsing et al., 2012).

Fishing bycatch

Recreational fishing is a source of mortality for Snapping Turtles, which can accidentally ingest fishing hooks after consuming dead fish with embedded hooks in them or can be hooked directly by anglers (COSEWIC, 2008). In a study conducted in the southeastern United States, Steen et al. (2014) reported that 3.6% of Snapping Turtles caught were found to have ingested a fishing hook. It is not known whether the use of circle hooks could reduce the hook ingestion rate or the severity of hooking injuries in Snapping Turtles, as is the case for sea turtle species (Serafy et al., 2012). Cases of Snapping Turtle mortality and injury (e.g., intestinal perforations caused by the ingestion of fishing line and jigs) as well as poisoning (e.g., ingestion of lead sinkers) have also been reported (Borkowski, 1997; Scheuhammer et al., 2003).

Commercial fishing is also a significant source of mortality for freshwater turtles. The threat posed by fixed gear (e.g., fyke nets/hoop nets), in particular, is well documented (Michaletz and Sullivan, 2002; Barko et al., 2004; Carrière, 2007). Since this type of gear is usually fully submerged, captured individuals are at risk of drowning if the nets are not checked often enough. Turtles that survive submergence may suffer impairments that can potentially lead to post-release mortality (Stoot et al., 2013). The Snapping Turtle is one of the species for which the threat posed by fixed gear has been documented (e.g., Laroque et al., 2012a) and it has been shown that bycatch mortality can have significant population-level impacts (Midwood et al., 2015). Bycatch mitigation can be achieved through the use of suitably modified gear (e.g., Laroque et al., 2012b; c; Cairns et al., 2013; Midwood et al., 2015) and through certain handling and recovery methods for captured turtles (e.g., LeDain et al., 2013).

Chemical contamination

Snapping Turtles can accumulate high concentrations of chemical contaminants, such as heavy metals (e.g., mercury[15]), pesticides and organochlorine contaminants, including polychlorinated biphenyls (PCBs)[16] (Bonin et al., 1995). One of the highest PCB concentrations ever measured in a free-ranging animal species was found in Snapping Turtles, near Cornwall, Ontario (de Solla et al., 2008). Furthermore, Snapping Turtle eggs can absorb the kinds of pesticides that are routinely used in agriculture, such as atrazine and metolachlor (de Solla and Martin, 2011), and the concentrations of organochlorine contaminants measured in some eggs exceed the maximum allowable levels in fish intended for human consumption as well as the limits set out in the Canadian environmental quality guidelines (on the shores of Lake Erie; de Solla et al., 1998). More recently, it was demonstrated that metam sodium (a pesticide, herbicide and fungicide) used as a non-selective soil fumigant[17], notably for potato production, is highly toxic to Snapping Turtle eggs. Eggs exposed to metam sodium had 100% mortality, even when this substance was applied at 0.1 times the recommended application rate (de Solla et al., 2014).

Elevated contaminant concentrations cause decreased hatching success and increased deformity rates in Snapping Turtles (Bishop et al., 1991; 1998; de Solla et al., 2008), which can have a long-term impact on the reproductive success of local populations (Rowe, 2008). The threat posed by chemical contaminants is prevalent in industrialized regions (e.g., along the St. Lawrence River) and in areas of intensive agriculture.

[15] Mercury is emitted to the environment from natural sources (e.g., volcanic eruptions and soil and rock erosion) and anthropogenic sources (e.g., industrial emissions, releases associated with mercury-containing products) (ECCC, 2014a).

[16] PCBs are industrial chemicals that were widely used in Canada. Although the import, manufacture and sale of PCBs were made illegal in 1977, the use of PCB-containing equipment is permitted until the end of its service life. The release to the environment of PCBs is illegal and the storage of PCBs has been regulated since the 1980s. However, accidental releases of PCBs to the environment still occur (ECCC, 2014b).

[17] A chemical which, in contact with water or air in the soil, spontaneously or under the effect of heat, evaporates or decomposes into gaseous particles that are toxic to nematodes, insects, bacteria and fungi.

Water level management
Artificially lowering water levels in lakes and impoundments through the operation of water control structures (e.g., hydroelectric dams) may limit the availability of hibernacula to turtles and may strand turtles in freezing temperatures and result in mortalities, depending on when such operations take place (COSEWIC, 2008). Snapping Turtles usually die when exposed to freezing temperatures during the hibernation period (see subsection entitled *Hibernation* in section *3.3 – Needs of the Snapping Turtle*). Management of water levels in beaver ponds also poses a problem for the species. Y. Dubois (pers. comm. 2014) reported that in several locations in Quebec, beaver dams have been partly or completely destroyed in order to lower water levels and reduce the size of flooded areas. There is a significant risk of Snapping Turtles becoming exposed to freezing temperatures if this operation is carried out during the hibernation period. A rapid increase in or drop in water levels is recognized as a threat to a number of freshwater turtle species including the Snapping Turtle, because of the potential for flooding turtle nests or the potential reduction in suitable nesting sites (COSEWIC, 2002; Compton, 1999).

Dredging
Dredging of ponds, lakes, ditches, marina basins and stormwater management facilities removes sediments and structures that Snapping Turtles use as shelter, and can kill turtles that are in the sediment at the time of dredging (Aresco and Gunzburger, 2004; COSEWIC, 2008). The severity of this threat in Canada is unknown, but dredging could have a significant impact on local populations and lead to extirpation in some cases (Aresco and Gunzburger, 2004).

Collisions with boats
Nine Snapping Turtles were found dead, apparently killed by propeller strikes during a two-year study in southern Ontario (Gillingwater, 2001). In a study on other freshwater turtle species injured by boats in Ontario, Bennett and Litzgus (2014) noted a Snapping Turtle with scars caused by a boat propeller. Turtles floating at or near the surface of the water are at risk of being struck and killed by boat propellers (Galois and Ouellet, 2007). Nonetheless, motor powered vessels are banned on many of the water bodies occupied by this species, which helps to lower the level of concern.

Potential threats
Some invasive alien species pose a potential threat to the Snapping Turtle. For example, in some regions, a non-native plant species, Common Reed (*Phragmites australis*), has invaded wetlands, lakes and rivers, forming a monoculture that has altered water conditions and reduced habitat quality (Wilcox et al., 2003; Hudon et al., 2005). Some sites could also be altered by invasive exotic plants to the point that they no longer provide suitable habitat for nesting or egg incubation (Bolton and Brooks, 2010). Furthermore, activities likely to reduce water quality (e.g., wastewater discharges) could also present a threat to the species, particularly during the overwintering period (A. Boutin, pers. comm. 2015).

5. Management Objective

The management objective is to maintain and, if possible, increase the index of area of occupancy of the Snapping Turtle in Canada (~ 858 000 km^2) and to maintain and, if possible, increase Snapping Turtle abundance in Canada, by reducing the main threats to the species, particularly those affecting adult Snapping Turtles.

COSEWIC (2008) indicated that Snapping Turtle habitat is diminishing in both quantity and quality in Canada, specifying that declines have been observed in the index of area of occupancy as well as in the number of sites where the species occurs. Furthermore, little is known about population abundance or trends with respect to local populations in Canada. Furthermore, Snapping 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 Snapping 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 Snapping 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 level, the Canadian Herpetology Society is the main non-profit organization devoted to the conservation of amphibians and reptiles, including turtles, through scientific investigations, public education programs and community projects, compilation and analysis of historical data, and habitat conservation and restoration projects.

Since the Snapping Turtle lives in association with other freshwater turtle species at risk in Eastern Canada (Spotted Turtle [*Clemmys guttata*], Eastern Musk Turtle [*Sternotherus odoratus*], Blanding's Turtle [*Emydoidea blandingii*], Spiny Softshell Turtle [*Apalone spinifera*], Wood Turtle [*Glyptemys insculpta*] and Northern Map Turtle [*Graptemys geographica*]), 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 Snapping Turtle conservation under the Aboriginal Fund for Species at Risk program (AFSAR) and the Habitat Stewardship Program (HSP) since 2001, and under the Interdepartmental Recovery Fund (IRF) since 2004. Projects have included activities such as undertaking surveys for the species; identifying important habitats for local populations, studying the severity of and/or mitigating threats such as road mortality; encouraging public reporting of sightings; and educating landowners and the general public on species identification, threats, and stewardship options.

A number of key stakeholders have implemented knowledge acquisition, habitat restoration, management, communication, and threat reduction and mitigation measures aimed at the Snapping Turtle. Examples are provided below.

- First Nations (e.g., a number of Algonquin, Mohawk, Abenaki and Micmac communities);
- Environmental non-governmental organizations (e.g., Wildlife Preservation Canada, Kawartha Turtle Trauma Centre, Ontario Nature, Scales Nature Park, Toronto Zoo, Upper Thames River Conservation Authority, Éco-Nature, Montreal Biodome, Nature Conservancy of Canada, Nature-Action Québec, Ecomuseum Zoo / St. Lawrence Valley Natural History Society, Nature-Action Québec, Nova Scotia Nature Trust);
- Academic community (e.g., Laurentian University, University of Guelph, University of Ottawa, Brandon University, Acadia University);
- Federal government departments and agencies responsible for land management (e.g., Parks Canada Agency, National Defence, National Capital Commission);
- Provincial departments and agencies responsible for land management (e.g., transportation departments) and for wildlife conservation and development

(e.g., Ontario Ministry of Natural Resources and Forestry, Ontario Parks, Quebec Department of Forests, Wildlife and Parks, New Brunswick Department of Natural Resources, Nova Scotia Department of Natural Resources).

Concrete examples of conservation measures implemented for the Snapping Turtle include:

- Since 1972, numerous studies have been carried out by University of Guelph researchers and colleagues at the Wildlife Research Station in Algonquin Provincial Park on the species' ecology (e.g., Obbard, 1983; Brown, 1992; Paterson et al., 2012), demography (e.g., Galbraith et al., 1988), threats (e.g., Brooks et al., 1991) and the effectiveness of mitigation measures (Paterson et al., 2013; Riley and Litzgus, 2013);
- Citizen science projects to collect data on Snapping Turtle occurrence in Ontario (Ontario Reptile and Amphibian Atlas Program; http://www.ontarionature.org/protect/species/herpetofaunal_atlas.php), in Quebec (Atlas des amphibiens et des reptiles du Québec; http://www.atlasamphibiensreptiles.qc.ca) and in Nova Scotia (Nova Scotia Herpetofaunal Atlas; http://landscape.acadiau.ca/herpatlas/guide.htm);
- Toxicology studies conducted in the Great Lakes–St. Lawrence basin (e.g., Bishop et al. 1998; de Solla et al., 2008);
- Production and dissemination of educational and outreach materials, for example:
    - Éco-Nature: http://www.eco-nature.ca/images/stories/fichiers/Tortues/Tortue_fiche4.pdf;
    - Ontario Nature: http://www.ontarionature.org/protect/species/reptiles_and_amphibians/snapping_turtle.php;
    - Nova Scotia Museum: http://novascotia.ca/museum/amphibians/en/turtles/snapping.asp;
- Various knowledge acquisition, habitat restoration, management and development, and public awareness measures are being implemented on Canadian Forces Base Borden in Ontario;
- Parks Canada has initiated landscape enhancement projects in the Rouge National Urban Park in collaboration with the agricultural community and other stakeholders. This approach could serve as a model for integrated enhancement of habitat and agricultural lands that will benefit the Snapping Turtle and other species;
- Enforcement of acts and regulations pertaining to native wildlife conservation by the provincial departments concerned;
- Consideration of the needs of the Snapping Turtle in the federal environmental assessment process;
- Surveys and mitigation measures to reduce road mortality (e.g., turtle fencing and ecopassages) implemented by the Abenaki community of Wôlinak.

6.2. Broad Strategies

The conservation measures recommended to achieve the management objective are divided into six broad strategies:

1. Conserve the Canadian Snapping Turtle population and its habitat through the use of legal and administrative tools;
2. Reduce the risks related to mortality, injury and harvesting of Snapping Turtles;
3. Conserve, manage and restore Snapping Turtle habitat throughout the species' Canadian range;
4. Carry out communication activities and develop or maintain partnerships in order to implement conservation measures for the Snapping Turtle in a collaborative manner;
5. Carry out surveys and monitoring of Snapping Turtle populations and habitats;
6. Conduct research and acquire knowledge necessary for management of the Snapping Turtle and its habitat (including threats).

6.3. Conservation Measures

Conservation measures are recommended (Table 2) for each of the broad strategies presented in section 6.2. The threats or concerns listed in the third column are numbered as follows for conciseness:

1. Conversion of aquatic or riparian habitats for agriculture and urban development purposes incompatible with the species' needs;
2. Water level management;
3. Dredging;
4. Road network;
5. Fishing bycatch;
6. Collisions with boats;
7. Legal and illegal harvesting;
8. Chemical contamination;
9. Persecution;
10. Human-subsidized predators;
11. Knowledge gaps.

Table 2. Conservation Measures and Implementation Schedule

Conservation Measures	Priority[18]	Threats or Concerns Addressed	Timeline
Broad strategy 1: Conserve the Canadian Snapping Turtle population and its habitat through the use of legal and administrative tools			
Continue to promote compliance with federal and provincial laws pertaining to the Snapping Turtle and its habitat.	High	1, 3, 4, 5, 7, 8, 9	2016-2021
Evaluate and, if necessary, improve federal and provincial acts pertaining to the Snapping Turtle and its habitat, such as: • Evaluate and adjust (as necessary) the regulations pertaining to harvesting of Snapping Turtles, in provinces where harvesting is currently permitted, to ensure the maintenance of viable populations. • Consider supporting the inclusion of the Snapping Turtle on CITES Appendix II so that the species is subject to the *Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act* (WAPPRIITA). • Ensure that the needs of the Snapping Turtle are taken into consideration in road design and improvement projects.	High	4,7	2016-2019
Encourage the integration of approved best management practices into the policies and practices of responsible agencies, jurisdictions and industry.	High	1, 2, 3, 4, 5, 6, 7, 8, 10	2016-2021

[18] "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.

Conservation Measures	Priority[18]	Threats or Concerns Addressed	Timeline
Broad strategy 2: Reduce the risks related to mortality, injury and harvesting of Snapping Turtles			
Continue to develop mitigation techniques (e.g., best management practices) and encourage the implementation of such techniques by various target audiences (e.g., general public, landowners, land managers, industry) in order to reduce mortality, injury and harvesting. Examples of priority mitigation measures: • Identify sites with high road mortality rates and develop and implement approaches for reducing mortality (e.g., discourage the construction of new roads in Snapping Turtle habitat, develop ecopassages, reduce speed limits near critical areas). • Implement and evaluate mitigation techniques in order to reduce fishing bycatch. • Implement and evaluate techniques aimed at controlling predator populations or limiting access to nesting habitat through direct or indirect measures (e.g., waste removal, predator habitat management, fencing).	High	4, 5, 6, 7, 8, 9,10	2016-2026
Broad strategy 3: **Conserve, manage and restore Snapping Turtle habitat throughout the species' Canadian range**			
Preserve suitable habitats that are large enough to meet the habitat needs of local populations, through stewardship, land acquisition, management and other tools.	High	1, 2, 4	2016-2026
Prevent or minimize habitat loss, degradation and fragmentation (e.g., filling of wetlands, shoreline development) by encouraging stewardship activities and promoting best management practices for habitat conservation.	High	1, 2, 3, 8	2016-2026
Evaluate needs and, if necessary, restore habitat using appropriate techniques in areas where habitat loss, degradation and fragmentation pose a threat to local Snapping Turtle populations.	Medium	1, 8	2016-2026

Conservation Measures	Priority[18]	Threats or Concerns Addressed	Timeline
Broad strategy 4: **Carry out communication activities and develop or maintain partnerships in order to implement conservation measures for the Snapping Turtle in a collaborative manner**			
Develop and implement approaches and strategies to promote more positive attitudes towards the species and the adoption of effective behaviours leading to a reduction in anthropogenic threats to the species.	High	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2016-2021
Engage Aboriginal people in the implementation of conservation measures for the benefit of the Snapping Turtle.	Medium	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2016-2026
Improve and maintain collaboration among stakeholders (e.g., develop and maintain partnerships with stakeholders whose activities impinge on the Snapping Turtle, other turtle species at risk and other environmental components relevant to the Snapping Turtle).	Medium	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	2016-2026
Encourage the transfer and archiving of information and tools, including traditional ecological knowledge.	Medium	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	2016-2026
Broad strategy 5: Carry out surveys and monitoring of Snapping Turtle populations and habitats			
Develop and implement a population monitoring program using a subset representative of local populations, along with a program to monitor habitat trends.	High	11	2016-2021
Encourage the submission of records of Snapping Turtle sightings to provincial conservation data centres or to provincial herpetological atlases.	Medium	11	2016-2026
Whenever possible, collaborate on and participate in existing survey and monitoring programs targeted to other species of aquatic habitats (e.g., turtle species at risk) in order to complement information on distribution and obtain baseline reference data.	Medium	11	2016-2026

Conservation Measures	Priority[18]	Threats or Concerns Addressed	Timeline
Broad strategy 6: Carry out research and acquire knowledge necessary for management of the Snapping Turtle and its habitat (including threats)			
Increase knowledge of the threats to the Snapping Turtle and its habitat in order to understand the full significance of the impacts and to document the associated severity, frequency, extent and causal certainty. For example: • Determine the characteristics of areas where high levels of mortality from roadkill have been recorded. • Continue to document turtle bycatch • Document the illegal harvesting of Snapping Turtles and estimate the impact on the maintenance of populations across Canada. • Determine the effect of human-subsidized predation on population persistence. • Determine the rate of mortality and habitat destruction caused by dredging and rapid lowering of water levels.	High	2, 3, 4, 5, 7, 10, 11	2016-2026
Increase knowledge of the cumulative effect of threats to the Snapping Turtle and its habitat.	Medium	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	2016-2026
Increase knowledge of the needs related to the species' habitat and demography (e.g., determine what constitutes a viable population size).	Medium	11	2016-2026

7. Measuring Progress

Every five years, progress toward achieving the management objective, and hence the success of the management plan, will be measured against the following performance indicators:

- Maintenance of or increase in the index of area of occupancy of the Snapping Turtle in Canada;
- The size of the population is stable or increasing in local Snapping Turtle populations for which demographic data are available;
- Reduction or mitigation of threats that could lead to population declines or a decrease in the amount of suitable habitat available throughout the species' Canadian range.

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Appendix A: Subnational Conservation Ranks of the Snapping Turtle in Canada and the United States

Global (G) Rank	National (N) Rank	Subnational (S) Rank
G5	Canada (N5)	British Columbia (SNA), Manitoba (S3), New Brunswick (S4), Nova Scotia (S5), Ontario (S3), Quebec (S4), Saskatchewan (S3)
	United States (N5)	Alabama (S5), Arizona (SNA), Arkansas (S5), North Carolina (S5), South Carolina (SNR), Colorado (S4), Connecticut (S5), North Dakota (SNR), South Dakota (S5), Delaware (S5), District of Columbia (S5), Florida (S5), Georgia (S5), Illinois (S5), Indiana (SNR), Iowa (S5), Kansas (S5), Kentucky (S5), Louisiana (S5), Maine (S5), Maryland (S5), Massachusetts (S5), Michigan (S5), Minnesota (S3), Mississippi (S5), Missouri (SNR), Montana (S3), Nebraska (S5), Nevada (SNA), New Hampshire (S5), New Jersey (SNR), New Mexico (S5), New York (S5), Ohio (SNR), Oklahoma (S5), Pennsylvania (S5), Rhode Island (S5), Tennessee (S5), Texas (S5), Utah (SNA), Vermont (S5), Virginia (S5), West Virginia (S5), Washington (SNA), Wisconsin (S4S5), Wyoming (S4)

Rank Definitions (NatureServe, 2015)

G5, N5 and S5 – Secure: At very low risk of extirpation or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.
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.
SNA – Not applicable: a conservation rank is not deemed applicable because the species is not considered a conservation target.
SNR – Unranked: not ranked because the species' conservation status has not been 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*[19]. 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 would affect any component of the environment or any of the Federal Sustainable Development Strategy[20] (FSDS) goals or targets.

Conservation planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of management plans may 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 on non-target species or habitats. The results of the SEA are incorporated directly into the management plan itself, but are also summarized in the statement below.

Most of the activities carried out to conserve Snapping Turtles and their habitat will also have a positive effect on other species that use similar habitat. Conservation of aquatic habitats and adjacent terrestrial habitat will help maintain their rich biodiversity. In addition, the reduction and mitigation of threats to the Snapping Turtle may help to reduce mortality in other animal species (e.g., use of ecopassages or fencing to reduce road mortality, improved fishing techniques capable of reducing bycatch, measures to reduce pollution of aquatic habitats). Some of these measures are likely to be found in other recovery documents, particularly those that deal with aquatic species and species that inhabit wetlands and adjacent areas. Table B-1 provides examples of species that may benefit from management of the Snapping Turtle population in Canada; other species that are not listed may also benefit.

[19] http://www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[20] http://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1

Table B-1. Species that may benefit from conservation and management measures for the Snapping Turtle in areas where this turtle species is present.

Common Name	Scientific Name	SARA Status
Eastern Foxsnake	*Pantherophis gloydi*	Endangered
Fowler's Toad	*Anaxyrus fowleri*	Endangered
King Rail	*Rallus elegans*	Endangered
Lake Erie Watersnake	*Nerodia sipedon insularum*	Endangered
Least Bittern	*Ixobrychus exilis*	Threatened
Pugnose Shiner	*Notropis anogenus*	Threatened
Spiny Softshell Turtle	*Apalone spinifera*	Threatened
Eastern Musk Turtle	*Sternotherus odoratus*	Threatened
Blanding's Turtle	*Emydoidea blandingii*	Threatened
Wood Turtle	*Glyptemys insculpta*	Threatened
Eastern Sand Darter	*Ammocrypta pellucida*	Threatened
American Eel	*Anguilla rostrata*	Threatened
Northern Map Turtle	*Graptemys geographica*	Special Concern
Snapping Turtle	*Chelydra serpentina*	Special Concern
Bridle Shiner	*Notropis bifrenatus*	Special Concern
Grass Pickerel	*Esox americanus vermiculatus*	Special Concern

Given that life-cycle and habitat needs may differ for all of these species, as may 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 will inadvertently have negative effects on the environment and on other species was considered. The majority of recommended actions are non-intrusive in nature, including surveys and communication activities. The present management plan should therefore not produce significant negative effects.