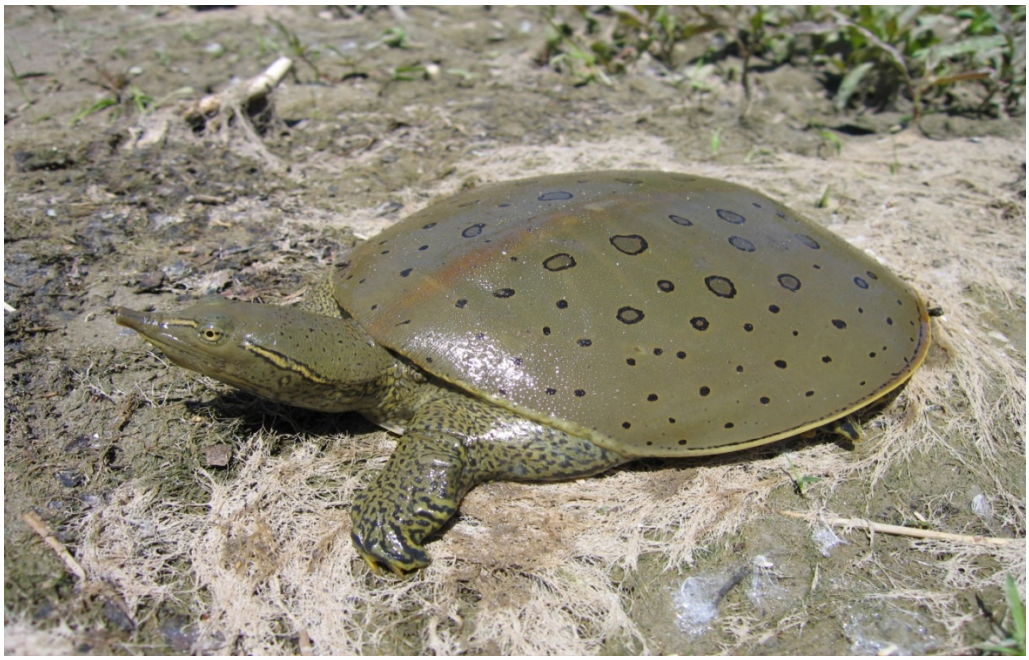
COSEWIC
Assessment and Status Report

on the

Spiny Softshell
Apalone spinifera

in Canada



ENDANGERED
2016

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

COSEWIC. 2016. COSEWIC assessment and status report on the Spiny Softshell *Apalone spinifera* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiii + 38 pp. (http://www.registrelep-sararegistry.gc.ca/default_e.cfm).

Previous report(s):

COSEWIC. 2002. COSEWIC assessment and update status report on the spiny softshell turtle *Apalone spinifera* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 17 pp.

Fletcher, M. 2002. Update COSEWIC status report on the spiny softshell turtle *Apalone spinifera* in Canada, *in* COSEWIC assessment and update status report on the spiny softshell turtle *Apalone spinifera* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-17 pp.

Campbell, C.A., and G.R. Donaldson. 1991. Revised and updated by Martyn E. Obbard. COSEWIC status report on the spiny softshell turtle *Apalone spinifera* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 32 pp.

Production note:
COSEWIC would like to acknowledge Patrick Galois and Martin Ouellet for writing the original drafts of the status report on the Spiny Softshell (*Apalone spinifera*) in Canada. This report was prepared under contract with Environment Canada and was overseen and edited by Ronald Brooks and Jim Bogart, consecutive Co-chairs of the COSEWIC Amphibian and Reptile Species Specialist Subcommittee.

Parts of this report have been omitted or revised and some of the entries in the Information Sources section have been shortened. This has been done to avoid revealing sensitive locality information for this species. The full version of the report and threats assessment spreadsheet may be requested from the COSEWIC Secretariat (ec.secretariatcosepac-cosewicsecretariat.ec@canada.ca).

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la Tortue molle à épines (*Apalone spinifera*) au Canada.

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Spiny Softshell in Ontario. Photo by Scott Gillingswater.

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COSEWIC
Assessment Summary

Assessment Summary – May 2016

Common name
Spiny Softshell

Scientific name
Apalone spinifera

Status
Endangered

Reason for designation
The continuing decline of this species in Ontario and Québec is attributed to very low recruitment that has resulted from loss of nesting habitat. Suitable nesting and basking sites have been lost and/or degraded by development, altered water regimes (e.g., dams, floods, erosion of river banks), invasive plants, recreational use, and illegal harvest of individuals. Without nest protection, few eggs survive predation by an increased abundance of mammals.

Occurrence
Ontario, Quebec

Status history
Designated Threatened in April 1991. Status re-examined and confirmed in May 2002. Status re-examined and designated Endangered in April 2016.

COSEWIC
Executive Summary

Spiny Softshell
Apalone spinifera

Wildlife Species Description and Significance

Spiny Softshell turtles (*Apalone spinifera*) are conspicuously sexually size-dimorphic, with males reaching a carapace length of 22 cm, and females 54 cm. The carapace is olive to tan, relatively flat, round to oval and covered in leathery skin, with spiny projections along the anterior edge that are most conspicuous in adult females. Spiny Softshells are well adapted for swimming, with a reduced lower shell, hydrodynamic shape and strongly webbed front and hind feet. The neck is long, and can extend to approximately 3/4 the length of the carapace. The head is relatively narrow and elongate with a long, snorkel-like snout. Members of the family Trionychidae have a global distribution and diverged from other turtles in the Cretaceous. The species is significant because it is the only native representative of the family Trionychidae in Canada. Canadian populations are at the northern limit of the species' range, and are adapted to a northern climate (e.g., extended hibernation). Unlike other Canadian turtles, where the sex of an individual is determined by the temperature of egg incubation, sex of Softshell turtles is genetically determined.

Distribution

Globally, the Spiny Softshell occurs in eastern North America from the New England states through extreme southern Quebec and Ontario, west to Nebraska, south to Texas and across the Gulf states to the Atlantic. The Canadian population is divided into two geographically distinct subpopulations: a Great Lakes/St. Lawrence subpopulation in southern Quebec and a Carolinian subpopulation in southern Ontario.

Habitat

Spiny Softshell inhabits a wide variety of aquatic habitats, including rivers, marshy creeks, oxbows, lakes and impoundments. Common habitat features include a soft bottom with sparse aquatic vegetation, as well as sandbars or mudflats. Overwintering sites are generally in well oxygenated lakes and rivers.

Biology

Spiny Softshell can live for several decades. Sexual maturity occurs late, and likely not before 12 - 15 years for females at the northern limit of the range in Canada. Influenced by climate, the life cycle of the species is characterized by a long hibernation and a short, active growing season. Cumulative heat units during the active season determine the time necessary to complete incubation. Eggs are typically laid in June or July, with an average clutch size of approximately 20. It is thought that most females deposit a single clutch annually, but some females lay two clutches in a single year. The incubation period generally varies from 60 to 75 days, and ambient nest temperatures can delay or accelerate incubation. Natural recruitment is low because of high egg predation.

Population Sizes and Trends

Population sizes are small and declining. In Ontario, the total number of mature individuals is estimated to be fewer than 1000 and continues to decline. Nest survey data from the three largest locations in Canada all suggest declines in the total number of mature individuals of approximately 45% in the past two decades. Future significant declines are predicted based on current threats. In Quebec, historic populations in three drainage basins have been lost or have become unviable. The last remaining population is estimated to have fewer than 50 adult females.

Threats and Limiting Factors

The primary threats are habitat and population fragmentation by infrastructure, alteration of the water regime (flooding of nests) by dams and changing weather patterns, increased recreational and agricultural use of nesting areas and adjacent aquatic habitats by humans (disturbance during nesting, ATV use, horseback riding, watercraft use), invasion of nesting areas by non-native plants (e.g., European Common Reed (*Phragmites a. australis*)), high populations of mammalian egg predators and egg poachers, injury and mortality from fishing and motor boating (collisions, propellers), and illegal capture of juveniles and adults. Cyanobacterial blooms (e.g., toxin bioaccumulation, impact on prey) may also impact the species. Limiting factors include the time taken to reach maturity, a low rate of recruitment, and the constraint of limited summer heat for completion of incubation and hatchling emergence.

Protection, Status and Ranks

Globally, Spiny Softshell is classified as Least Concern (G5) by IUCN because it has a wide distribution, is abundant, and the global population is considered stable. It has a national rank of N3 (Vulnerable) in Canada, a rank of S3 (Vulnerable) in Ontario and a rank of S1 (Threatened) in Quebec. Spiny Softshell also has a rank of S1 in Vermont. In Canada, COSEWIC first assessed Spiny Softshell as Threatened in 1991 and again in 2002. It has been listed on Schedule 1 of the *Species at Risk Act* since 2005. In Ontario, it was assessed as Threatened by the Committee on the Status of Species at Risk in Ontario (COSSARO) in 1996. It is protected under the 2007 *Endangered Species Act* and is also a

specially protected species under the *Fish and Wildlife Conservation Act*. In Quebec, Spiny Softshell was designated as Threatened in 1999 under the *Loi sur les espèces menacées ou vulnérables* and is afforded protection under the *Loi sur la conservation et la mise en valeur de la faune*.

TECHNICAL SUMMARY

Apalone spinifera

Spiny Softshell

Tortue molle à épines

Range of occurrence in Canada: Ontario, Quebec

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines(2011) is being used)	Generation time = age at maturity + 1/rate of mortality of adults = 15 +1/0.05 = ~35 yrs. **(See Life Cycle and Reproduction)**
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, significant ongoing decline throughout the Canadian range.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Decline estimated from annual counts of nests of at least - 43% **(See Tables 1 and 2).**
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Estimated decline of - 43% based on nesting data at the three largest sites in Canada and significant loss of habitat from invasive *Phragmites a. australis* as well as numerous anthropogenic threats
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	If the estimated rate of ongoing decline persists for even 1 generation the species will likely be extirpated from Canada. Results of the threats calculator came out as **Very High.**
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Observed, inferred and suspected reduction. Although there are no precise data, recent surveys in southern Ontario indicate there were declines over the past 2 decades of at least -40%.
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. Difficult to reverse. b. Partially understood. c. Not ceased.
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	24,851 km^2
Index of area of occupancy (IAO) (Always report 2x2 grid value).	600 km^2

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	~10. Most locations appear to have fewer than 10 adults and likely do not represent viable subpopulations.
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Yes, observed, inferred, and projected decline in EOO.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, observed. There has been a loss of subpopulations in three drainage basins in Quebec, in Lake Ontario, and in nesting sites on rivers in southwestern Ontario.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Yes, observed and projected. In the past 50 years, Quebec subpopulations in three drainage basins have been extirpated or have become nonviable as have some Ontario subpopulations in western Lake Ontario.
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Yes, observed and projected. Several locations have become extirpated in the past 50 years (see above) and several other locations appear to be close to extirpation.
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, observed and projected. High rates of loss of oviposition sites are occurring at all known locations in Ontario, including the three largest known communal oviposition sites. Basking and thermoregulation habitat has declined in quality or has been lost. Ongoing agricultural practices have caused habitat quality to degrade (erosion, siltation, contamination, etc.). The loss of area of nesting sites in the 3 largest sites has been over 50% in the past 20 years.
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term.

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Ontario	~ 900
Quebec	< 100
Total	~ 1000

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not done.

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes.

i. alteration of water regime (flooding of nests due to dams and other water control and bank stabilization methods) (Threat 7.2 – High)
ii. egg poaching, high populations of mesopredators of eggs and juveniles, continued development pressure on nest sites (Threat 8.2 – High)
iii. farming practices leading to bank erosion, water siltation and sedimentation, nests and individuals crushed by cattle, habitat polluted by cattle, loss of gestation, oviposition, thermoregulation and nursery habitat (Threat 2.3 – Medium)
iv. illegal captures of all age classes for food, medicine or pets (Threat 5.1 – Medium)
v. recreational use of nesting areas by humans and potential consequences (disturbance during nesting, ATV use, horseback riding), harassment of nesting females, vandalism of nests (Threat 6.1 – Medium)
vi. increasing loss of oviposition habitat to invasive, non-native vegetation (Threat 8.1 – Medium)
vii. varied effects related to climate change (e.g., increase in average temperature, extreme weather events, droughts, flooding) (Threat 11.1 – Medium)
viii. fragmentation of riverine habitat and populations by infrastructure
ix. incidental captures of juveniles and adults by commercial and sport fisheries
x. injury and mortality related to motorboats (collisions, propellers)
xi. possible impact of cyanobacterial blooms (e.g. toxin accumulation, impact on prey)

What additional limiting factors are relevant?

i. late maturity, low rate of recruitment
ii. constraint of limited summer heat for completion of incubation and hatchling emergence

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Michigan: no status (S4) New York: Special Concern (S2/S3) Vermont: Threatened (S1) Ohio SNR

Is immigration known or possible?	It is probable that the Quebec subpopulation is sustained by turtles from Vermont. It is possible, but unlikely that immigration from Michigan might provide some weak rescue effect across Lake St Clair/Detroit River. New York or Ohio could provide rescue across Lake Erie but this has not been observed. Rescue across Lake Ontario is highly unlikely.
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	There is limited habitat and it continues to decrease.
Are conditions deteriorating in Canada?[+]	Yes
Are conditions for the source population deteriorating?[+]	Yes, in Vermont, and possibly in Michigan and New York.
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	Likely from Vermont but Spiny Softshell Turtles are Threatened in that state. Possibly from the Detroit River. Uncertain from Lake Erie, Lake St. Clair, Lake Huron, or Lake Ontario as no data exist on movement from the U.S. into Ontario.

Data Sensitive Species

Is this a data sensitive species? Yes.

Current Status

COSEWIC: Threatened
Year Assessed: 2002
COSEWIC Status History: The species was assessed as Threatened in April 1991. Its status was re-examined and confirmed by COSEWIC in May 2002. Its status was re-examined and designated Endangered in April 2016.

Status and Reasons for Designation:

COSEWIC Status: Endangered	**Alpha-numeric codes:** A2bcd+3bcd+4bcd
Reasons for designation: The continuing decline of this species in Ontario and Quebec is attributed to very low recruitment that has resulted from loss of nesting habitat. Suitable nesting and basking sites have been lost and/or degraded by development, altered water regimes (e.g., dams, floods, erosion of river banks), invasive plants, recreational use, and illegal harvest of individuals. Without nest protection, few eggs survive predation by an increased abundance of mammals.	

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect).

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Endangered A2 - estimated reduction of >50% over last 3 generations (105 years). Meets Endangered A3 - estimated reduction of >50% within the next 3 generations (105 years). Threats were calculated as Very High. Meets Endangered A4 - estimated reduction of >50% over any 3 generation period. Based on (b) index of abundance appropriate for the taxon, (c) decline in quality of habitat, and (d) potential levels of exploitation.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not met. EOO and IAO exceed thresholds, no known fragmentation, no known fluctuations.
Criterion C (Small and Declining Number of Mature Individuals): Not met. Although number of mature individuals is less than 2,500, the continuing decline of mature individuals is unknown.
Criterion D (Very Small or Restricted Population): May meet Threatened D1 (population approximately 1000).
Criterion E (Quantitative Analysis): Not done.

PREFACE

Since the publication of the last COSEWIC status report (COSEWIC 2002), surveys, research projects and nest monitoring programs have continued to document the biology and ecology of Spiny Softshell in Canada and to identify threats and implement measures to reduce them. These studies began in the 1990s and expanded in the early 2000s after the COSEWIC (2002) status report. Unfortunately, little of this research culminated in peer-reviewed literature, nor has it been subject to much scientific rigour. Nevertheless, the Canadian range of the species has become more precisely identified and numbers of adult females have been estimated from annual nest counts. In Quebec, the species is considered extirpated or non-viable from three drainage systems. In Ontario, no intensive survey has been conducted in the drainage systems, where the species' presence is known only from occasional observations. The status of the species is difficult to assess in these areas, which seem to contain few individuals which have little effect on estimates of total adult numbers.

In the four main Ontario subpopulations, logistic constraints have meant that the information gathered on abundance and trends has focused mainly on numbers of nests rather than numbers of turtles. Nest numbers provide approximate minimum numbers (slightly inflated because females may nest twice in a season) of mature females, which in turn allow an estimate of the number of mature individuals and a quantification of trends in abundance. Data from the nest sites of greatest abundance all suggest significant declines have occurred since the last COSEWIC assessment. Major threats are continuing, and programs to improve recruitment (nest protection, artificial incubation) and habitats (e.g., buffer strip restoration) are being hampered by these ongoing threats.

COSEWIC HISTORY

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

COSEWIC MANDATE

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

COSEWIC MEMBERSHIP

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

DEFINITIONS
(2016)

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

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

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

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

Environment and Climate Change Canada
Canadian Wildlife Service
Environnement et Changement climatique Canada
Service canadien de la faune
Canada

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

COSEWIC Status Report

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TABLE OF CONTENTS

List of Figures

List of Appendices

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Class: Reptilia

Order: Testudines

Family: Trionychidae

Genus: *Apalone*

Species: *Apalone spinifera*

Common name: Spiny Softshell

French name: Tortue molle à épines

Eastern Spiny Softshell (*Apalone spinifera spinifera*) is the only one of six subspecies of *Apalone spinifera* whose range extends north into Canada (Ernst and Lovich 2009) (Fig 1). The genus name is derived from *apala*, meaning soft, and the species epithet from *spinifer*, which means thorn-bearing. Originally classified as *Trionyx spiniferus* Lesueur, 1827, the generic name *Apalone* was recently applied to the three American species of Spiny Softshell turtle (Smith and Smith 1980). The recommended common species name is Spiny Softshell in English (Crother 2012) and *tortue molle à épines* in French (Green 2012).

Morphological Description

This freshwater turtle has a flat profile and a thick leathery carapace without scales. The species exhibits marked sexual dimorphism. Males can reach a carapace length of near 24 cm, and females near 54 cm (Ernst and Lovich 2009). The carapace is olive to tan, flat, and round with spiny projections along the anterior edge, which are most conspicuous on adult females. The carapace surface may be slightly rough, like sandpaper, particularly in older juveniles. Adult males retain the juvenile pattern of ocelli, spots and lines, whereas females develop a mottled or blotched pattern that is slightly noticeable even at the time of hatching. The Spiny Softshell is well adapted for swimming, with a reduced lower shell, hydrodynamic shape and strongly webbed front and hind feet. The neck is long, approximately 3/4 the length of the carapace, and the head is relatively narrow and elongate with a long snorkel-like snout.

Population Spatial Structure and Variability

Canadian Spiny Softshell has a disjunctive distribution. The Quebec subpopulation is the most northeastern subpopulation of the species, and is currently isolated from all other Canadian subpopulations despite aquatic links with Ontario populations to the west and southwest. In Canada, no subpopulations are currently known along these links east of Lake Erie, where there are few historical records, and recent validated records involve only isolated individuals (Bonin 1997; Galois 2007, 2012). A phylogeny of the three North American softshell turtle species revealed low mitochondrial DNA (mtDNA) variability among northern populations of all three species (Weisrock and Janzen 2000). This is consistent with genetic patterns of other northern aquatic species following post-Pleistocene dispersal into formerly glaciated areas. Distinct mtDNA haplotypes were, however, detected in a population from Ontario, but there was minimal sequence divergence with other haplotypes in the broader "northern" clade (~0.1%; Weisrock and Janzen 2000). The turtles sampled from Quebec possessed the same mtDNA haplotype as was found in most Ontario samples (Weisrock and Janzen 2000). A population genetic analysis comparing populations in Quebec and Vermont is currently underway. Preliminary results seem to show no gene flow between females in Quebec and those in Vermont (Kilpatrick 2011).

Spiny Softshell is present in southwestern Ontario. The species is thought to be extirpated from the Ottawa River and Lake Ontario, as its presence there could not be confirmed by recent intensive surveys, and is only supported by occasional records. Upon closer examination, it was discovered that some of the records from the Ottawa River were non-native softshell turtle subspecies (released individuals) (Kruschenske pers. comm. 2012), as has been the case in Lake Ontario (Harrison pers. comm. 2012; Gillingwater pers. comm. 2012). It is also possible that the information was not valid (Kruschenske pers. comm. 2012).

Designatable Units

The Canadian range of Spiny Softshell is confined to the Great Lakes Plains National Ecological Area and the Great Lakes - Upper St. Lawrence Biogeographical Zone. The range is split between the Carolinian (in Ontario) and the Great Lakes/St. Lawrence (in Quebec) Terrestrial Amphibian and Reptile Faunal Provinces (COSEWIC 2011). There is, however, no evidence of genetic differentiation of softshells between these two regions (Weisrock and Janzen 2000, McGaugh *et a*l. 2008). Nuclear microsatellite primers for Spiny Softshell have been published (Davy *et al*. 2012) but have not yet been employed (Davy pers. comm. 2013). Climatic and other differences between the Ontario and Quebec subpopulations may drive local adaptation, but no explicit studies have been conducted. They exist at the northern limits of the species' range and the loss of either subpopulation would result in a range contraction for the species. Spiny Softshell is considered to represent a single designatable unit in Canada consisting of a Carolinian subpopulation and a Great Lakes/St. Lawrence subpopulation.

Special Significance

Spiny Softshell is the only species of its family in Canada, and Canadian populations are at the northern limit of the family range. Spiny Softshells are adapted to the northern climate (e.g., they engage in extended hibernation). Loss of Spiny Softshell turtles from either subpopulation would constitute a major loss for the species' global range and for biodiversity in Canada.

DISTRIBUTION

Global Range

The range of Spiny Softshell (Figure 1) occurs mainly in the watersheds of the Mississippi and Ohio rivers and extends from western New York and Pennsylvania and southern Ontario and Quebec, west to the Dakotas, Montana, Nebraska and Wyoming and south to North and South Carolina, Georgia and the Gulf coastal states, then west to Arizona and New Mexico (Ernst and Lovich 2009). *Apalone s. spinifera* (Eastern Spiny Softshell), is the only subspecies native to Canada, and occurs east of the Mississippi River to Vermont, southern Quebec and southwestern Ontario, west to Wisconsin and south to North Carolina, Virginia and Tennessee (Ernst and Lovich 2009). The species is most abundant and more evenly distributed in the watersheds of the Mississippi and Ohio rivers and the lower Great Lakes. Populations are currently established in some areas to which Spiny Softshell has been introduced, such as New Jersey, the southwestern United States (Arizona, California, New Mexico, Utah), and in the Colorado River watershed, where the species is expanding its range westward. It has also been introduced into Hawaii and parts of Mexico (Ernst and Lovich 2009).

Canadian Range

Spiny Softshell's current Canadian range represents approximately 1% of its global range. The species was formerly more widespread in the lower Great Lakes/St. Lawrence watershed, and today, it can only be found in a handful of isolated locales throughout this historical range. The Canadian population is divided into two subpopulations, one in southern Quebec and one in southwestern Ontario.

The Quebec subpopulation's former range included two river systems from which it is considered extirpated. Currently, the only confirmed extant subpopulation occurs in a single river-lake system. In a second river system, one individual was captured, and up to three others were sighted over the period of 2006-2008 but telemetry and surveys could not confirm the presence of a viable population (Rioux and Desroches 2007; Bernier *et al.* 2008a,b).

The Ontario subpopulation, which is the more abundant, occupies riverine and coastal wetland habitats within southwestern Ontario.

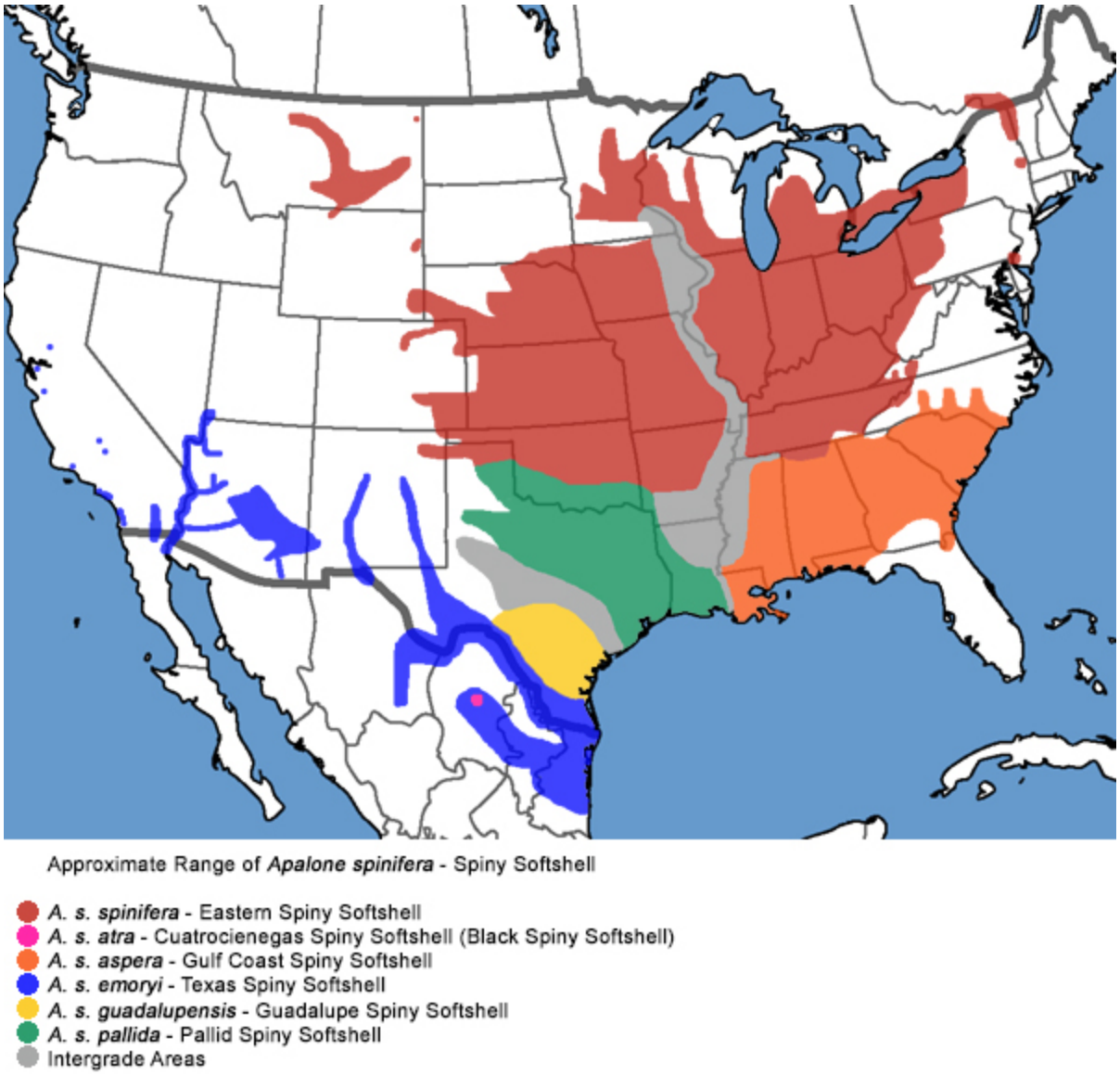

Figure 1. Global range of Spiny Softshell (*Apalone spinifera*) from Nafis, G.A. (2000-2013) *A Guide to the Amphibians and Reptiles of California*. http://www.californiaherps.com/turtles/pages/a.s.emoryi.html (accessed June 29, 2016).

Extent of Occurrence and Area of Occupancy

In the previous status report (COSEWIC 2002), the EOO for Canadian Spiny Softshell, was calculated as 55,250 km^2 with an IAO of 3,000 km^2. The values included sites that are no longer extant. The present calculations provided by the COSEWIC secretariat are 51,070 km^2 (EOO) and 600 km^2 (IAO) for the Canadian range. Two Quebec occurrences were omitted from the calculations; their inclusion would increase both values slightly.

Search Effort

Information on the distribution of Spiny Softshell was obtained from recorded sightings by the public and professionals and from search efforts focused on Spiny Softshell or other turtles, including visual surveys, mark-recapture studies, radio-telemetry monitoring, and searches for nesting sites. Observations of Spiny Softshell were made by professionals involved in research and conservation projects across Ontario and Quebec, such as surveys and nesting site monitoring. Observations by the public were also obtained through reptile awareness and education campaigns.

Location-specific accounts of search effort withheld.

HABITAT

Habitat Requirements

Spiny Softshell inhabits a wide variety of aquatic habitats, including rivers, marshy creeks, bayous, oxbows, lakes and impoundments. Common habitat features include a soft bottom with sparse aquatic vegetation, as well as sandbars or mudflats. Five habitat components appear to be essential: sandy or gravelly nesting areas that are close to the water and relatively clear of vegetation, shallow muddy or sandy areas in which to burrow, deep pools for hibernation, basking areas, and suitable habitat for crayfish and other food sources (Ernst and Lovich 2009). Spiny Softshell generally inhabits soft-bottomed bodies of water with an abundance of prey sources and an availability of nesting sites near the water (Ernst and Lovich 2009).

Nesting areas:

Females appear to prefer laying eggs close to water in substrates ranging from sand to fine or coarse gravel mixed with sand. In the Carolinian subpopulation in parts of the riverine habitats, nest sites with some gravel are used more frequently than sandy sites (Gillingwater unpub. data).This habitat is most frequently found downstream of eroding sandy slopes where sand or sand and gravel have been deposited on the inside of a bend or where islands have formed. When sand or gravel is lacking, turtles were found to nest on exposed clay banks, or on gravel roads. Eggs in all such observed nests failed to survive (Fletcher 1996; Gillingwater 2004; Gillingwater 2011). Nests are built on sandy beaches (Bolton and Brooks 2007, 2010) in the Great Lakes/St. Lawrence subpopulation, females lay eggs on bars of sand and fine gravel on riverine shorelines or on sandy strips in bay heads. The rarity of these habitats is a limiting factor for the species in Quebec (Galois *et al.* 2002). As well, such areas are often popular with waterfront residents as recreational beaches.

Shallow underwater muddy or sandy areas:

Spiny Softshell turtles bury themselves in these substrates (Dobbyn and Smith 2005). These areas also appear to be critical nursery habitat for juveniles (Gillingwater 2004), which are highly vulnerable to predation in the first few years of life. Juveniles may also use these substrates for thermoregulation (Feltz and Tamplin 2007). Data collected on the areas used in summer in the Great Lakes/St. Lawrence subpopulation suggest that the preferred substrates are shallow areas such as bays, mouths of tributaries, and associated marshes (Galois *et al*. 2002). In the riverine habitat of the Carolinian subpopulation, softshells use calm backwater areas and nearby oxbows for thermoregulation, gestation and nursery habitat for hatchlings (Fletcher and Gillingwater 1994, Gillingwater 2004, 2007, 2011). In coastal wetland habitats softshells use calm waters of bays or nearby inland ponds and marsh (Gillingwater and Brooks 2001; Gillingwater and Piraino 2004, 2005; Gillingwater 2004).

Basking areas:

Softshells typically bask on denuded shorelines, floating vegetation, partially submerged fallen trees, rocks (natural or rip-rap), and concrete structures. They do not appear to use steeper areas where concrete walls and stone blocks line the river bank. In the Great Lakes/St. Lawrence subpopulation, observations of basking turtles are primarily concentrated in intact natural areas and areas with little shoreline alteration and little human disturbance (Galois *et al*. 2002).

Deep pools:

In the riverine habitats of the Carolinian subpopulation, pools that are more than 1 m deep during summer low water levels will not freeze completely in winter and can be used for hibernation. Oxygen levels in the water are generally close to saturation (Galois *et al.* 2002; Ultsch 2006). During summer, deep pools may also provide cover and food and allow the turtles to moderate body temperature (Fletcher 1995). In the Great Lakes/St. Lawrence subpopulation, known hibernation sites are more than 3 m deep and are located in deep lake waters (Graham and Graham 1997; Galois *et al.* 2002; Vermont Fish and Wildlife 2009).

Foraging habitat:

Softshells eat crayfish, tadpoles, small fish, aquatic insects and carrion. Adequate food sources appear to be available in inflowing creeks, shallow inlets, shallow muddy, rocky or sandy areas, within vegetative debris and aquatic plants. Softshells also use bays, marshes and rocky areas.

Although all these habitat features appear to be required for the subpopulations studied, they are not all used to the same extent. Nesting areas and deep pools, which are only used at certain times of the year, are not always plentiful or located in close proximity to one another. Turtles may therefore be required to migrate long distances prior to nesting or hibernation. Sites that provide shallow muddy or sandy areas, basking areas and abundant food sources are generally occupied for most of the summer. Even if all five features are present, turtles must be able to move freely from one of these areas to the next to complete their yearly cycle.

Geographic information system mapping in the riverine habitats of the Carolinian subpopulation confirms that most sightings occur at, or just downstream from, bends in the rivers. This correlates with the availability of important habitat features in these areas and suggests that along these rivers, any river bend and the area directly downstream of it may contain potential softshell habitat (Fletcher *et al*. 1995).

Habitat Trends

The information available shows that there has been extensive habitat loss within the historical range of Softshell Turtles (Bonin 1997; Gillingwater pers. comm. 2014). The previous status report (Fletcher 2002) suggested that the remaining softshell habitat is sub-optimal and that it continues to be degraded by development from agriculture, recreation, and road and bridge building. Most of the areas where softshell turtles occur in river systems are on private lands, but the Great Lakes' sites are primarily government-owned lands (Robinson pers. comm. 2012). These lake habitats are therefore better protected from anthropogenic habitat decline, but nevertheless they face increasing pressure from recreational use and boat strikes. Nesting sites in particular are being degraded (Gillingwater and Brooks 2001; Bolton and Brooks 2007, 2010).

<u>Quebec</u>

Although gains have been made in protecting the shoreline and certain habitats used for nesting, shoreline habitat degradation and loss have continued despite existing regulations. New regulations enacted in 2005 are more stringent regarding the width of the buffer strip to be preserved and the preservation of shorelines below the high-water mark. Support programs for waterfront property owners and municipalities typically promote the application of these new standards. For example, there is a guide for waterfront residents and municipalities (OBVBM 2010), an awareness and assistance program about improving buffer strips, and manuals for waterfront property owners (OBVBM and Amphibia-Nature 2008, 2011). Regarding habitat in shallow water, an awareness program involving the distribution of an eco-nautical map and the deployment of nautical patrols has been put in place. The eco-nautical map indicates which areas are sensitive, but there are no regulations or statutes governing the use of such areas. The effectiveness of the program is still difficult to evaluate. In 2011, the Nature Conservancy of Canada launched a project for the installation of buoys in sensitive areas, along with information panels at boat launching ramps. The objective is to encourage boaters to slow down to limit disturbance and reduce the risk of collisions or propeller injuries. Blue-green algae (cyanobacteria) blooms over the

past few summers have reduced boating and waterfront activities on some lakes, likely reducing the risk of collision and disturbance for turtles. But the impact of this pollution on turtles, their prey, and their significant habitat has yet to be documented (Galois 2012).

Ontario

Many factors have contributed to reduced softshell habitat availability and quality in Ontario. Increasing human recreational use near or on nesting sites has significantly impacted softshell turtle behaviour and presence and has contributed to substrate and egg compaction (Gillingwater 2004, 2006, 2011). Illegal development along water courses including stream diversion, pond excavation and boat launch/dock installation at, or adjacent to, oviposition and thermoregulation sites also degrades these important habitats (Gillingwater unpub. data).

Agricultural and residential activities in areas adjacent to, or on, softshell oviposition habitat, has resulted in loss or degradation of the habitat. In some instances all vegetation has been removed to increase crop/yard size, and or view of the river. In other situations cattle have access to river and stream areas resulting in loss of bank stability and erosion of shoreline habitat, and subsequent sedimentation and siltation of aquatic habitat (affecting foraging, nursery, aquatic thermoregulation habitats). In addition, areas frequented by cattle increase nutrient loads that wash into aquatic systems or are excreted directly into these environments (Gillingwater 2004, 2006, 2011; Gillingwater unpub. data; UTRCA Report). Artificial bank stabilization has reduced softshell habitat. This is most obvious within urban areas where hard-pack erosion mitigation materials prevent use or even access by turtles. Erosion control methods such as concrete and sheet piling walls, rip-rap, gabion baskets/walls, and large boulders prevent use by softshells in most cases, and also alter adjacent habitat by creating unnatural flow and changes in sediment dispersal (Gillingwater 2004).

The creation of trail systems and new residential areas has also changed habitat availability for softshells by increasing human use and related reduction of habitat quality (i.e. reduction of understory, cutting of limbs, trampling of shoreline habitat) from such use. Spiny softshells are timid and will abandon nesting attempts and thermoregulation sites if disturbed frequently (Bolton and Brooks 2007). Softshells are either no longer, or rarely, observed in some of these once-prominent thermoregulation sites and a former oviposition site. A number of housing developments have also been built or proposed adjacent to softshell habitat, and most worrisome is the recent encroachment of residential developments near the only known large river communal nesting site, one of only three large communal nesting sites known in Canada (Gillingwater 2004; Gillingwater pers. comm.).

In the past 15 years, significant changes to habitat availability and quality caused by invasive plant species has occurred at all known softshell oviposition sites in southern Ontario, causing complete loss of habitat in some areas. Information below suggests these losses are a major problem for the softshell's life cycle. Spiny Softshells nest in open sand and sand gravel areas, free of vegetation. In contrast to some other turtle species, softshell turtles are intolerant of vegetation at oviposition sites. Without continuous, yearly efforts to mitigate this threat, successful incubation can no longer occur at most sites. Invasive exotic plant species such as Purple Loosestrife (*Lythrum salicaria*), European Common Reed (*Phragmites a. australis*) and Japanese Hops (*Humulus japonicus*) are altering topography and either prevent oviposition or prevent successful incubation of eggs. The changes in habitat availability and quality from 1994 to 2014 along the largest communal nest site has been all-encompassing, resulting in complete loss of oviposition habitat in all but a single sandbar. This sandbar is not suitable for nesting due to desiccation of eggs in late summer and trampling by cattle (Fletcher 1996-1999; Gillingwater 2004; Gillingwater 2011; Gillingwater unpub. data). At other nesting sites, European Common Reed has reduced nesting success by shading sites and altering thermal regimes at nests (Bolton and Brooks 2010).

Along rivers where softshells occur, the majority of habitat is on private property, often in agricultural areas. A Spiny Softshell stewardship guide has been produced, providing a summary of the state of knowledge of the species and a list of threats (Gillingwater 2004, 2006). Ecosystem-based recovery teams, habitat stewardship funding bodies (federal/provincial governments and NGOs), conservation authorities, local stewardship projects and concerned citizens contribute to stewardship and awareness activities to protect aquatic and terrestrial Species at Risk habitat, in both long and short term. Large tree planting efforts, promotion and implementation of best management practices for farms, wetland rehabilitation projects and garbage cleanup initiatives all contribute to watershed recovery. Unfortunately, the rapidly changing floodplain landscape (flooding, sediment dispersal, rapid plant growth, erosion of buffers, etc.) and other increasing human and environmental pressures require that most softshell oviposition site protection and rehabilitation be repeated and maintained each year to have any real effect. Despite yearly efforts to restore and improve habitat, habitat loss still exceeds habitat creation (Gillingwater 2004; Gillingwater 2011).

BIOLOGY

The Spiny Softshell can live for several decades. Sexual maturity occurs late, particularly in females, who must reach a minimum size before reaching sexual maturity. Influenced by climate, the life cycle of the species is characterized by comparatively slow growth and rate of recruitment, late maturity, long hibernation and a short active season.

Life Cycle and Reproduction

In the southern portion of the species' range, sexual maturity is thought to occur in females when the plastron length reaches 18–20 cm, and in males when the plastron length reaches 9–10 cm (Ernst and Lovich 2009). Maturity may occur later in the northern part of the range because females must reach a minimum size to lay eggs and the active season is limited to a few months of the year in Canada. The minimum plastron length of the females captured at nesting sites in Ontario was 23.1 cm, significantly greater than in most U.S.A. populations (Bolton and Brooks 2006). Mating can occur throughout the active season. Eggs are laid from late May to mid-July, but primarily from early June to mid-July. Based on recent work conducted in Ontario, clutch size averages 15-20 eggs per nest (range 6 - 43), with some double clutching known to occur (Fletcher 2002; Gillingwater 2004; Gillingwater unpubl. data). In Quebec, monitoring of a nesting site showed clutches ranging from 11 to 30 eggs from 2003 to 2011, with an average of 19 eggs per nest (ÉRTMÉQ unpubl. data). The eggs are spherical and have a diameter of 24–32 mm. Softshells are unique among Canadian turtle species in that the eggs have a hard shell that increases their resistance to desiccation (Packard *et al.* 1979), thus potentially enabling softshells to nest in dry sandy areas where other turtle species could not (Fletcher 2002). The sex of the embryo is genetically determined and does not depend on incubation temperature (Ernst and Lovich 2009). The eggs hatch in late summer (August to September) after incubating for an average of 60 to 75 days, with an approximately 1:1 sex ratio of hatchlings (30–40 mm long) (Fletcher 2002).

The hatching success varies among sites and years. The major causes of egg losses are predation, flooding, invasive plants, compaction of the substrate from humans or other animals, infertility, and collection by humans (Gillingwater 2004, 2011; Bolton and Brooks 2006, 2007; Ernst and Lovich 2009).

The maximum life expectancy of the species is thought to be greater than 50 years, but the length of the fertile period is unknown (Ernst and Lovich 2009). Age at maturity has not been determined in Canadian populations, but, as with other turtles, it is likely later than the estimates for U.S. populations further south, given that Canadian turtles grow more slowly and mature at a larger size (Bolton and Brooks 2006). A recent long-term study in Arkansas found that female softshells started nesting at age 13-14 years at a plastron length of 18.0 cm (Plummer and Mills 2015), which is much less than the 23.1 cm of the smallest recorded nester in Ontario. This difference suggests that female softshells in Ontario mature later than 14 years. Natural rates of mortality are also unknown, and can only be estimated by comparisons with other long-lived, late-maturing, large-bodied Canadian turtles such as the Snapping Turtle (*Chelydra serpentina*). Therefore, using the IUCN formula to estimate generation time: GT = age at maturity + 1/rate of mortality of adults = 15 +1/0.05 = ~35 years. This equation uses 15 years as the estimate of female age at maturity and a low rate of annual mortality (5%) as compared to estimates of 10-15% from some U.S.A. studies. The U.S.A. studies did not consider "natural" mortality rates rather than rates that incorporated mortality derived from anthropogenic sources, and also their mortality rates were likely inflated by assuming that marked turtles that were not recaptured were all dead.

Physiology and Adaptability

Hibernation is a crucial phase in the species' life cycle. The Spiny Softshell hibernates in waters where oxygen saturation remains high (Graham and Graham 1997; Galois *et al.* 2002). The Spiny Softshell is the most intolerant of anoxia or hypoxia of any Canadian turtle species (Reese *et al*. 2003; Ultsch 2006). This constraint is all the more important in Canada, where turtles remain in this vulnerable phase for up to six months, from October to late April. Softshell turtles have been observed to hibernate communally (Graham and Graham 1997; Galois *et al*. 2002; Dobbyn and Smith 2005). Any event that alters the physical and chemical conditions of the water or any intervention in the hibernaculum during that period could have a major impact on the already-reduced populations.

Softshell turtles are sensitive to disturbances in their environment and tend to avoid disturbed areas until conditions return to normal (Plummer 2008; Bolton and Brooks 2010). However, the physiological impact of these periods of disturbance, which may cause increased energy expenditures (more movement) or the use of less favourable areas (e.g. reduced feeding), is unknown. The impact of cyanobacterial blooms is unknown (toxicity, toxin bioaccumulation, reduction of oxygen levels).

Dispersal and Migration

Radio-tracking studies throughout the Canadian range indicate that the Spiny Softshell can travel long distances between nesting and hibernation sites over the course of a year. Radio-tracked adult females moved up to 30 km (Fletcher 1996). Two females travelled at least 12 km between oviposition and overwintering habitat; in contrast two males moved less than 500 m between the point of initial capture in spring and overwintering habitat in late fall (Gillingwater 2004). A 2004 study tracked six adult females. Movements of close to 7 km in 24 hours were observed (Fletcher 2005), and a single female moved over 20 km (Gillingwater unpub. data). Another radio-tracking study showed greater seasonal movement by females at nesting time and in late summer as they returned to the hibernation site (Dobbyn and Smith 2005).

In Quebec, radio-tracking has documented seasonal turtle movements in Canada as well as in Vermont. A home range included two gathering areas, one for fall-winter and one for spring-summer, that can be more than 25 km apart (Galois *et al*. 2002). Movements occurred mainly in May as turtles came out of hibernation and increased again starting in August as they returned to hibernation sites. Some females were also observed travelling many kilometres to nesting sites (Daigle *et al.* 2002b). Males appeared to be more sedentary than females.

Interspecific Interactions

The Spiny Softshell is primarily carnivorous. Its diet includes a variety of items but primarily comprises crayfish, other invertebrates (insects, molluscs) and fish (Ernst and Lovich 2009). The Spiny Softshell is prey to different predators at each stage in its life cycle. The most common predators of the eggs are the Raccoon (*Procyon lotor*), Striped Skunk (*Mephitis mephitis*), Red Fox (*Vulpes vulpes*) and Coyote (*Canis latrans*) (Bolton and Brooks 2007; Ernst and Lovich 2009). Flies (*Tripanurga importuna*) (Diptera: Sarcophagidae) infest the nests, particularly at hatching time (Gillingwater and Piraino 2001, 2002). Up to 10% of the nests were affected at certain sites in Ontario (de Solla *et al.* 2003). Female flies lay eggs in the substrate after detecting decomposing animal material, leaving the larvae to dig down to the eggs (Bolton *et al.* 2008). The fly larvae are opportunistic scavengers, feeding on dead or necrotic tissue, and so confine themselves mainly to cracked and infertile eggs and late-term-mortality embryos. However, fly larvae may occasionally attack living young pipping or recently emerged from the egg, gaining entrance through the yolk sac attachment area or other soft areas. These flies have a negligible impact on softshell turtle hatching success (Bolton *et al*. 2008).

Juveniles are preyed upon by fish, other turtles, birds and mammals (Ernst and Lovich 2009). Predation by Bald Eagles (*Haliaeetus leucocephalus*) has been reported (Mabie *et al.* 1995; Ernst and Lovich 2009) as well as by American Mink (*Mustela vison)* and Coyote (*Canis latrans*) (Gillingwater pers. comm.).

POPULATION SIZES AND TRENDS

The previous status report indicated that since the publication of the original status report (Campbell and Donaldson 1985), the Carolinian subpopulation had been estimated at 800–1000 individuals (Fletcher 2002). Because individuals were not marked, there has been no precise recent or historical estimate of the number of individuals. An historical decline in certain populations was inferred, because a 1792 record (Gray 1956) documented the capture of hundreds of softshell turtles in a small section of a river in just a few days, whereas a 1997 survey reported fewer than 10 individuals in the same area (Fletcher 1997). The Quebec population was thought to be stable, but probably with no more than 100 mature individuals and with limited prospect of increase (Fletcher 2002).

Sampling Effort and Methods

No intensive mark-recapture study has been conducted in Canada to determine the size of softshell turtle populations. Data on current abundance are deduced from observation, limited mark-recapture, radio-tracking and nesting site monitoring. The latter provides an estimate of the number of mature females, whereas the others indicate the minimum number of individuals in a given area. When the number of individuals is based on a nest count, the figure is approximate because it depends on search effort and accuracy of estimates of the number of double-clutching females in a given year.

Abundance

Population abundance is estimated using proxy data that are necessarily approximate because they are based on the maximum number of nests found at the major sites. However, in Ontario long-term trends in nest numbers over a minimum of 10 to 15 years can be compared at some of these sites giving a reasonable evaluation of both abundance and trends in abundance.

Great Lakes/St. Lawrence Subpopulation

In a river system now considered to be extirpated, efforts to document the species were concentrated in two areas from 2003 to 2005, but were unsuccessful at finding any softshells (Kruschenske pers. comm. 2012). The species is considered extirpated from most of Quebec, with occasional records that are difficult to validate and that may actually include released individuals of non-native species or subspecies, as was the case in Ontario (Gillingwater pers. comm. 2012).

According to data on egg-laying in the only remaining extant occurrence in Quebec, the number of mature individuals is thought to be fewer than 100, assuming a 1:1 sex ratio.

Carolinian Subpopulation

The Lake Ontario subpopulation, historically very rare, seems to have declined further or even disappeared in the past 30 years. There are records from three areas in 1970, 1971, and 1981 (the latter was a captured male) (Campbell and Donaldson 1991; Obbard and Down 1984). However, other recent records (from 1997, 2003 and 2011), which are documented by photos, are not native softshells, but rather the Texas subspecies *A. s. emoryi* (Kathryn Harrison pers. comm. 2012). Intensive surveys conducted from 2003 to 2010 were unable to confirm the species in Lake Ontario. Therefore, the Spiny Softshell is considered locally extirpated or potentially extirpated (Theysmeyer pers. comm. 2012) from Lake Ontario.

Within southwestern Ontario, four areas have few records, and no systematic surveys have taken place. The occurrences are generally thought to be greatly reduced and small (references withheld).

In an additional area, a turtle survey program conducted each spring from 2005 to 2011 recorded 34 to 66 sightings per years. Earlier surveys in 1994 recorded 87 softshell observations, suggesting declines have occurred. Assuming that each sighting was a different individual and an adult, and that sex ratio of the observations was even, gives a range of 34-87 adults (66 is the most recent maximum) or 17-44 female adults (33 most recent maximum) (references withheld).

Most individuals in southwestern Ontario inhabit three remaining areas, which have received a variety of survey effort, including nest monitoring, and in two cases, PIT tagging of females. There was a wide range in numbers of nests from 1994 to 2013, but taking the nest counts in the most recent year sampled from each area, and assuming each nest is from a different female, the combined populations of these sites is about 368 mature females; assuming an even sex ratio gives an estimate of about 736 mature individuals (references withheld). Overall, the numbers for the four largest areas yield a rough estimate of 868 adults. One could add a handful from the first four areas (see above). However, research since 2005 suggests declines and very few turtles in most of these areas (references withheld).

Fluctuations and Trends

Monitoring of population trends has consisted of visual surveys in spring, with a search implemented in some years depending on the site, as well as nesting site monitoring. This species is difficult to mark owing to their soft carapace, so most visual surveys usually have to assume that each sighting is a new animal. As described above, based on nesting surveys, the extant populations appear to be declining owing to habitat loss and the various threats they are currently facing (Brooks 2007). Earlier surveys have a greater likelihood of underestimating numbers given that the surveys were conducted by researchers with less experience in search techniques and with the location of nesting areas.

Many years of nesting site monitoring at the three largest communal oviposition sites in Canada provide estimates of the number of mature females in these areas. From the 1990s to 2013, data were collected on all observed nests at the three communal oviposition sites, which all had fairly consistent search effort. These data suggest a decline in the number of nesting females of as much as 70% at what was the largest nesting site in Canada and an overall decline of about 45% across all three of these sites (Fletcher 1999, Gillingwater and Brooks 2001; Gillingwater and Piraino 2003; Bolton and Brooks 2006, 2007; Gillingwater 2011; Davy pers. comm. 2013).

Declines have been consistent with the increasing loss of habitat, as discussed in **Habitat Trends** above, and with increased disturbance of nest sites (Gillingwater and Brooks 2001; Gillingwater and Piraino 2002-2003; Bolton and Brooks 2006, 2007, 2010; Gillingwater 2011). The extensive loss of habitat, apparent decrease in adult nesting females and decrease in natural nest success strongly suggest declines throughout southwestern Ontario.

No information is available on population fluctuations and trends in Quebec. The population is probably smaller than in the past because of various threats, including loss of habitat (particularly nesting habitat), intense depredation of eggs, and mortality associated with fishing and motorboats.

Rescue Effect

No information is available on rescue effect in Ontario. The species is present in New York State in southern Lake Ontario (Wayne and Monroe counties, City of Rochester) (New York State Department of Environmental Conservation 2007), but there is no indication that individuals are moving into the western (Canadian) part of Lake Ontario. A decline has also been observed in Wayne County, New York since the late 1980s (Paul and Simonin 2007), and the Spiny Softshell is designated a species of special concern in New York State. The species is present in New York State in eastern Lake Erie (Chautauqua county, south of Buffalo), in Pennsylvania, and in Ohio on the southern shoreline of Lake Erie (Ohio Department of Natural Resources 2011). Considering their known ranges, these populations seem to be disjunct (no records associating them), and there is nothing to indicate that they are in contact with the Carolinian subpopulation. The species is present in Michigan on the west bank of the Detroit River, in Lake St. Clair and in Lake Erie (Monroe County) (Michigan Department of Natural Resources 2011; Jones pers. comm. 2012). Because the species can travel long distances, exchanges may take place with the Canadian bank of the Detroit River (less than 2 km) and the Canadian shorelines of Lake St. Clair and western Lake Erie. The species has no special status in Michigan, where it is considered common.

In Quebec, rescue effect is possible from Vermont (Galois *et al*. 2002), where the Spiny Softshell is ranked S1 (critically imperiled; NatureServe 2014).

THREATS AND LIMITING FACTORS

Threats

Habitat Loss, Degradation, and Disturbance

Habitat loss is undeniably the main threat to both subpopulations of the Spiny Softshell. Their remaining terrestrial and aquatic habitats are being degraded and destroyed by shoreline alteration, construction of roads, bridges, and dams, urbanization, intensive agricultural activity (drainage and alteration of the water regime of rivers and streams, trampling by cattle), intensive and increasing recreational activity especially boating, increasingly severe hydrologic changes from climate change (drought and flooding), spread of invasive plants, and declining water quality (pollutants, turbidity, eutrophication).

Habitat loss and alteration continues in virtually all areas occupied by softshells. The development of trail systems and new residential areas can reduce habitat quality and availability for softshells by increasing disturbance. Illegal shoreline and floodplain development occurs in softshell habitat (Gillingwater unpub. data). Prompted by fear of a recurrence of such events, shoreline residents raise the level of their land and/or install rip-rap on shorelines. The overall balance of recent habitat gains and losses is therefore unknown. What is clear is that past habitat losses were substantial and are continuing, and current populations are fragmented, generally small, and facing different threats.

Nesting Habitat Loss

Availability of nesting sites is limited owing to shoreline alteration, increased human presence (disturbance) and increased recreational use of the remaining potential sites (sandy beaches). In Quebec, only four nesting sites have been identified, two of which are used by most of the remaining turtles. In Ontario, the major nesting areas are also heavily frequented by humans, both on land and offshore in boats, with significant consequences. Female softshell turtles are particularly sensitive to disturbance during egg laying, which takes place during the day (Bolton and Brooks 2006). Nest site availability and quality are also compromised by flooding, agricultural practices, subsidized predators, and invasive plant species, as discussed below. In addition, ATVs, horseback riders, 4X4 trucks, mountain bikes, anglers, hikers and campers moving over nesting areas have all been implicated in egg loss (compaction), habitat alteration/destruction and disturbance to adult turtles (Gillingwater 2004, 2011).

Another major threat to nest sites is erosion of nesting beaches (Davy pers. comm. 2013). At one site, large metal and chain link enclosures were erected a safe distance from water in 2008 and nests were moved into the enclosures to protect them from predators. The beach has been eroded to the point where the enclosures are washed out and now can be reached by waves in summer storms. The beach has become extremely narrow and nests are at risk of inundation from the lake. There are only a few points where softshells can still access nesting sites because growth of European Common Reed has made large stretches inaccessible to turtles, so they either have to use these specific points, or they have to swim to the lake side to emerge and nest. These changes force nests to be concentrated in small areas that expose them to increased predation.

Alteration of the water regime of streams and rivers by agricultural drainage and the installation of dams provides additional threats. Fluctuations in water levels are no longer only seasonal (e.g., spring flooding), but are also related to major summer rainfall events and water level control by dams. Changing environmental conditions, with impacts to habitat compounded by flood control structures have been increasing. The increasing severity of summer storm events, noted from the mid-1990s to 2013 has resulted in higher rates of flooding during oviposition and embryo development. During oviposition, high flood waters either delay oviposition or force females to nest at inadequate sites. High flood waters during incubation can result in embryo death if eggs are submerged longer than 12 to 24 hours. Such flooding events have been increasingly implicated in complete loss of clutches, and in recent years, loss of all eggs laid in a season. Flood control designed to release water at a sustained rate to protect property increases the time that flood waters remain over nest sites. From 1995 to 1999, flood waters caused some nest losses, but in 2000 destroyed all nests on a major nest site. Between 2002 and 2011, with the exception of 2007, flood waters affected all nests at the largest Canadian communal nesting site. From 2008 to 2011, storm events resulted in all nest sites (except one, which was trampled by cattle) being submerged during embryo development for more than 48 hours, drowning all embryos. Thus, habitat availability for oviposition has been lost for known softshell nest sites in recent years (Fletcher and Gillingwater 1994; Fletcher *et al.* 1995; Fletcher 1996-

1999; Gillingwater and Piraino 2002; Gillingwater 2004; 2011). Similar flood problems affect nest sites in Quebec (Gautier pers. comm. 2014).

Subsidized Predators

Predation, a natural phenomenon with which turtles have evolved, has become a threat because of recent increases in mesopredators such as Raccoon, Striped Skunk, Virginia Opossum (*Didelphis virginiana*), Red Fox and Coyote. Habitat alteration and urban development have created conditions particularly favourable to these mammals in agricultural areas (Rivest and Bergeron 1988), in urban and suburban areas (e.g., Spencer-Diermair 2007), and in many parks and protected areas (deSolla *et al*. 2003; Phillips and Murray 2005; Browne and Hecnar 2007; Phillips 2008). Relocating these predators is not a solution. Predation pressure is therefore exceptionally high and may repeatedly restrict or entirely prevent annual recruitment. A comparative study on fly infestation, contamination and predation of nests at three sites showed that mammalian predators are the main cause of nest loss (de Solla *et al*. 2003). A study on turtle population structure identified low recruitment, primarily due to high predation of nests by Raccoons, which in turn caused decline in abundance and an increase in mean age of local turtle populations (Browne and Hecnar 2007; Phillips 2008). At other sites, up to 100% mortality of unprotected eggs has been noted (Fletcher 1999; Gillingwater and Brooks 2001; Gillingwater and Piraino 2002; Bolton and Brooks 2006; Gillingwater 2011). Many nests were depredated before researchers could protect them with wire caging.

Pollution

Contamination of Spiny Softshell eggs has been studied in Ontario (de Solla *et al.* 2003). Organochlorine pesticides and polychlorinated biphenyls have been detected in eggs at three different sites. The study was unable to determine the effect of the contamination on hatching success. The contamination levels measured were similar to those found in Snapping Turtle (*Chelydra serpentina*) eggs at Lake Erie, where no effect on that species was detected.

Invasive Plants

One of the most significant threats related to habitat alteration in Ontario is the spread of invasive plants. Since 1996, changes to habitat availability and quality due to invasive plant species at all known softshell oviposition sites in southern Ontario has been noted, and in some cases have caused total loss of oviposition habitat. Japanese Hops (and to a lesser extent Purple Loosestrife and European Common Reed) have eliminated the potential of most nests to be successfully incubated. Spiny Softshell nests cannot withstand the roots or shading of most plant species (Fletcher 1996, 1997, 1999; Gillingwater 2004, 2008, 2011). The invasion of a nesting site by European Common Reed showed that recruitment is affected (Bolton and Brooks 2010). Turtles nest in areas where plants have not yet emerged from the ground. During summer, some nests are therefore breached by roots and shaded by plants, prolonging incubation times and reducing or eliminating hatching success. Furthermore, progressive encroachment reduces the available area of

the nesting site each year. In 1996, oviposition sites and adjacent gestation/nursery ponds at one site were mostly devoid of European Common Reed. In the intervening years this invasive reed has become increasingly common at both oviposition and nursery/gestation sites. By 2009 most oviposition sites previously used by softshells had been invaded (Mackenzie pers. comm. to Gillingwater 2009) and a brief shoreline survey by boat by Gillingwater in 2011 confirmed that most previously used habitat was altered by European Common Reed. Similar changes at other sites from 1995 to 2011 have also been noted (Gillingwater and Brooks 2001; Gillingwater and Piraino 2004; Gillingwater 2006; Gillingwater unpub. data).

Boating and Fishing Bycatch

Spiny Softshells are injured and often killed after colliding with boats or motorboat propellers (Galois and Ouellet 2007a, 2007b). Boating-related injuries and mortalities are difficult to quantify in this species, because the turtles are often struck in the open lake and are unlikely to be noticed. Injured and killed softshells are observed and especially females concentrated near nesting sites. Injuries caused by boats have been frequently observed in Northern Map Turtles (*Graptemys geographica*) (Clavering and Pomfret 2003; Bernier and Rouleau 2010; Bulté *et al*. 2010; Carrière and Blouin-Demers 2010; COSEWIC 2012). Boat collisions are a major cause of injuries and mortality for map turtle populations in lakes and rivers with heavy boat traffic, similar to habitats frequented by softshells. In shallow bays many softshell and map turtles have evidence of boat propeller injuries on their carapaces (Gillingwater pers. comm. 2011; Buck pers. comm. 2012).

Quantitative assessments of boat impacts come from research on marked map turtles from Lake Opinicon and St. Lawrence Islands National Park. Researchers found obvious scars from boat propellers (3.8% and 8.3% respectively of captured individuals), and it is likely that many turtles are killed annually in these areas by such collisions (Bulté *et al*. 2010; Carrière and Blouin-Demers 2010; COSEWIC 2012). The prevalence of propeller injuries was two to nine times higher in adult females than in adult males and juvenile females as a result of demographic differences in patterns of movement, habitat use, and aquatic basking. Boating near nesting concentrations represents a major threat to adult female softshell turtles. Population viability analyses conducted on map turtle populations concluded that even low boat mortality rates for adult females (i.e., a risk of mortality greater than 10% when hit by a boat) led to a high probability of extirpation of the population. For example, if only one adult female is killed by a boat every three years the probability of extinction over 500 years is 63% for the Lake Opinicon population and 99% for the St. Lawrence Islands National Park population (Bulté *et al*. 2010; COSEWIC 2012). Given that most nesting female Softshell Turtles in Canada occur in large water bodies, in areas with heavy motorized boat traffic, the scope of this threat is likely considerable and especially so with increased recreational boating.

Commercial fishing traps present another potentially serious mortality risk for softshell turtles. The Great Lakes, including Lake Erie, represent one of the largest freshwater commercial fisheries in the world (Raby *et al*. 2011). The potential threat of bycatch mortality for softshell populations living in commercial fishing zones is serious and deserves further investigation. The life history of turtles renders them unable to cope with harvest pressure and populations can be decimated quickly (Raby *et al*. 2011). For instance, Dorcas *et al*. (2007) found that age and sex ratio of a Diamondback Terrapin (*Malaclemys terrapin*) population in South Carolina was greatly altered by trapping bycatch, because selective mortality of smaller individuals resulted in a female-biased population with an older distribution. Furthermore, Diamond-back Terrapin populations have reportedly declined across their range as a result of drowning in commercial traps (Seigel and Gibbons 1995). A recent study in two lakes in Eastern Ontario (Larocque *et al*. 2012a) found that 93 – 100% of non-fish bycatch consisted of four different species of turtles (*Graptemys geographica, Sternotherus odoratus, Chrysemys picta,* and *Chelydra serpentina*). Modifying fyke nets using floats to create air spaces effectively reduced turtle bycatch mortality without significantly affecting fish catch rates or composition; however, turtle mortality was still severe (33% died) in nets tended infrequently (every 2-6 days). Frequent tending (every 8 to 48 h) of nets reduced turtle mortality (Larocque *et al*. 2012b). Furthermore, regulations restricting commercial fishing to the fall would be beneficial, as this restriction does not appear to reduce fish catches, yet greatly reduces the incidence of turtle captures (Larocque *et al*. 2012b). The addition of escape chutes and/or turtle excluder devices have also been found to reduce freshwater turtle bycatch by 77% - 100% (Lowry *et al*. 2005; Larocque *et al.* 2012c; COSEWIC 2012). Softshell turtles also become snagged or bite on baited fish hooks and lures. Fishers may try to free the turtle, but some simply cut the line, leaving the turtle with little chance of surviving (Galois and Ouellet 2007a, b; Wright and Des Brisay 2009). The number of fishing-related mortalities is rising in Ontario, with increasingly frequent reports of turtles found dead with hooks in their mouths (Gillingwater pers. comm. 2012). Reducing such mortalities is difficult because it would require controlling or even prohibiting motorboating and fishing in popular aquatic areas heavily used by humans.

Illegal Collection

The illegal take of juveniles and adults as pets, as well as collection of individuals for consumption has been confirmed in Canada (Ministry of Natural Resources 2011; Gillingwater pers. comm.). Additionally, hundreds of softshell eggs have been destroyed or stolen from protected nests, hampering conservation efforts (Fletcher 1999; Gillingwater and Brooks 2001). The frequent occurrence of Asian and U.S. softshell turtles in the pet trade also testifies to problems of illegal harvest of softshells.

Limiting Factors

Factors that would limit the existence and persistence of Softshell Turtles are habitat requirements that would include a river or lake with suitable overwintering and nesting areas, and life history parameters. At the northern limit of the species' range, temperature would be a limiting factor that relates to the duration of egg incubation, foraging time (for growth), and winter hibernation in an oxygen-rich aquatic environment. Softshells require several years to reach maturity, but live a long time. Each year, a mature female can lay relatively large numbers of eggs but recruitment is very low or non-existent per year per individual female. The number of adult individuals, and especially females, would limit the viability of a population. Removing adults from a population will have serious consequences for the future of that population.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

In Canada, prior to the current assessment, the Spiny Softshell was assessed by COSEWIC as Threatened in April 1991. Its status was re-examined and confirmed in May 2002 (COSEWIC 2002). It has been listed in Schedule 1 of the *Species at Risk Act* since 2005 (*Canada Gazette* 2005). A proposed federal recovery strategy was published in 2016, in which critical habitat was partially identified (Environment Canada 2016). At the federal level, it is also indirectly protected by fish habitat protection provisions of the *Fisheries Act*.

In Ontario, Spiny Softshell was designated Threatened in 1996. The species is protected under the 2007 *Endangered Species Act* (S.O. 2007, Chapter 6), which grants greater protection to species at risk and their habitat than the previous statute. Spiny Softshell is also a specially protected species under the *Fish and Wildlife Conservation Act* (S.O. 1997, Chapter 41); the Act prohibits capturing, harassing and killing the species and a licence is required to keep a Spiny Softshell in captivity for any educational or scientific purpose. The Natural Heritage component of the Provincial Policy Statement under Ontario's *Planning Act* provides for the protection of significant habitat of threatened species. Furthermore, some populations are located in provincial and national parks, as well as federally protected National Wildlife Areas.

In Quebec, the Spiny Softshell is designated Threatened under the *Act respecting threatened and vulnerable species* (R.S.Q., c. E-12.01) (*Gazette officielle du Québec* 1999). Since 2002, the *Act respecting the conservation and development of wildlife* (R.S.Q., c. C-61.1) has prohibited the exchange (of live individuals) or keeping in captivity of any softshell turtle species, whether native or alien (Schedule II to the *Regulation respecting animals in captivity*), and protects Spiny Softshell from capture for commercial or other purposes. The importation of specimens of this species is also prohibited. Its habitat may be protected under other statutes and regulations, such as the *Environment Quality Act* (R.S.Q., c. Q-2, a. 2.1), and under the Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains. The Policy includes a definition of the mandatory width of

buffer strip (10 m in 2005). Section 22 of the *Environment Quality Act* requires authorization in order to build (e.g., houses) in natural environments. Section 26 of the *Act respecting the conservation and development of wildlife* states: “No person may disturb, destroy or damage a beaver dam or the eggs, nest or den of an animal.” The species would also be included in areas under government protection, such as Ecological Reserves and land acquired by the Nature Conservancy of Canada. As a cross-border species, the Spiny Softshell is protected in Vermont, where it is designated Threatened (Vermont Statutes Annotated 2005) and where a recovery plan has been developed (Vermont Fish and Wildlife Department 2009). The proposed critical habitat is defined as a territory consisting of a watercourse, a body of water, a wetland and adjacent lands used for breeding, feeding, resting, hibernating or moving, as demarcated on a chart prepared by the minister. The order-in-council is expected to be approved in future and will apply to public land.

Non-Legal Status and Ranks

The Spiny Softshell was classified as Least Concern in 2010 by the IUCN (van Dijk 2013). A taxon is classified as Least Concern if it meets certain assessment criteria and is not eligible to be listed as Critically Endangered, Endangered, Vulnerable or Near Threatened. The IUCN’s justification for status is: “Widespread, cryptic and locally common species with an adaptable life history and high reproductive potential by turtle standards. Harvest rates appear not significant enough to have led to documented localised declines”.

According to NatureServe Canada (2012), the Spiny Softshell has a global rank of G5 (Secure—Common: widespread and abundant; June 19, 2011), a rank of N3 (Vulnerable: due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation; June 17, 2011) in Canada, a rank of S3 (Vulnerable) in Ontario and a rank of S1 in Quebec.

Habitat Protection and Ownership

The Spiny Softshell occurs in several protected areas in Canada (conservation areas, parks, reserves), and its habitat in those areas is protected to a certain extent. However, a large portion of its range is on private land. Stewardship and acquisition programs are run by various organizations, such as the Nature Conservancy of Canada, to increase the amount of protected habitat.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Patrick Galois, PhD, has more than 20 years' experience as a research biologist and is currently a project leader at Amphibia-Nature. He has conducted a variety of surveys, impact assessments, and conservation, education, awareness and research projects focusing mainly on amphibians, reptiles and mammals and their habitats. He has authored or co-authored a number of scientific articles, including some on the Spiny Softshell. He has been a member of the Équipe de rétablissement de la tortue-molle à épines du Québec since its creation in 1996 and a coordinator since 2006. He has participated in research on the Quebec population since 1995, including province-wide population surveys, nesting studies, and radio-telemetry activities. He also participated in impact studies for the construction of a bridge over a major Spiny Softshell hibernation site in Vermont. He has served as a coordinator for the recovery strategy implementation team for five turtle species in the St. Lawrence watershed (2004–2005) and participates in a marine turtle observation network in Quebec and Saint-Pierre and Miquelon.

Martin Ouellet, DVM, IPSAV, veterinarian, has more than 20 years' experience as a veterinarian, herpetologist and environmental researcher. As a member of the research group Amphibia-Nature, he studies the distribution, ecology, health and conservation of amphibian and reptile populations in Quebec and worldwide. He has served as a director and/or project leader for research, survey, conservation, education and awareness projects on amphibians, reptiles and mammals and their habitats. He has also participated in environmental impact assessments in northern and southern Quebec. He has authored a number of scientific publications and is internationally recognized in the field of herpetology. He has served on the recovery strategy implementation team for five turtle species in the St. Lawrence watershed (2004–2005) and on the recovery and recovery plan implementation team for the Western Chorus Frog in western Quebec (1998–2006). He launched and now coordinates a marine turtle observation network in Quebec (2003–) and Saint-Pierre and Miquelon (2008–).

COLLECTIONS EXAMINED

No collections were examined for this report.

Appendix 1. Threats Calculator, All Canada.

THREATS ASSESSMENT WORKSHEET

Species or Ecosystem Scientific Name	Spiny Softshell (entire Canadian population)
Element ID	**Elcode**
Date (Ctrl + ";" for today's date):	13/08/2014
Assessor(s):	Kristiina Ovaska (facilitator), Jim Bogart (SSC Co-chair) Scott Gillingwater, Ron Brooks, Christina Davy, Joe Crowley (ON), Sylvain Giguere (CWS), Marie-France Noel (CWS), Isabelle Gauthier (QC)
References:	COSEWIC status report (draft August 2014)

Overall Threat Impact Calculation Help:

Threats		**Level 1 Threat Impact Counts**	
A	Very High	0	0
B	High	2	2
C	Medium	4	4
D	Low	0	0
Calculated Overall Threat Impact:		Very High	Very High

Assigned Overall Threat Impact:	
Impact Adjustment Reasons:	
Overall Threat Comments	Generation time: 35 yrs; 3 generations 105 years

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development		Negligible	Negligible (<1%)	Serious (31-70%)	High (Continuing)	
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Serious (31-70%)	High (Continuing)	In Ontario, you cannot build in the flood plains where most of the sites are located, so scope is negligible. Construction of docks is a threat, however. Actual impacts of residential development are dealt with under 6. Human Intrusions and Disturbances and 9. Pollution
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Extreme - Serious (31-100%)	Unknown	Dredging
1.3	Tourism & recreation areas						Already in existence
2	Agriculture & aquaculture	C	Medium	Restricted (11-30%)	Extreme (71-100%)	High (Continuing)	
2.1	Annual & perennial non-timber crops						Dealt with under 9. Pollution

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching	C	Medium	Restricted (11-30%)	Extreme (71-100%)	High (Continuing)	Erosion of shoreline; farmers decreasing buffers; nests and individuals crushed by cattle. Threat affecting main nest sites. See also 9. Pollution.
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						
4	Transportation & service corridors		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Road mortality limited but some recorded; road construction; bridge construction (increase in sedimentation and machinery could have an impact)
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use	C	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	C	Medium	Restricted (11-30%)	Extreme (71-100%)	High (Continuing)	Illegal captures of all age classes for food, medicine or pets in Ontario, with hunting. This does not seem to be an apparent threat in Quebec according to data from recovery team.
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources	C	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	Incidental captures of adults by commercial and recreational fisheries, however, no solid data; lots of uncertainty on “severity”
6	Human intrusions & disturbance	C	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	
6.1	Recreational activities	C	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	Recreational use of nesting areas by humans and potential consequences (disturbance during nesting, collisions with watercraft); injury and mortality related to motorboats (collisions, propellers), ATV use, horseback riding; harassment of nesting females (largest impact); vandalism of nests. Boat collisions particularly problematic in a lake where there are many marinas
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						
7	Natural system modifications	B	High	Large (31-70%)	Extreme (71-100%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.1	Fire & fire suppression						
7.2	Dams & water management/use	B	High	Large (31-70%)	Extreme (71-100%)	High (Continuing)	Scope is closer to lower end of range. Alteration of water regime via dams and other water control and bank stabilization methods are flooding the nests. Major floods which are jeopardizing progress made in shoreline naturalization. In Quebec, approx. 15 sites are flooded almost every year for 2 days due to storms and flooding.
7.3	Other ecosystem modifications		Unknown	Unknown	Unknown	High (Continuing)	Piers alter dunes, thus reducing nesting habitat. Possible impact of cyanobacterial blooms (e.g. toxin accumulation, impact on prey) in a large lake, but no data on the impact to the species or habitat.
8	Invasive & other problematic species & genes	B	High	Large (31-70%)	Serious (31-70%)	High (Continuing)	
8.1	Invasive non-native/alien species	C	Medium	Restricted (11-30%)	Extreme (71-100%)	High (Continuing)	Increasing loss of oviposition habitat to invasive, non-native vegetation. “Scope” is on the low end of the range.
8.2	Problematic native species	B	High	Large (31-70%)	Serious (31-70%)	High (Continuing)	Nest predation higher than what is required to sustain recruitment; high predation rates by raccoons, skunk, fox, coyotes have been documented.
8.3	Introduced genetic material						
9	Pollution		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Small (1-10%)	Unknown	High (Continuing)	A major city has lots of spills during storm events which end up in the river. No data on how this affects population.
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Farming practices leading to bank erosion, water siltation and sedimentation; concentrations of pesticides were shown in the eggs but no data linking pesticides and survivorship or hatch success.
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather	C	Medium	Restricted (11-30%)	Serious (31-70%)	High (Continuing)	
11.1	Habitat shifting & alteration	C	Medium	Restricted (11-30%)	Serious (31-70%)	High (Continuing)	Storms or flooding at one locale are narrowing the dunes, thus reducing number of nesting sites

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.2	Droughts	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)	river sites
11.3	Temperature extremes						
11.4	Storms & flooding						Dealt with under 7.2 Dams and water management/use.
Classification of Threats adopted from IUCN-CMP, Salafsky et al. (2008).							