COSEWIC
Assessment and Status Report

on the

Spotted Turtle
Clemmys guttata

in Canada

ENDANGERED
2014

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. 2014. COSEWIC assessment and status report on the Spotted Turtle *Clemmys guttata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiv + 74 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Previous report(s):

COSEWIC. 2004. COSEWIC assessment and update status report on the spotted turtle *Clemmys guttata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 27 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Oldham, M.J. 1991. COSEWIC status report on the spotted turtle *Clemmys guttata* in Canada. Committee on the Status of Endangered Wildlife in Canada. 93 pp.

Production note:
COSEWIC would like to acknowledge Teresa Piraino for writing the status report on the Spotted Turtle, *Clemmys guttata,* in Canada, prepared under contract with Environment Canada. This report was overseen by Jim Bogart, Co-chair of the COSEWIC Amphibians and Reptiles Specialist Subcommittee.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la Tortue ponctuée (*Clemmys guttata*) au Canada.

Cover illustration/photo:
Spotted Turtle — Photo provided by author.

Catalogue No. CW69-14/382-2015E-PDF
ISBN 978-1-100-23116-7

COSEWIC
Assessment Summary

Assessment Summary – November 2014

Common name
Spotted Turtle

Scientific name
Clemmys guttata

Status
Endangered

Reason for designation
This species has an unusually low reproductive potential, including late age at maturity and low fecundity, and occurs in small, isolated subpopulations. Although some subpopulations are in protected areas, there is evidence from extensive monitoring and projected calculated declines that even these populations are in jeopardy despite low exposure to anthropogenic threats. The main threats to the species are road mortality; collection for the pet, food and traditional medicine trade; and habitat loss due to invasive plants and development. There is no potential for rescue from outside populations.

Occurrence
Ontario, Quebec

Status history
Designated Special Concern in April 1991. Status re-examined and designated Endangered in May 2004 and November 2014.

COSEWIC
Executive Summary

Spotted Turtle
Clemmys guttata

Wildlife Species Description and Significance

The Spotted Turtle (*Clemmys guttata*) is a relatively small freshwater turtle, with an adult shell length typically less than 13 cm. The species is recognized by its black shell overlaid with an irregular pattern of yellow-orange spots. The Spotted Turtle is amongst the most popular of turtle species in the pet trade and the poaching of wild specimens presents a real threat to its survival. Due to relatively recent taxonomic changes, the Spotted Turtle is currently the only representative of the genus *Clemmys*. Despite being small and isolated from one another, Canadian Spotted Turtle subpopulations are not genetically impoverished.

Distribution

The Spotted Turtle is restricted to eastern North America in disjunct populations from southern Ontario and Maine southward along the Atlantic Coastal Plain to central Florida, and westward along the south shores of the Great Lakes to northeastern Illinois.

Habitat

Spotted Turtles inhabit a variety of wetland habitats that provide unpolluted, slow-moving, shallow water, with abundant emergent and aquatic vegetation, such as bogs, fens, marshes, swamps, and shallow graminoid meadows. Soft substrate, sphagnum moss, grass tussocks, sedges, cattails, floating plants and mats of vegetation, and hydrophilic shrubs are important components of aquatic habitats used by Spotted Turtles.

Biology

Emergence from hibernation occurs from late March to late April. Spotted Turtles aggregate in aquatic habitats in spring (May) to mate, and show fidelity to their breeding sites. Nesting occurs from mid- to late June. Clutch sizes range from 1-7 eggs, with a mean of 4-5 eggs. Most females in Georgian Bay do not produce eggs every year; however, those from southwestern Ontario often nest annually, while those from the southern U.S. may produce multiple clutches in a year. Summer dormancy occasionally takes place and may occur in terrestrial or aquatic sites, mainly from July through August but even into September or October, after which turtles enter hibernation. Spotted Turtles may hibernate

singly or communally and often show fidelity to hibernacula or to a hibernation area (returning to within <20m from the previous year's locale). Sexual maturity is attained when turtles are 11-15 years old. Some individuals in Ontario subpopulations are at least 44 years old, and maximum longevity in a Georgian Bay subpopulation was estimated to be 110 years for females and 65 years for males based on 24 years of mark - recapture data.

Population Sizes and Trends

The Natural Heritage Information Centre (NHIC) recognizes 109 Spotted Turtle sites in Ontario. Of the 109 sites, 81 (74%) are currently considered historical (i.e., no known records in at least 20 years) and 3 (3%) are considered extirpated, despite the submission of hundreds of new records to NHIC in 2013. Although only 25 sites (23%) are currently known to be extant, a lack of recent records at historical sites should not be used to infer decline, especially if dedicated Spotted Turtle surveys have not been conducted at these sites and suitable habitat still remains. Nevertheless, evidence does exist that several subpopulations, even in protected and pristine areas, have disappeared or are currently in decline. Whether the Spotted Turtle currently occurs in Québec is uncertain as no records have ever been confirmed.

Threats and Limiting Factors

Spotted Turtle numbers are in decline mainly due to road mortality; collection for the pet, food, and medicine trade; and the loss and degradation of wetland habitat from invasive plants and development. The Spotted Turtle is particularly susceptible to habitat destruction and to exploitation by poachers in spring and fall when turtles aggregate at breeding and hibernation sites, respectively. Low juvenile recruitment, low fecundity, and late age of maturity exacerbate the Spotted Turtle's vulnerability to decline. Subpopulations are at high risk of demographic stochasticity given their small sizes and high degree of isolation from each other.

Protection, Status and Ranks

The Spotted Turtle was designated 'Endangered' by COSEWIC in 2004 and again in 2014. It is protected as an 'Endangered' species under the federal *Species at Risk Act, 2002* (S.C. 2002, C.29) and the Ontario *Endangered Species Act, 2007* (S.O. 2007, ch.6), and as a 'Threatened' species under the Québec *Loi sur les espèces menacées ou vulnérables, 1989* (*Act Respecting Threatened or Vulnerable Species;* R.S.Q. 1989, ch. E-12.01).

The global conservation status rank of the Spotted Turtle is G5 (‘secure’) while its national rank is N5 (‘secure’) in the U.S. and N3 (‘vulnerable’) in Canada. Its provincial rank is S1 (‘critically imperilled’) in Québec while its provincial rank in Ontario has just been changed from S3 (‘vulnerable’) to S2 (‘imperilled’) based on information provided in this report. Its General Status Rank in Canada, Ontario, and Québec is ‘At Risk’. In 2011, the IUCN Red List assessed the Spotted Turtle as Endangered and in March 2013, CITES (Convention on the International Trade in Endangered Species) added the Spotted Turtle to Appendix II, so that its international trade is now regulated.

TECHNICAL SUMMARY

Clemmys guttata

Spotted Turtle — Tortue ponctuée

Range of occurrence in Canada: Ontario, Québec

Demographic Information

Generation time = Age of first reproduction + 1/adult mortality (IUCN 2011 guidelines). Mortality rate estimated as 1 - 0.965 = 0.035 [based on an age of maturity at 12 years (Litzgus 2006) and an annual adult female survivorship of 0.965 (Enneson and Litzgus 2008)].	Gen Time = 12 + 1/0.035 = 40.6 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? Yes. Observed, inferred and projected. See Fluctuations and Trends.	Yes
Estimated percent of continuing decline in total number of mature individuals within 2 generations (i.e. 82 years). > 30% based on an estimated 10% of adults dying annually in a southwestern Ontario subpopulation (Enneson 2009) and an estimated 5% of adults dying annually in a Georgian Bay subpopulation (Litzgus 2006; Enneson and Litzgus 2008).	> 30%
[Observed, estimated, inferred, or suspected] percent reduction in total number of mature individuals over the last 3 generations (i.e. 123 years). Unknown for this time period. It is inferred that most reduction has occurred in the recent past.	Unknown
[Projected or suspected] percent reduction in total number of mature individuals over the next 3 generations (i.e. 123 years). > 40% projected based on current trends. See 'Fluctuations and Trends'.	> 40%
[Observed, estimated, inferred, or suspected] percent reduction in total number of mature individuals over any 3 generations period, over a time period including both the past and the future. > 40% inferred based on recent observations, habitat loss, and present threats.	> 40%
Are the causes of the decline clearly reversible and understood and ceased? They're clearly understood but not clearly reversible or ceased. See Threats and Limiting Factors.	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence Including only recent records = 153,200 km^2 Recent and historical (pre-1994) = 161,873 km^2.	Between 153,200 km² and 161,873 km².
Index of area of occupancy (IAO) (Always report 2 x 2 km grid value). Discrete IAO based on grids over recent (post-1994) records only: 115 grids = 460 km² Continuous IAO based on grids over recent (post-1994) records and including grids between records <2 km from each other: 460 km² to 2000 km² Discrete IAO based on grids over all recent (post-1994) and historical (pre-1994) records: 312 grids = 1248 km². Continuous IAO based on grids over all recent (post-1994) and historical (pre-1994) records and including grids between records <2 km from each other: 1248 km² - 2000 km².	Between 460 km² and 2000 km².
Is the population severely fragmented? See Biology - Dispersal and Migration.	Likely
Number of locations Likely 20-30. See Locations.	20-30
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence? Yes, inferred. Species is no longer believed to have occurred in Québec and the number of historical sites in Ontario is increasing.	Yes
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy? Yes, inferred. Although a few new subpopulations have been recently discovered, several more subpopulations have declined or have become historical (i.e. no records in at least 20 years) in the last 10 years. See Fluctuations and Trends.	Yes

Is there an [observed, inferred, or projected] continuing decline in number of populations? Yes, inferred. Despite the submission of hundreds of new Spotted Turtle records to NHIC in 2013, only 25 of 109 sites (23%) are currently known to be extant. Targeted surveys at historical sites are needed to determine if true decline has occurred. See Fluctuations and Trends.	Yes
Is there an [observed, inferred, or projected] continuing decline in number of locations*? Yes, inferred. See Locations.	Yes
Is there an observed continuing decline in area, extent and/or quality of habitat? Yes, habitat is declining in area, extent and quality. See Extent of Occurrence and Area of Occupancy and Threats and Limiting Factors.	Yes
Are there extreme fluctuations in number of populations?	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

Number of Mature Individuals (in each population)

Population	**N Mature Individuals**
Georgian Bay/Bruce/Greater Area 1	>152 (Litzgus pers. comm. 2013)
Georgian Bay/Bruce/Greater Area 2	11 (95% CI: 11-21) (Davy 2013)
Georgian Bay/Bruce/Greater Area 3	>15 (Reeves 2007)
Georgian Bay/Bruce/Greater Area 4	>54 (Reeves and Litzgus 2008; NHIC data)
Georgian Bay/Bruce/Greater Area 5	>49 (Riley *et al.* pers. comm. 2013; Morin *et al.* pers. comm. 2014)
Georgian Bay/Bruce/Greater Area 6	110 (95% CI: 109-116) (Davy 2013)
Georgian Bay/Bruce/Greater Area 7	5 (Crowley pers. comm. 2013)
Georgian Bay/Bruce/Greater Area 8	60 (95% CI: 46-95) (Davy 2013)
Southeastern Ontario 1	24 (95% CI: 22-32) (Davy 2013)
Southeastern Ontario 2	60 (95% CI: 39-119) (Davy 2013)
Southeastern Ontario 3	16 (95% CI: 16-22) (Davy 2013)
Southeastern Ontario 4	45 (95% CI: 34-78) (Seburn 2003)
Southeastern Ontario 5	55 (95% CI: 30-80) (Haxton 1998)
Southeastern Ontario 6	>18 (Blythe pers. comm. 2014)

Southwestern Ontario 1	560 (Davy pers. comm. 2013)
Southwestern Ontario 2	43 (95% CI: 34-72) (Davy 2013)
Southwestern Ontario 3	>27 (Gillingwater unpub. data)
Southwestern Ontario 4	~370 (320-421) (Enneson 2009; Gillingwater unpub. data)
Southwestern Ontario 5	>20 (Gillingwater unpub. data)
Southwestern Ontario 6	143 (SE=5) (Yagi and Litzgus 2012)
Southwestern Ontario 7	>6 (Hopkins pers. comm. 2014)
10 First Nations reserves w/recent records	??
Remaining sites (most known from 1-10 observations; currently 81 of 109 sites are considered historical)	??
Minimum Mean Estimate	1843
Minimum Lower Estimate	1704
Minimum Upper Estimate	2110
Note: estimates preceded by a > symbol indicate the minimum number of adults observed or marked in a subpopulation (used where no subpopulation estimates have been provided).	

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Probability of 6 or more of 9 known subpopulations in Ontario becoming extinct in 100 years is 26%. Probability of GB1 subpopulation (studied since 1977) becoming extirpated in 100 years is 60%, despite a relatively pristine environment (Enneson and Litzgus 2009)

Threats (actual or imminent, to populations or habitats)

- Road mortality (and likely railroad mortality)
- Collection for the pet, food, and traditional medicine trade
- Habitat loss and degradation (invasive plants, development, wetland modifications, beaver dam removals, forestry, mining/quarrying, pollution, climate change)
- Mortality due to agricultural practices and human recreational activities
- Increased predation of nests, juveniles and adults by “subsidized predators”
- Mainly occurs in small isolated subpopulations throughout its range which increases the threat of demographic stochasticity (most sampled subpopulations maintain <200 mature individuals)
- The Spotted Turtle’s long-lived life history characteristics (late age of maturity, high juvenile mortality) and low fecundity are limiting factors that exacerbate its vulnerability to decline from the above-mentioned threats

Rescue Effect (immigration from outside Canada)

Status of outside population(s)?	Declining across most of U.S. range (ranked as S1-S3 in all states adjacent to Canadian border). See Table 1.
Is immigration known or possible?	No See Rescue Effect.
Would immigrants be adapted to survive in Canada?	Possibly
Is there sufficient habitat for immigrants in Canada?	Likely in the Georgian Bay/Central Ontario region; however, little habitat remains in areas adjacent to the U.S./Canadian border.
Is rescue from outside populations likely?	No

Data-Sensitive Species

Is this a data-sensitive species?	Yes. The Spotted Turtle is highly vulnerable to collection for the pet, food and medicine trade. See Threats and Limiting Factors.

Status History

COSEWIC: Designated Special Concern in April 1991. Status re-examined and designated Endangered in May 2004 and November 2014.

Status and Reasons for Designation:

Status: Endangered	**Alpha-numeric code:** C1
Reasons for designation: This species has an unusually low reproductive potential, including late age at maturity and low fecundity, and occurs in small, isolated subpopulations. Although some subpopulations are in protected areas, there is evidence from extensive monitoring and projected calculated declines that even these populations are in jeopardy despite low exposure to anthropogenic threats. The main threats to the species are road mortality; collection for the pet, food and traditional medicine trade; and habitat loss due to invasive plants and development. There is no potential for rescue from outside populations.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Threatened A3bce+4bce since there is an estimated reduction of greater than 40% (22-70% based on threats calculation) decline based on the threat of invasive species.

Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable.
Criterion C (Small and Declining Number of Mature Individuals): Meets Endangered C1 since the total number of mature individuals is less than 2,500 individuals and there is a continuing decline in the total number of mature individuals of at least 20% within 2 generations.
Criterion D (Very Small or Restricted Population): Not applicable since the number of mature individuals, the IAO, and number of locations exceed the threshold.
Criterion E (Quantitative Analysis): None conducted.

PREFACE

Since the previous status assessment in 2004, several mark-recapture and radio-telemetry field studies have been conducted on this species in Ontario. Preliminary data suggest that subpopulations are in decline due to several observed threats, the most serious of which include: road mortality; collection for the pet, food, and traditional medicine trade; and habitat loss and degradation due to invasive species and development. According to the NHIC only 25 of 109 sites (23%) are currently known to be extant while 81 (74%) are now considered historical (i.e. no new records in at least 20 years) and 3 (3%) are considered extirpated (Oldham pers. comm. 2014). It is assumed that the species likely still occurs at several historical sites where suitable habitat remains, and that a lack of dedicated survey efforts at the right time of year by experienced observers may be a large part of the reason why no recent records have been reported at these sites. Nevertheless, since the last status assessment, the number of historical sites has risen significantly from 32 (31%) to 81 sites (74%), identifying a bona fide need for targeted surveys at these sites to determine whether or not the large increases in historical sites reflect true decline. Research over the past ten years has produced a better understanding of the Spotted Turtle's genetic structuring, subpopulation demographics and abundance, movement patterns, physiology, micro-habitat preferences, reproduction, and nest success. Findings of particular interest include data that suggest Spotted Turtle subpopulations do not show genetic reduction in heterozygosity and that seasonal movement ability and fecundity are greater than previously thought. Nonetheless, subpopulations are isolated with most maintaining small numbers of individuals, and are thus at increased risk of demographic stochasticity. Evidence reveals that some subpopulations in Ontario have already been lost or are declining, even from within protected or relatively undisturbed areas.

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
(2014)

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.

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

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

The Spotted Turtle, *Clemmys guttata* (Schneider 1792), derives its Latin name from the word *guttatus,* which means “spotted” or “speckled” (Boundy *et al.* 2008). The French common name for this species is Tortue ponctuée. The Mohawk common name for this species is lotsisthoronnion anowara (turtle like the star spot the sky) and the Anishnabie common name for this species is Gidugako misheekehn (Lickers pers. comm. 2013). No subspecies or varieties are recognized.

The Spotted Turtle was first described as *Testudo guttata* by Schneider (1792) and according to Ernst (1972) has undergone several name changes since that time [*Testudo punctata* Schoepff 1792; *Testudo anonyma* Schneider 1792; *Emys guttata* (Schweigger 1812); *Emys punctata* Merrem 1820; *Cyclemys punctata* (Wagler 1830); *Terrapene punctata* (Bonaparte 1831); *Clemmys punctata* (Fitzinger 1835); *Geoclemys guttata* (Gray 1855); *Nanemys guttata* (Agassiz 1857); *Clemmys guttata* (Strauch 1862); *Geoclemmys sebae* (Gray 1869); *Chelopus guttatus* (Cope 1875); *Clemmys guttata* (Wright 1918); *Melanemys guttatus* (Shufeldt 1919); and *Clemmys guttata* (Conant and Collins 1991; Crother 2012; Feldham and Parham 2002; TTWG 2014)].

Morphological Description

The Spotted Turtle is a relatively small freshwater turtle species, with adult carapace (upper shell) length averaging 9-13cm (Graham 1995; Harding 1997; minimum 8cm - Behler and King 1979; maximum 14cm - Haxton 1998). The species is recognized by its black keel-less, unserrated carapace overlaid with an irregular pattern of yellow or yellow-orange spots (Ernst and Lovich 2009) **[see Figure 1]**. Hatchlings usually have one spot per carapacial scute (Ernst and Lovich 2009). The plastron (lower shell) is orange to yellow-orange with black blotches on each scute; however, the plastron tends to become more black with age (Ernst and Lovich 2009). Individuals from some subpopulations may exhibit a spotless carapace or an entirely black plastron (Ernst and Lovich 2009). The head is black, with yellow to yellow-orange spots and large orange “ear” patches on either side (Harding 1997). The legs are black with yellow-orange spots on the upper surface and orange to pinkish-orange on the lower surface (Ernst and Lovich 2009).

Figure 1. Adult female Spotted Turtle. Photo by Scott Gillingwater.

Spotted Turtles are sexually dimorphic. Females have orange mandibles and irises, a flat to convex plastron, and relatively small, thin tails with cloaca at the margin of the carapace. In contrast, males have brown-buff mandibles and irises, a concave plastron, and larger, thicker tails with cloaca extending past the margin of the carapace (Ernst and Lovich 2009) **[see Figure 2]**. Male colouration may not develop until maturity (Ernst and Lovich 2009).

Adult Spotted Turtles may be confused with juvenile Blanding's Turtles (*Emydoidea blandingii*). which have a similarly dark carapace with yellow spots and flecks; however, young Blanding's Turtles can be distinguished by their yellow throats and chins and by the yellow, rather than orange scales, on their otherwise black legs (Ernst and Lovich 2009).

Figure 2. Close-up showing male (bottom) versus female (top) facial characteristics. Photo by Scott Gillingwater.

Population Spatial Structure and Variability

The Spotted Turtle typically moves over smaller distances than other turtles (Litzgus 1996; Dobbyn and Marchand 2007; Gillingwater and Piraino 2007; Ernst and Lovich 2009; Rasmussen and Litzgus 2010a; Yagi and Litzgus 2012; Gillingwater unpub. data) and occurs in small isolated subpopulations across its range (van Dijk 2011). In Ontario, most sampled subpopulations maintain <200 individuals **[see Technical Summary]**. These factors would suggest that current gene flow between sites is severely limited.

A recent study of Spotted Turtles across the Canadian range revealed that significant genetic structuring does in fact occur among subpopulations (Davy and Murphy 2014). This comprehensive study sampled 253 turtles (approximately 10% of the current estimated Canadian population size) from 13 sites across the Canadian range (52% of the currently known extant sites) and individuals were genotyped using 11 microsatellite loci originally developed for the Bog Turtle (*Glyptemys muhlenbergii*; King and Julian 2004). Results concluded that a minimum of six genetic populations and a maximum of 10 genetically differentiated subpopulations were represented in the dataset, but some extant subpopulations were not sampled and it is therefore possible that further genetically distinct populations occur in Ontario. The six genetic clusters were differentiated strongly enough that assignment tests identified an individual's subpopulation of origin with 77 - 78% accuracy. Pairwise distances between the sampled sites ranged from 3-670 km (average 277 km).

Despite genetic isolation and small size, each subpopulation maintained high heterozygosity (0.510 to 0.743) and showed no evidence of inbreeding or subpopulation decline (within-site allellic richness ranged from 3.18 - 4.49) and no subpopulations were fixed for alleles at any loci (Davy 2013; Davy and Murphy 2014). Furthermore, landscape genetics analyses revealed that the Hastings County and Bruce Peninsula Spotted Turtle subpopulations are isolated from neighbouring subpopulations by significant biogeographic barriers and that the Hastings County subpopulation is genetically distinct from all other sampled subpopulations making it a priority for protection (Davy 2013; Davy and Murphy 2014). Although these patterns were most likely caused by historic barriers, current landscape modification and subpopulation declines are likely to reinforce them.

These results suggest that demographic stochasticity currently presents a greater threat to Spotted Turtle subpopulations than genetic stochasticity; that low dispersal, fecundity, and subpopulation sizes do not predict low genetic diversity within Spotted Turtle subpopulations; and that Spotted Turtle reproductive behaviours such as aggregation breeding and possibly non-random mate choice ('inbreeding avoidance') may be influencing genetic diversity within subpopulations more greatly than small subpopulation size and genetic isolation (Davy 2013; Davy and Murphy 2014).

Designatable Units

Although recent genetic research reveals that there is significant genetic structuring among Spotted Turtle subpopulations throughout the Canadian range and despite the fact that subpopulations are biogeographically isolated (Davy 2013; Davy and Murphy 2014) and spread across different eco-regions (Great Lakes/St. Lawrence Faunal Province and Carolinian Faunal Province), there is no evidence of local adaptation or significant differences in subpopulation trends or factors affecting them. In their microsatellite study, Davy and Murphy (2014) addressed the possibility of using their data to allocate Canadian Spotted Turtle populations into separate designatable units (DUs). They concluded that the categorization of Canadian populations of *C. guttata* as DUs may not be justifiable or necessary at this time. Therefore, only one DU, the Canadian population, is recognized.

Special Significance

Given that recent taxonomic changes have left the Spotted Turtle as the only remaining representative of the genus *Clemmys*, the loss of this species (estimated to have already suffered range-wide declines of more than 50%; van Dijk 2011), would be especially poignant. The Spotted Turtle is a particularly coveted species in the commercial pet trade and it has become increasingly popular in the food and traditional medicine trade within North America in recent years (Miller pers. comm. 2013) **[see POPULATION SIZES AND TRENDS - Pet, Food, and Traditional Medicine Trade]**. Thus, poaching poses a serious threat to the survival of this species in the wild.

DISTRIBUTION

Global Range

The Spotted Turtle's current distribution is restricted to eastern North America **[see Figure 3]**. Disjunct subpopulations range from southern Ontario and Maine southward along the Atlantic Coastal Plain to central Florida, and westward through Pennsylvania, Ohio, Indiana, northeastern Illinois, and across the lower peninsula of Michigan (Ernst *et al.* 1994; Barnwell *et al.* 1997).

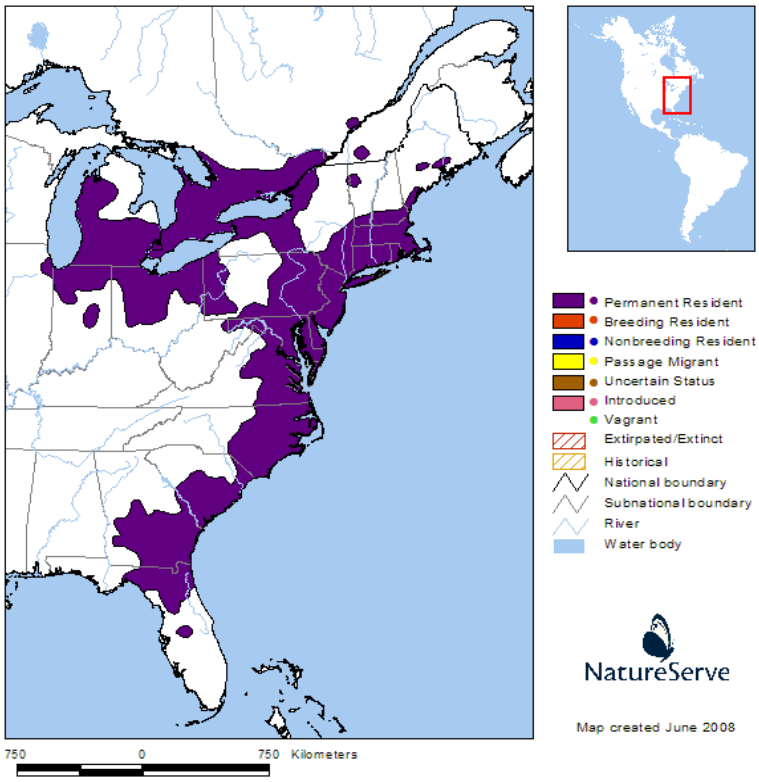

Figure 3. Global distribution of the Spotted Turtle (NatureServe 2013).

Canadian Range

In Canada, Spotted Turtles have been reported from southern Ontario and southern Québec. Subpopulations are not contiguous. Seburn and Seburn (2000) suggest that Canadian subpopulations of the Spotted Turtle are limited to Ontario. Current Ontario subpopulations are scattered from Georgian Bay through to southwestern and southeastern Ontario. Of six records for Spotted Turtle in Québec, three have been ruled out as erroneous while three from experienced observers are considered potentially valid: Provancher (Canadian Museum of Nature) reported a specimen from Nicolet near Lake Saint Pierre in 1874; Ernst reported a road-killed specimen 8 km south of Sherbrooke in 1967 (Ernst *et al.* 1994); and a record was reported from Île de Laval. However, these records remain questionable/doubtful as no photos or specimens were collected to confirm identification and may very well represent misidentified species (Cook pers. comm. 2014; Gauthier pers. comm. 2014; Litzgus pers. comm. 2014). Thus, the presence of the Spotted Turtle in Québec remains hypothetical (Gauthier pers. comm. 2014) and it seems likely that the species has either never occurred there (Litzgus pers. comm. 2014) or has been extirpated from the province (Fortin pers. comm. 2014).

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EO) for this species within Canada's extent of jurisdiction falls between 153,200 km² to 161,873 km² (former is based on recent records only while latter includes both recent and historical records). This estimate was calculated by minimum convex polygon encompassing the records with areas outside Canada's jurisdiction removed. Records for Québec were not included in the estimate because they have never been confirmed.

Although this estimate is approximately 100,000 km² greater than that reported in the previous status report (2004), this is due to differences in calculation methods rather than actual range expansion. EO used to be calculated by removing areas of unsuitable habitat; however, the new method of estimation is now based on a minimum convex polygon around all known, inferred or projected sites of present occurrence of the species; therefore, the previous and new estimates cannot be compared (Wu pers. comm. 2014). A comparison of distribution mapping for this species between 2004 and 2014 revealed that the range has changed very little; however, if some historical sites no longer maintain Spotted Turtles, then the EO has declined since the last status assessment.

The index of area of occupancy (IAO) lies somewhere between 460 km² to 2000 km². Discrete IAO was calculated by summing the area under 2 x 2 km grids overlain directly on Spotted Turtle observations. This provided an estimate between 460 km² to 1248 km² (based on 115-312 grids) depending on whether historical records were excluded (former) or included (latter) from the calculation. Continuous IAO, was calculated in the same manner but also included grids between observations <2 km from each other. This provided a range estimate of 460 km² to 2000 km² (based on recent records only) versus 1248 km² to 2000 km² (based on recent and historical records). The continuous IAO was based on the recognized separation distances for Spotted Turtle **[see BIOLOGY - Dispersal and Migration]**. If some historical sites no longer maintain Spotted Turtles, then the IAO has declined since the last status assessment.

Search Effort

Much of what we know about the Spotted Turtle's distribution in Canada has been collected over the last 30 years via the citizen science volunteer-reporting programs known as the Ontario Herpetofaunal Summary Atlas (since 1984), the Ontario Reptile and Amphibian Atlas (since 2009), the Toronto Zoo's Ontario Turtle Tally Program (since 2003) and the Atlas des amphibiens et reptiles du Québec (since 1988).

In Québec, no further targeted surveys have been conducted for Spotted Turtle in Nicolet and Sherbrooke (the sites of the most reliable, yet still unsubstantiated historical records) since the early 2000s and no new observations have been reported in these regions (Desroches pers. comm. 2002; Rodrigue pers. comm. 2002, Bernier pers. comm. 2013; Dubois pers. comm. 2013; Giguère pers. comm. 2013; Toussaint pers. comm. 2013; Desroches pers. comm. 2014). Recent targeted surveys have been conducted at the Lac Saint-François National Wildlife Area and Akwesasne Indian Reserve based on the availability of suitable habitat at these sites (Giguère 2006) and at the Snye Wetland Complex where the Mohawk People of Akwesasne have reported historical observations (Lickers pers. comm. 2013); no Spotted Turtle observations have been confirmed from these sites.

Of 26 First Nations' communities within the Ontario range for Spotted Turtle, eight of 10 communities with recent records maintain some data on resident Spotted Turtle subpopulations and distributions (Lickers pers. comm. 2013).

According to NHIC, most of the 109 currently recognized sites in Ontario are represented by 1-10 observation records each (Oldham 1991). Over the last 10 years, targeted surveys for Spotted Turtle have been conducted at several localities throughout the Ontario range; however, information on search effort is not readily available and thus the level of search effort is not fully understood or represented below.

In the Georgian Bay region and surrounding greater area (including Muskoka and Parry Sound districts and the counties of Bruce, Grey, and Simcoe) survey efforts have continued at one site that has been studied since 1977 (Litzgus 2012); however, at least 21 additional sites in this region (including historical sites and areas of suitable habitat without previous records) have also been surveyed since 2004. Spotted Turtles have been confirmed as extant at 15 of these sites, either incidentally or as part of targeted search efforts (Reeves 2007; Reeves and Litzgus 2008; Davy and Murphy 2011; Crowley pers. comm. 2013; Davy 2013; McCarter pers. comm. 2013; Rasmussen pers. comm. 2013; Riley *et al.* unpub. data; NHIC data).

In southeastern Ontario, further survey efforts have been conducted at four extant locales that have been monitored since the late 1980s or early 2000s (Davy 2013; Brdar pers. comm. 2014; Davy pers. comm. 2014; Seburn pers. comm. 2013; 2014). Roadside surveys and search efforts in 2000-2001 (19 person days) within 10km of a subpopulation studied in the mid-1980s did not find any turtles (Cebek 2003); however, Spotted Turtles were recently confirmed at a new locale on an adjacent private property in 2010 and have continued to be monitored (Blythe pers. comm. 2014). There has been some limited search effort at two protected areas in the region since the mid-1990s or early 2000s, but no Spotted Turtles have been reported (Alvo pers. comm. 2002; OMNRF pers. comm. 2014).

In southwestern Ontario, survey efforts have continued over the last 10 years at three protected sites with subpopulations that have been consistently monitored since the mid-1990s or early 2000s (Saumure 1995; Gillingwater and Brooks 2001; Gillingwater and Piraino 2004, 2007; Piraino and Gillingwater 2005, 2006; Gillingwater 2009, 2013; Yagi and Litzgus 2012; OMNRF unpub. data; Davy unpub. data). Periodic Spotted Turtle surveys or herpetofaunal surveys have also been conducted at four additional protected locales in the region; none have been observed at two of these sites in recent years, while small numbers persist at the other two sites (Haggeman 1981; Dewey *et al.* 1982; Lovisek 1982; Gillingwater and Piraino 2004; 2005; 2007; Gillingwater 2009; 2013; MacKenzie *et al.* 2014). Limited Spotted Turtle search efforts at fourteen historical sites on county-owned or private lands in Chatham-Kent, Lambton, Norfolk, Oxford and Middlesex were conducted between 2002-2014; a handful of individuals were observed at two sites (Gillingwater and Piraino 2002; Gillingwater pers. comm. 2013; McCarter pers. comm. 2013). Three years of spring surveys were recently conducted between 2009-2011(Davy 2013) at an extant site where only a few incidental observations had been previously reported (Gillingwater 2005; NHIC data). Recent in-depth turtle search efforts and research (~2000 person-hours) at Pinery Provincial Park from 2008-2012 failed to find any Spotted Turtles and the species is believed to be absent from the Park (Davy pers. comm. 2013). One new locale in southwestern Ontario was discovered on private property in 2009 and the tiny subpopulation has been monitored since (Hopkins pers. comm. 2014).

Overall, although some new and historical sites have been confirmed in the Georgian Bay/Bruce/Greater Area region over the last 10 years, several subpopulations across the range have declined or have become historical despite recent search efforts. For further discussion on search efforts for Spotted Turtles in Ontario that produced positive results **[see POPULATION SIZES AND TRENDS - Abundance]** and for further discussion of search efforts at locales where the species is now considered extirpated **[see POPULATION SIZES AND TRENDS - Fluctuations and Trends]**.

HABITAT

Habitat Requirements

Spotted Turtles occur in high organic content wetlands with unpolluted shallow waters, soft substrates, and high amounts of aquatic and emergent vegetation including: ponds, acidic bogs, alkaline fens, Cattail/tussock marshes, shallow graminoid meadowmarsh, woodland streams, sheltered edges of shallow bays, and various swamp habitats including those dominated by Ash (*Fraxinus* sp.), Cedar (*Thuja* sp.), Maple (*Acer* sp.) and shrubs such as Buttonbush (*Cephalanthus occidentalis*), Dogwood (*Cornus* sp.), Meadowsweet (*Spiraea* sp.), Mountain Holly (*Nemopanthus mucronata*), Speckled Alder (*Alnus rugosa*), Sweet Gale (*Myrica gale*), and Winterberry (*Ilex verticillata*) (Ernst *et al.* 1994; Haxton and Berrill 1999; Litzgus and Brooks 2000; Gillingwater and Brooks 2001; Gillingwater and Piraino 2004; Enneson and Litzgus 2008; Ernst and Lovich 2009; Rasmussen and Litzgus 2010a; Crowley pers. comm. 2013; Gillingwater pers. comm. 2013; Blythe pers. comm. 2014; Hopkins pers. comm. 2014; OMNRF unpub. data). Sphagnum moss, grass and sedge tussocks, cattails, floating plants and mats of vegetation, and hydrophilic shrubs appear to be important components of aquatic habitats in northern populations (Joyal 1996; Barlow 1996; Litzgus and Brooks 2000; Gillingwater and Brooks 2001; Gillingwater and Piraino 2004; Rasmussen and Litzgus 2010a; Blythe pers. comm. 2014; Hopkins pers. comm. 2014). Individuals from an isolated subpopulation on a small island in Georgian Bay were observed using small rock pools devoid of vegetation for thermoregulation and/or feeding; a behaviour not known from any other subpopulation (Reeves and Litzgus 2008).

Spotted Turtles use a mosaic of habitat types, display distinct seasonal shifts in habitat use and may require terrestrial habitats during certain times of their seasonal activity cycle (Graham 1995; Haxton and Berrill 1999; Litzgus and Brooks 2000; Joyal *et al.* 2001; Beaudry *et al.* 2009; Rasmussen and Litzgus 2010a; Gillingwater unpub. data). In Maine, radio-tagged Spotted Turtles (N=40) used an average of 3.4 ± 2.14 SD unique wetlands per year (range 1-9; Beaudry *et al.* 2009). Individuality has been shown to play a role in microhabitat use (Rasmussen and Litzgus 2010a) and 90-99% of Spotted Turtle activity has been shown to occur within aquatic habitat (Yagi and Litzgus 2012). At least one study reports a marsh complex in which only juveniles were found (Riley *et al.* unpub. data), suggesting that there may be differences in habitat use between age classes.

Home Range

A recent study revealed that the home ranges of Spotted Turtle individuals contained more meadow marsh, open wetlands, woody wetlands and open uplands than were available within the entire range of the subpopulation; furthermore, meadow marsh habitat was both highly abundant and utilized within individual home ranges (Rasmussen and Litzgus 2010a). Within dredged wetlands or wetlands mined for peat, movements can be largely confined to pre-existing channels, or at least during low water years (Seburn 2003; Yagi and Litzgus 2012; Gillingwater unpub. data).

The reported minimum convex polygon (MCP) home range area for Spotted Turtles across the range generally falls between 0.2 to 10ha (Ernst 1970a; Wilson 1994; Graham 1995; Haxton and Berrill 1999; Litzgus 1996; Lewis and Faulhaber 1999; Milam and Melvin 2001; Gillingwater and Piraino 2004, 2007; Litzgus and Mousseau 2004b; Kaye *et al.* 2005; Smith *et al.* 2005; Dobbyn and Marchand 2007; Treanor 2007; Harms 2008; Rasmussen and Litzgus 2010a; Seburn 2012; Yagi and Litzgus 2012; Blythe pers. comm. 2014; Hopkins pers. comm. 2014). However, one study found that that home range size more than doubled with post-flooding conditions (i.e. greater preferred habitat availability) caused by Beaver (pre-flood: mean=3.2ha, max=8.8ha; post-flood: mean=7.1ha, max=15.5ha; Yagi and Litzgus 2012). Recent research in a relatively pristine wetland complex in Georgian Bay reported even larger home range sizes, with an average of 10 ± 3.98ha (N=16) and a maximum of 64ha (Riley *et al.* pers. comm. 2013), suggesting that seasonal migrations are influenced by availability of preferred habitat across the landscape. Spotted Turtles may migrate up to hundreds of metres among aquatic sites, and between aquatic and terrestrial sites (Ernst *et al.* 1994; Litzgus 1996; Beaudry *et al.* 2009).

Dobbyn and Marchand (2007) found that the MCP method actually produced the lowest average home range estimate (1.05ha) for 10 tracked turtles compared to the Jennrich-Turner method (J-T; mean 1.33ha) and the Kernel method (1.76ha). Furthermore, once home ranges were recalculated to only include preferred habitat types, the estimates were reduced by 18-31% (1.34ha Kernel; 1.13ha J-T; 0.87ha MCP). Mean home range area using Kaufmann's 1995 Quadrat Summation method for Georgian Bay Spotted Turtles was 2.30ha ± 0.74 for females (N=8) and 2.06ha ± 1.14 for males (N=5) (Litzgus 1996).

Reported annual home range lengths fall between 115 to 1680m (mean 155-330m; Haxton 1998; Lewis and Faulhaber 1999; Joyal *et al.* 2001; Milam and Melvin 2001; Seburn 2003, 2012; Gillingwater and Piraino 2007; Gillingwater unpub. data). Average daily movements are typically <30m (Ernst 1976; Litzgus 1996; Haxton 1998; Litzgus and Mousseau 2004; Rasmussen and Litzgus 2010a; Yagi and Litzgus 2012; Riley *et al.* unpub. data 2013; Gillingwater unpub. data); however, males searching for mates (Lovich 1990), and gravid females searching for nest sites (Litzgus 1996; Haxton and Berrill 1999) may move considerably further distances.

Significant differences in mean home range sizes between the sexes are reported in some studies (Haxton 1998; Haxton and Berrill 1999; Litzgus and Mousseau 2004; Riley *et al.* unpub. data) but not in others (Ernst 1970; Litzgus 1996; Seburn 2003, 2012; Gillingwater and Piraino 2007; Rasmussen and Litzgus 2010a; Yagi and Litzgus 2012). Two juveniles tracked in Georgian Bay displayed stark differences in home range size, 0.5ha versus 64ha (Riley *et al.* unpub. data).

Nesting Habitat

At the northern limit of its range, Spotted Turtles nest in areas exposed to full sunlight. One study reported that nest sites maintained 75-100% exposure to noon sun (Rasmussen and Litzgus 2010b). Nests may receive limited shade for a small portion of the day from adjacent tall vegetation or nearby trees (Gillingwater unpub. data). Nesting habitat includes: shallow soil under lichen, moss, and leaf litter on Canadian Shield rock outcrops (Haxton 1998; Litzgus and Brooks 1998a; 2000; Riley *et al.* unpub. data), mossy hummocks in flooded zones, open peat areas along drain banks, hayfield edges adjacent to wetlands (OMNRF unpub. data), muskrat lodges, mossy bases of grass tussocks within aquatic areas, and along the edges of ATV trails and dykes (Gillingwater and Brooks 2001; Gillingwater and Piraino 2004; Piraino and Gillingwater 2007). Nesting may occur within the right-of-way of roads (Riley *et al.* unpub. data). In the southern part of its North American range, the Spotted Turtle has also been reported to nest in marshy pastures, sphagnum mats and hummocks, root hummocks, decaying logs/stumps within swamps, and in various anthropogenic sites including lawns, gardens, paved road shoulders, young clearcuts (< 3 years old), horse pastures, powerline right-of-ways, and mowed fields (Joyal *et al.* 2001; Milam and Melvin 2001; Litzgus and Mousseau 2004; 2006; Ernst and Lovich 2009; Beaudry *et al.* 2010).

Females radio-tracked over two years (N=25) displayed stronger fidelity to nesting substrate (including gravel, sand, soil, sphagnum, and clay) than to nesting site (2 – 211 m away from previous locale; Rasmussen and Litzgus 2010b). Eggs are laid anywhere from 0 – 312 m from the nearest wetland (Joyal *et al.* 2001; Milam and Melvin 2001; Dobbyn and Marchand 2007; Beaudry *et al.* 2010; Rasmussen and Litzgus 2010a; Steen *et al.* 2012; Gillingwater unpub. data). One study reported that average nest temperatures (21.43 ± 0.45°C ± SE) did not differ significantly from substrate temperatures generally available in nesting habitat (21.24 ± 0.45°C; Rasmussen and Litzgus 2010b).

Aestivation (Summer Dormancy) Habitat

In some subpopulations, excursions are made to terrestrial habitats for summer dormancy (Graham 1995; Perillo 1997; Litzgus and Brooks 2000). In Georgian Bay, aestivation habitat was located in forests, sphagnum swamps, and on rock outcrops where turtles were found buried in sphagnum hummocks, or under leaves, branches, lichen, and especially under juniper bushes (Litzgus and Brooks 2000). At a southern Ontario bog, Spotted Turtles were found aestivating within damp soil at the bottom of drains, Sphagnum moss hummocks, or under Raspberry (*Rubus idaesus strigosus*), Blueberry (*Vaccinium corymbosum*), Leatherleaf (*Chamaedaphne calyculata*), and Cotton Grass (*Eriophorum vaginatum*) tussocks (Yagi and Litzgus 2012). At a southern Ontario marsh, aestivation occurred within shallow aquatic areas (8 - 50 cm in depth) including tussock marsh, flooded cattail stand, flooded sedge meadow, and dry sedge meadow with puddles; no terrestrial aestivation was observed (Gillingwater unpub. data). In the U.S., Spotted Turtles have also been observed aestivating in floating sphagnum mats (Beaudry *et al.* 2009); muskrat burrows or pools of running water (Ernst 1976, Kiviat 1978b); and in upland forest, grassland, flooded woodland and field edges where turtles bury terrestrially beneath leaves, grasses, ferns, branches or decaying vegetation (Ward *et al.* 1976; Creighton and Graham 1993; Graham 1995; Beaudry *et al.* 2009; Ernst and Lovich 2009).

Hibernation Habitat

Canadian Spotted Turtles utilize a variety of hibernation habitats including sphagnum swamps, shrub-dominated swamps or fens, rock outcrop caverns that extend into wetlands, moss and tree/shrub root hummocks, graminoid shallow or meadow marsh, cattail/tussock marsh, the edges of shallow dredged ponds and channels, drains in mined peatlands, and even roadside ditches or wetlands edges that occur within the road right-of-way (Litzgus *et al.* 1999; Seburn 2003; Dobbyn and Marchand 2007; Rasmussen and Litzgus 2010a; Yagi and Litzgus 2012; Blythe pers. comm. 2014; Hopkins pers. comm. 2014; Gillingwater unpub. data; Riley *et al.* unpub. data). Water depths at hibernacula range from 0 - 100 cm (Rasmussen and Litzgus 2010a; Blythe pers. comm. 2014; Hopkins pers. comm. 2014; Gillingwater unpub. data; OMNRF unpub. data). One study found Spotted Turtles chose hibernation sites that maintained some sort of structural protection (i.e., woody vegetation, vegetation mounds, muskrat burrows) and shallower water than was generally available (0 – 49 cm; Rasmussen and Litzgus 2010a).

Habitat Trends

Spotted Turtle habitat in Ontario has declined in quality and quantity due to various factors.

The Southern Ontario Wetland Conversion Analysis study reported that prior to European settlement (c. 1800), there were approximately 2 million ha of wetland in southern Ontario (25% of the total area); by 1967 only 637,020 ha remained (8% of the total area) and by 2002 this was furthered reduced to 560,000 ha (7% of the total area; Ducks Unlimited 2010). Overall, approximately 1.4 million ha or 72% of pre-settlement wetlands ≥10 ha in size were lost by 2002 (Ducks Unlimited 2010; **see Figure 4**). Most counties experienced losses of 45-85%; however, the counties of Essex, Kent, Lambton, Middlesex, Perth and Russell underwent losses of 89-98% (Ducks Unlimited 2010). Development was the significant factor in wetland loss within the Golden Horseshoe; however, beyond that region, agricultural lands, forest clearings, urban fields, and clearings for hydro and transportation right-of-ways were the primary land uses accounting for 94% of wetland loss in southern Ontario (Ducks Unlimited 2010).

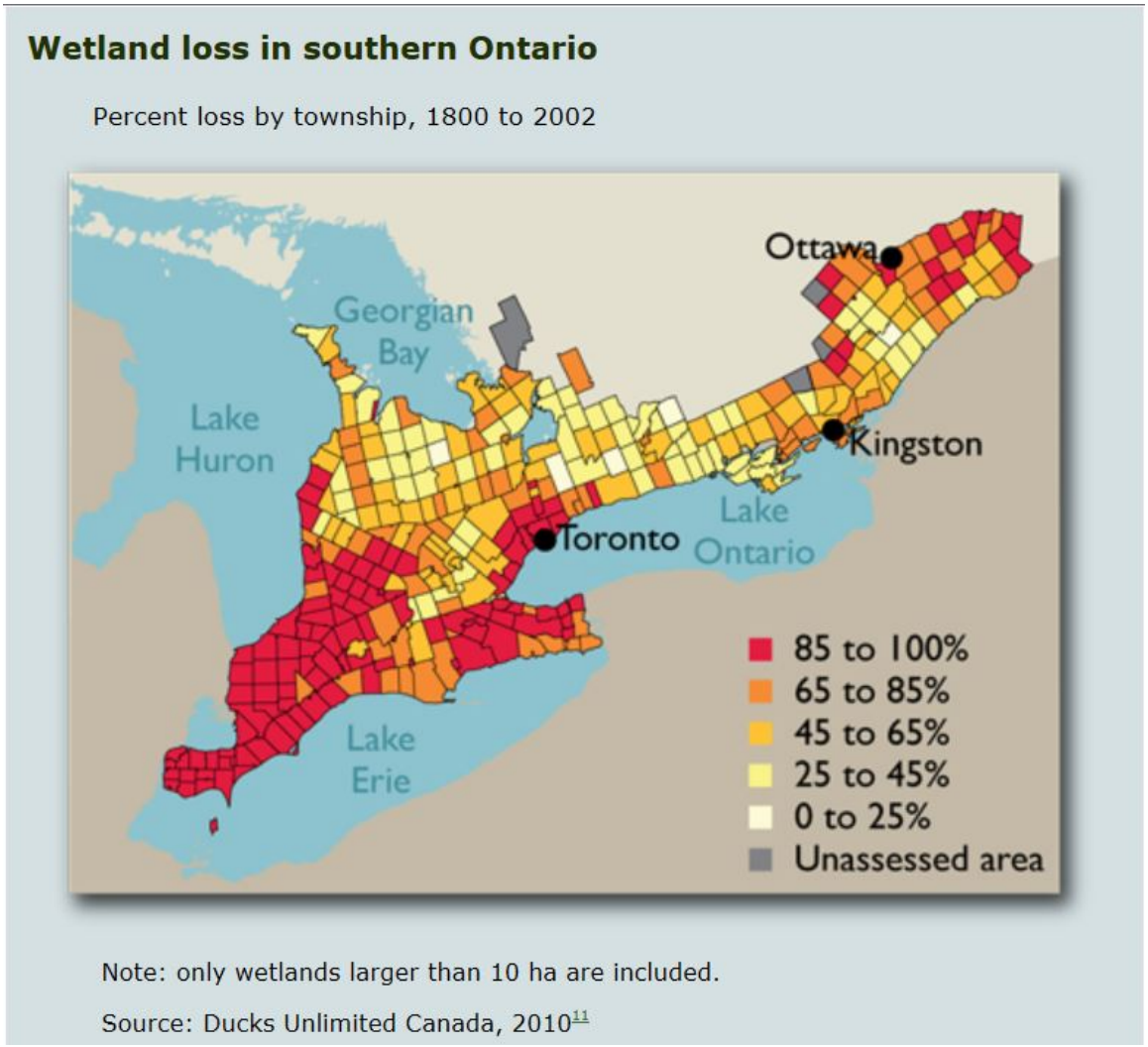

Figure 4. Wetland loss in southern Ontario (Ducks Unlimited Canada 2010).

The coastal wetlands of Georgian Bay have experienced incremental loss from agricultural encroachment and cottage development with >50% of the wetlands along the central coast, the western coast of the Bruce Peninsula and southern Georgian Bay affected (Environment Canada and Ontario Ministry of Natural Resources 2003). A study of wetland loss in Severn Sound in southern Georgian Bay indicated that wetland habitats have decreased by 16-68% in some areas since 1951 (Severn Sound Remedial Action Plan, 1993b). The main causes of wetland loss were shoreline modification, road construction, filling for urban and cottage development and dredging and channelization associated with marina development (Severn Sound Remedial Action Plan, 1993a). **See THREATS AND LIMITING FACTORS** for further discussion regarding declines in habitat quantity and quality.

BIOLOGY

The following section provides a discussion of the life cycle, reproduction, development, demography, diet, morality, interspecific interactions, physiology and dispersal abilities of Spotted Turtles. Over the last 10 years, since the last COSEWIC report, more information has been gathered on Ontario Spotted Turtles regarding reproductive success and fecundity, foraging ecology, movement patterns, thermoregulatory preferences, and micro-habitat features of hibernacula.

Life Cycle and Reproduction

Breeding Habits and Reproductive Schedule

Spotted Turtles aggregate in aquatic habitats in early spring to mate (Ernst 1967; Perillo 1997; Litzgus and Brooks 1998a; A.Yagi, pers. comm. 2003; Gillingwater unpub. data), and tend to show fidelity to breeding sites (Litzgus *et al.* 1999; Litzgus and Brooks 2000; Piraino and Gillingwater 2005). In a Georgian Bay subpopulation, the same 10-15 adults returned in May to a single beaver pond for more than 20 years, presumably to mate (Bird unpub. data; Oldham unpub. data; Litzgus unpub. data).

Nesting takes place from late May to late June (Litzgus and Brooks 2000; Rasmussen and Litzgus 2010b; Gillingwater and Piraino 2004) and is primarily nocturnal with most reports of nest construction starting between 1700 and 2300 hrs (Logier 1939; Rhodes pers. comm. 1981; Chippindale 1989; Litzgus and Brooks 1998a; Gillingwater and Piraino 2004; Gillingwater unpub. data); however, females will also nest on warm overcast afternoons during rain events (Gillingwater and Piraino 2004). Females may disperse outside their regular home range to oviposit (Ernst 1970; Wilson 1994), making upland travels of 0-900 m and spending up to 9 days on land before returning to wetland habitat (Beaudry *et al.* 2010).

Egg incubation is at least 72 days in the wild (Gillingwater unpub. data) with up to 108 days recorded for a couple of nests at a southwestern Ontario marsh (Dobbyn and Marchand 2007). In Ontario, hatchling emergence occurs between early September and late October (Dobbyn and Marchand 2007; Gillingwater unpub. data; OMNRF unpub. data; Rasmussen unpub. data), though neonates may overwinter in the nest chamber and emerge the following spring (Ernst and Lovich 2009; Gillingwater unpub. data).

Fecundity and Reproductive Success

Spotted Turtles have low reproductive output. Clutch sizes for northern Spotted Turtles range from 1-7 eggs, with a mean of 4-5 eggs (Litzgus and Brooks 1998a; Gillingwater and Piraino 2004; Enneson and Litzgus 2008; Rasmussen and Litzgus 2010b; Gillingwater unpub. data; OMNRF unpub. data). An average of 58% of adult female Spotted Turtles were judged to be gravid in June of each year of a 4-year study in Georgian Bay (Litzgus and Brooks 1998a). Most females in Georgian Bay and Bruce County do not oviposit every year (Litzgus and Brooks 1998a; Enneson and Litzgus 2008; Rasmussen and Litzgus 2010b), and some do not produce eggs for at least three consecutive years (Litzgus and Brooks 1998a); however, females in southwestern Ontario often nest annually or biannually (Rasmussen and Litzgus 2010b; OMNRF unpub. data). A female in Bruce County reportedly double-clutched within a season, producing a clutch of three eggs followed by a clutch of two eggs two weeks later; the second clutch did not develop (Rasmussen and Litzgus 2010b).

Adult females in better body condition (i.e. non-gravid body mass relative to carapace length) have been shown to produce more eggs through greater frequency of reproduction (Rasmussen and Litzgus 2010b). Spotted Turtles at the northern limit of their range are larger and have larger clutch sizes, but reproduce less frequently than their southern U.S. counterparts (Litzgus and Mousseau 2003, 2006; Rasmussen and Litzgus 2010b). Thus, northern Spotted Turtles are faced with a larger loss of reproductive output for each failed nest (Rasmussen and Litzgus 2010b). Reported Spotted Turtle nest success rates range from 27-33% (N = 6 - 11; Beaudry *et al.* 2010; Rasmussen and Litzgus 2010b). A stage-classified matrix model, based on average nest survivorship data collected from across the North American range, estimated that average egg survivorship for this species is 55% (Enneson and Litzgus 2008).

Longevity and Development

In Ontario, sexual maturity is delayed until turtles are 11 to 15 years old and > 10 cm straight carapace length (SCL) (Litzgus and Brooks 1998b). The longevity of wild Spotted Turtles is unknown but some individuals in a Georgian Bay subpopulation were >44 years (Litzgus unpub. data). Maximum longevity in a Georgian Bay subpopulation was estimated to be 110 years for females based on a minimum adult female survivorship of 96.5% and 65 years for males based on minimum adult male survivorship of 94.2%, calculated from 24 years of mark-recapture data (Litzgus 2006). Generation Time is estimated at 40.6 years [IUCN 2011 Guidelines: Gen Time = age of maturity + 1/mortality rate] based on age of maturity of 12 years (Litzgus 1998) and a calculated mortality rate of 0.035 based on annual adult female survivorship of 0.965 (Enneson and Litzgus 2008).

Spotted Turtle body size varies across the species' range with the largest turtles occurring in the northern (45°N latitude) and the smallest turtles occurring near the north-central part of the range (39°N latitude; Litzgus *et al.* 2004). This drop in body size near 39° N latitude likely represents a "transition zone" where there is a tradeoff between growth and reproductive output, with turtles north of this zone producing fewer clutches per year and thereby allotting more resources to growth (Litzgus *et al.* 2004). In southwestern Ontario, the average size of adults (N = > 300 capture events) was 108mm SCL (range 93-122mm; Gillingwater unpub. data). An adult female from a southeastern Ontario subpopulation reportedly attained an SCL of 143mm (Haxton 1998).

Population Structure and Demographics

Some Ontario studies reported equal sex ratios (Litzgus 1996; Gillingwater and Brooks 2001; Seburn 2006; Yagi and Litzgus 2012; Rasmussen unpub. data), others reported skewed sex ratios in favour of females (Haxton 1998 [1 M:1.9 F]; Seburn 2003 [1M: 3.5F]; Seburn 2011 [1 M: 2.75 F]; Reeves and Litzgus 2008 [1 M: 3.8 F]), and at least one subpopulation maintains a skewed ratio in favour of males (Saumure 1995 [2.5 M:1 F]; Gillingwater and Piraino 2007 [mean 1.5M:1F]). The latter subpopulation is heavily impacted by road mortality (Gillingwater and Piraino 2007) and thus this skewed ratio in favour of males may reflect a greater loss of adult females during movements in search of nesting habitat.

Of 12 Ontario subpopulations sampled for at least two years, three subpopulations appear to maintain large percentages of juveniles (30-50%; Reeves and Litzgus 2008; Seburn 2011; Davy unpub. data; Riley *et al.* unpub. data); three appear to maintain moderate percentages of juveniles (15 - 25%; Seburn 2003; Davy unpub. data; Rasmussen unpub. data); four appear to maintain low percentages of juveniles (5 - 11%; Seburn 2006; Litzgus 2012; Davy unpub. data; Gillingwater unpub. data); and one appears to maintain a very low percentage of juveniles (< 2%; Davy unpub. data; Gillingwater unpub. data). However, these differences in juvenile abundances across subpopulations may be more reflective of greater dispersal of individuals through larger habitats than of actual subpopulation demography, as the largest percentages of juveniles are generally reported from the smallest sites (< 25 ha), while smaller percentages are reported from larger sites

(> 100 ha). Although, one study (Riley *et al.* unpub. data) reported a large percentage of juveniles (33%) from an expansive site (4700 ha), this may result from finding of a “nursery habitat” that was used solely by juveniles.

Feeding and Diet

Spotted Turtle foraging events were recorded at water temperatures ranging from 7.7 - 31.7°C and water depths from 2 - 40cm (Rasmussen *et al.* 2009). Foraging observations (n=227) were composed of 74% aquatic invertebrates (snails 37.2%, Trichoptera 11.6%, Leech 2.3%, Crayfish 2.3%, unidentified 20.9%), 2.3% vegetation, 2.3% tadpoles, and ~16% carrion (Rainbow Trout, Carp, Minnows, Leopard Frog). Food items reported for U.S. Spotted Turtles include algae, cranberries, earthworms, aquatic insect larvae, small crustaceans, snails, tadpoles, salamanders, and carrion from fish and birds (Ernst *et al.* 1994).

Aestivation (Summer Dormancy) Behaviour

Some individuals in some subpopulations avoid the hot, dry, and desiccating conditions of summer by aestivating in either aquatic or terrestrial habitats. Summer dormancy may be a more appropriate term than aestivation for this behaviour as not all turtles become inactive in summer and for those that do, activity becomes reduced, rather than ceased (Litzgus and Brooks 2000; Rasmussen and Litzgus 2010a; Gillingwater unpub. data). This reduced activity period may occur from late June through to early September (Litzgus and Brooks 2000; Gillingwater unpub. data) and even into late October (Yagi and Litzgus 2012), and may last several days or weeks (range 2 - 100 days; Ward *et al.* 1976; Graham 1995; Joyal *et al.* 2001; Gillingwater and Piraino 2004; Yagi and Litzgus 2012; Gillingwater unpub. data). During July and August in Georgian Bay, Spotted Turtles spent approximately half their time buried and the other half active (Litzgus and Brooks 2000). In southwestern Ontario, 78% of tracked individuals (n = 9) entered reduced activity periods during the post-nesting season for a period of 9 - 43 days with average daily movements between 0 - 0.5 m; maximum 1.75 m (Gillingwater and Piraino 2004). Yagi and Litzgus (2012) found that the majority of their radio-tagged individuals did not aestivate when suitable aquatic habitat (i.e. shallow flooded zones < 40 cm) remained throughout the active season, suggesting that the behaviour is closely tied to the availability of preferred habitat.

Hibernation Behaviour

Hibernation in Ontario lasts 6 - 7 months (Litzgus *et al.* 1999; Haxton and Berrill 2001; Rasmussen and Litzgus 2010a; Gillingwater unpub. data). Emergence from hibernation in Canadian subpopulations occurs from late March to late April with dispersal from hibernacula occurring from early to late April (Haxton and Berrill 1999; Litzgus *et al.* 1999; Litzgus and Brooks 2000; Seburn pers. comm. 2003; Gillingwater unpub. data). Spotted Turtles move back to hibernation areas in late summer to late fall and enter hibernacula between mid-September and mid-November, where they remain until the following spring (Litzgus *et al.* 1999; Litzgus and Brooks 2000; Blythe pers. comm. 2014; Gillingwater

unpub. data). Timing differences in these behaviours are dependent on latitude, with southwestern Ontario subpopulations arriving at hibernacula up to a month later, and leaving hibernacula up to a month earlier, than more northerly subpopulations.

Spotted Turtles often hibernate communally (Behler 1996; Lewis and Ritzenthalter 1997; Perillo 1997; Haxton and Berrill 1999; Litzgus *et al.* 1999; Seburn 2003; Lewis *et al.* 2004; Rasmussen and Litzgus 2010a; Blythe pers. comm. 2014; Hopkins pers. comm. 2014; Gillingwater unpub. data) and as many as 16 - 34 individuals have been observed using a single den (Lewis *et al.* 2004; Rasmussen and Litzgus 2010a); however, they also hibernate singly. One study reported that 66% of Spotted Turtle tracking events to hibernacula were to individual dens (Gillingwater unpub. data). Therefore, the presence of a communal hibernaculum within a wetland does not necessarily preclude the existence of several additional hibernacula occupied by lone individuals scattered discretely throughout the same wetland. In Ontario, Spotted Turtles have also been observed to occasionally share hibernacula with Blanding's Turtles (Blythe pers. comm. 2014; Gillingwater unpub. data).

Spotted Turtles often show fidelity to hibernation areas (Litzgus *et al.* 1999; Seburn 2003; Rasmussen and Litzgus 2010a; Blythe pers. comm. 2014; Gillingwater unpub. data); however, individuals may also choose hibernacula that differ in habitat and locality between years (distances apart ranged from 50 - 490 m; Rasmussen and Litzgus 2010a; Gillingwater unpub. data). One study reported that 55% of Spotted Turtle tracking events to hibernacula were within 20 m of the previous year's den site and 44% were within 10 m (Gillingwater unpub. data). Another study reported that 56% were within 10 m and 39% were within 1 m (Rasmussen and Litzgus 2010a). Spotted Turtles may hibernate in the same areas and habitat types used for summer activity, making no significant movements towards hibernacula (Dobbyn and Marchand 2007; Gillingwater unpub. data); however, they may also hibernate outside their summer range (Seburn 2003; Gillingwater unpub. data).

Mortality

Known predators of adult Spotted Turtles include Raccoon (*Procyon lotor*), Striped Skunk (*Mephitis mephitis*), Red Fox (*Vulpes vulpes*), Coyote (*Canis latrans*), River Otter (*Lontra canadensis*), American Mink (*Mustela vison*), Black Bear (*Ursus americanus*), and Bald Eagle (*Haliaeetus leucocephalus*) (Ernst *et al.* 1994; Litzgus 1996; Gillingwater and Brooks 2001; Gillingwater and Piraino 2004; 2007). Predators of both Spotted Turtle eggs and hatchlings include Raccoon, Red Fox, Coyote, Striped Skunk, and ants (Formicidae) (Litzgus 1996). Other predators of hatchlings include Green Frogs (*Lithobates clamitans*; DeGraaf and Nein 2010), Snapping Turtles (*Chelydra serpentina*), Muskrats (*Ondatra zibethicus*), Watersnakes (*Nerodia sipedon*), crows (*Corvus* sp.) and large wading birds (Ernst and Lovich 2009). Litzgus and Mousseau (2006) report possible nest predation by a snake (likely *Pantherophis vulpinus*) as there was a smooth tunnel that entered through the nest cage (installed by researchers) and into the nest cavity where the eggs were consumed whole.

It is not unusual to find a relatively large proportion of the adults in Spotted Turtle subpopulations with injuries in the form of missing limbs, stubbed tails, and deep scratches in the shell. Reported rates of predator-related injuries for various Spotted Turtle subpopulations range from 13.5-50% (Ernst 1976; Lovich 1989; Litzgus 1996; Gillingwater and Brooks 2001; Gillingwater and Piraino 2004; Harms 2008; Reeves and Litzgus 2008; Rasmussen pers. comm. 2013). One study reported finding 16 dead adults in one field season during mark-recapture surveys; the causes of death included road mortality (N=7), unknown causes of death (N=7), Mink depredation (N=1), and mortality during hibernation (N=1; Gillingwater and Piraino 2007; Gillingwater unpub. data). This study also reported a 27% mortality rate for turtles that were radio-tracked from one to four seasons (N=18). Causes of death included road mortality (N=2), Mink depredation (N=1), mortality during hibernation (N=1), and unknown causes of death (N=1). A radio-telemetry study in a Beaver-influenced wetland reported a 57% mortality rate for turtles tracked for six years during pre-flooding conditions (N=7) and 0% for turtles tracked for two seasons during post-flooding conditions (N=12), which increased the area of preferred shallow aquatic habitat (Yagi and Litzgus 2012).

Northern Spotted Turtles are particularly susceptible to predation after the long (6-8 months) hibernation period. Limited oxygen uptake causes lactic acid buildup in the body tissues; the acid imbalance and cold temperatures cause turtles to be extremely lethargic and less capable of defence from predators. In the Georgian Bay subpopulation, recently injured and dead turtles were most often found in late fall and early spring, near hibernacula (Litzgus unpub. data). One study found at least five freshly killed adult females in a very small area (~30m^2) in the early spring (Rasmussen pers. comm. 2013). Overwintering mortality has been reported (Gillingwater and Piraino 2007; Blythe pers. comm. 2014; OMNRF unpub. data) and may be attributable to anoxic or freezing conditions within the hibernacula; one current study reports an ongoing overwintering mortality rate of 1-2 dead turtles/year since 1999 (OMNRF unpub. data).

Models based on over 24 years of mark-recapture data from a Georgian Bay subpopulation produced the following minimal annual survivorship estimates for Spotted Turtles: 96.5% for adult females, 94.2% for adult males (Litzgus 2006; Enneson and Litzgus 2008) and 82% for juveniles (Enneson and Litzgus 2008); annual adult recruitment (i.e., % of juveniles that turn into adults each year) was very low at only 2.2% (Enneson and Litzgus 2008). See **THREATS AND LIMITING FACTORS** for further discussion regarding anthropogenic causes of Spotted Turtle mortality.

Physiology and Adaptability

Life-history Strategy

Spotted Turtles, like other turtle species, have been called “bet-hedgers”. This life history strategy involves high egg and juvenile mortality, iteroparity (repeated reproductive events over the lifespan), low adult mortality, and a long life. Turtle subpopulations can sustain years of low juvenile recruitment as long as reproducing adults are not lost to death or overharvesting (Stearns 1976; Roff 1992). Sensitivity analysis of life table parameters indicated that Spotted Turtle subpopulation viability is highly dependent upon adult survivorship (Litzgus unpub. data). These life history attributes make turtle subpopulations susceptible to decline and extirpation when as little as 1-3% of reproducing adults are lost from subpopulations (Doroff and Keith 1990; Brooks *et al.* 1991; Congdon *et al.* 1993; 1994; Gibbs and Shriver 2002; Enneson and Litzgus 2008).

Thermoregulation and Basking Behaviour

Spotted Turtles are often the first among syntopic turtles to emerge from hibernation, usually emerging as soon as snow cover melts (Ernst 1982), and are most active in the cool, early spring (Ward *et al.* 1976; Lovich 1988; Litzgus and Brooks 2000). The normal activity range is 3 to 32°C, and activity can occur at water temperatures as low as 1 to 5°C (Ernst 1982; Litzgus *et al.* 1999). The critical thermal maximum for this species is approximately 42°C (Hutchison *et al.* 1966).

The preferred body temperature of Spotted Turtles tested under laboratory conditions ranged from 20-26°C (Yagi and Litzgus 2013). Tracked turtles (N=16) in a southwestern Ontario bog, however, were only found to be within the preferred body temperature range 28% of the time throughout the active season (March to October) and up to 67% of the time during July to August (Yagi and Litzgus 2013). During the fall, both habitat and body temperatures deviated far from the preferred body temperature range, suggesting a seasonal shift in Spotted Turtle thermal preferences possibly to reduce metabolism during periods of limited resources and temperatures (Yagi and Litzgus 2013). Prior to beaver flooding at this bog site, drains were the only available aquatic habitat, yet they provided the lowest thermal quality. On the other hand, shallow flooded zone habitat created by beaver damming was found to have the highest thermal quality and provided Spotted Turtles with greater preferable thermal opportunities (Yagi and Litzgus 2013).

Temperature-dependent Sex Determination

The sex of developing embryos is dependent upon temperature during incubation (temperature-dependent sex determination or TSD). Females are produced at temperatures of 30°C and higher, whereas males are produced at temperatures below 27°C (Ewert and Nelson 1991). For species whose sex is determined by temperature during embryonic development, including the Spotted Turtle, some researchers have claimed that global climate change may deleteriously impact subpopulation sex ratios (Janzen 1994a).

Aestivation

In Pennsylvania, Spotted Turtles became inactive when water temperatures reached 30°C (Ernst 1982). In southwestern Ontario, aestivation may occur from mid-June to late September or October (Yagi and Litzgus 2012; Gillingwater unpub. data) at water temperatures as cool as 15°C (Gillingwater unpub. data). Some researchers found that most aestivating turtles chose terrestrial sites that were not cooler than ambient temperatures and it was unknown whether metabolic depression (a characteristic of true aestivation) accompanied the inactivity (Litzgus and Brooks 2000; Haxton and Berrill 2001). The average body temperature for aestivating turtles in Georgian Bay was 21.8°C (Litzgus and Brooks 2000). Yagi and Litzgus (2012) found that the behaviour occurred significantly less during post-flooding conditions when thermally preferable habitat (shallow flooded zones < 40 cm that maintained temperatures within the preferred body temperature range of 20-26°C) was more greatly available.

Hibernation

Spotted Turtles survive the extreme environmental conditions of the northern winter by hibernating in sites that do not freeze and that maintain temperatures close to 0°C (Litzgus *et al.* 1999; Rasmussen and Litzgus 2010a; Hopkins pers. comm. 2014; OMNRF unpub. data). Spotted Turtles in Georgian Bay entered hibernacula when body temperatures were between 12 and 16°C (mean 9.5°C) and exited hibernacula when ambient temperatures ranged between 1 and 5°C (Litzgus *et al.* 1999; Litzgus and Brooks 2000). In southwestern Ontario, Spotted Turtles began migration away from the hibernation area once water temperatures rose above 5°C (Gillingwater unpub. data).

Despite fluctuations of 37°C over a 5-day period during the coldest part of the winter, a Spotted Turtle outfitted with a datalogger in a hibernaculum maintained a remarkably stable body temperature between 1 and 2°C (Litzgus *et al.* 1999). At a partially mined peatland, Spotted Turtles selected open drains for hibernation likely because they provided greater temperature stability over natural habitats (i.e. shallow flooded zones), suggesting different habitats provide higher thermal quality at different times of year (Yagi and Litzgus 2013).

Spotted Turtles appear to be tolerant of low oxygen levels in water during hibernation. Reported dissolved oxygen concentrations at hibernacula range from 1.0 to 118 mg/L (Litzgus *et al.* 1999; Rasmussen and Litzgus 2010a; Hopkins pers. comm. 2014; OMNRF unpub. data). It is believed that Spotted Turtles may hibernate near the ice surface where dissolved oxygen is highest but water temperatures are lowest (near 0°C; OMNRF unpub. data).

Dispersal and Migration

The recognized separation distances (i.e. distances over which a species would not normally travel and which are based on typical movements or home ranges for the species) for Spotted Turtle are 2km in areas of unsuitable habitat and 3km in areas of suitable

habitat (NatureServe 2014). Therefore, dispersal of individuals cannot create links between isolated populations.

According to IUCN (2014) “a taxon can be considered severely fragmented if most (>50%) of its total area of occupancy is in habitat patches that are (1) smaller than would be required to support a viable population, and (2) separated from other habitat patches by a large distance”. Given that approximately 80% of the current mean estimated Canadian population occurs in southwestern and southeastern Ontario in small isolated habitat patches that are mostly separated by distances >10km (several times greater than the average dispersal distance of 2-3km for this species), the Spotted Turtle seems to meet the criterion for “severe fragmentation”; however, this may need to be re-evaluated if more subpopulations are discovered in the Georgian Bay region where large contiguous habitats remain.

Interspecific Interactions

Spotted Turtles seems to share a positive relationship with both Beaver (*Castor canadensis*) and Muskrat (*Ondatra zibethicus*). Beaver dams can create shallow flooded zones (“Beaver meadows”) and thereby increase the water surface area of Spotted Turtle preferred habitat (Yagi and Litzgus 2012; Yagi *et al.* 2012). In turn, the greater availability of preferred habitat allows individuals to increase mobility (daily movements and home range size) and acquire more energy reserves through remaining active longer and spending greater time feeding (Yagi and Litzgus 2012). Controls put on the height of beaver dams by landowners has led to drought conditions and fires resulting in Spotted Turtle mortality (A. Yagi pers. comm. 2013). However, one study reported a negative effect on Spotted Turtle from Beaver flooding when water levels became *too* deep (>140cm) causing vegetation type to change and leading to Spotted Turtle disappearance from the area (Litzgus 2012).

Muskrat lodges and mounds provide nesting and basking habitat while the shallow channels and areas of cleared emergent vegetation created by this aquatic mammal provide movement corridors for various turtle species, including Spotted Turtles (Gillingwater unpub. data). Muskrat burrows also provide potential hibernation habitat for Spotted Turtles (Rasmussen and Litzgus 2010a). Thus, it is likely that Beaver lodges and channels also provide nesting, basking, movement, and hibernation opportunities for Spotted Turtles. Hunting or removal of these mammals from wetlands is likely to have a negative impact on Species at Risk turtles such as the Spotted Turtle, through the removal of important habitat features for movement, reproduction, thermoregulation, and overwintering (Gillingwater 2013).

Leech species known to parasitize the Spotted Turtle include: *Placobdella parasitica, P. ornata, Helobdella stagnalis, Desserobdella phalera,* and *Alboglossiphonia heteroclita* (Saumure 1995; Davy *et al.* 2009).

See **BIOLOGY - Feeding and Diet** for a list of species that Spotted Turtle prey upon and see **BIOLOGY- Mortality** for a list of species that prey upon Spotted Turtles.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Mark-recapture studies have been conducted on several Spotted Turtle subpopulations across the Ontario range. Over 30 years of mark-recapture data have been collected from a mainland Georgian Bay subpopulation since 1977 (Bird unpub. data; Oldham unpub. data; Litzgus 2012; Oldham pers. comm. 2014). Between 1 - 8 years of sampling efforts have been conducted for a variety of other subpopulations within the Georgian Bay/Bruce greater area (Reeves and Litzgus 2008; Rasmussen and Litzgus 2010a; Davy and Murphy 2011; Crowley unpub. data; Parks Canada unpub. data; Rasmussen unpub. data; Riley *et al.* unpub. data; Morin *et al.* unpub. data; Urquhart unpub. data).

In southwestern Ontario, 10-15 years of sampling efforts have been conducted at three locales (Saumure 1995; Gillingwater and Brooks 2001; Gillingwater and Piraino 2004, 2007; Piraino and Gillingwater 2005, 2006; Yagi and Litzgus 2012; Davy 2013; Gillingwater unpub. data; OMNRF unpub. data); while 3-6 years of sampling efforts have been conducted at two other locales (Davy 2013; Hopkins pers. comm. 2014).

In southeastern Ontario, one site has been monitored for 17 years since 1983 (Chippindale 1984; Seburn 2003) while 2 - 10 years of sampling efforts have been conducted at six other wetlands maintaining small subpopulations (Haxton 1998; Seburn 2006, 2011; Davy 2013; Blythe pers. comm. 2014; OMNRF unpub. data).

Abundance

The total number of Spotted Turtles in Canada is not known for certain; however, the above sampling efforts provide a mean estimate of ~1840 mature adults from *sampled* sites alone (range ~1700 - 2100; ~220 throughout southeastern Ontario; ~1170 throughout southwestern Ontario; ~450 throughout the Georgian Bay/Bruce greater area). It is doubtful that many more undiscovered subpopulations occur in southern Ontario; however, there are likely some undiscovered subpopulations throughout central Ontario due to the presence of extensive suitable habitat and the lack of survey efforts in remote areas. Furthermore, there are 10 First Nations' communities throughout Ontario that maintain recent records of this species but for which abundances have not been provided (Lickers pers. comm. 2013). Lastly, several historical and extant sites have had limited sampling efforts. That being said, it is doubtful that thousands more Spotted Turtles occur in Ontario for a variety of reasons:

1) A lack of intensive survey efforts at most sites does not necessarily suggest that much larger subpopulations will be revealed with greater survey efforts. For instance, although a Georgian Bay subpopulation occurring in a large, remote and pristine environment has been surveyed for over 30 years since 1977 (making it the most intensively surveyed site in all of Canada with ~1700 person-days of search effort) it does not maintain the largest known subpopulation (in fact, it does not even make the top three of the largest known subpopulations and it has suffered a marked and continuing decline in recent years despite low exposure to anthropogenic threats **[see POPULATION SIZES AND TRENDS - Fluctuations and Trends].**

2) Although large remote areas of central Ontario have not been surveyed for this species, it is unlikely that thousands of Spotted Turtles occur through this region given that densities appear to be much lower at the more northerly latitudes; reported densities ranged from 0.1 to 0.6 turtles/ha in central Ontario (Litzgus 1996; Haxton 1998; Seburn 2003; Blythe pers. comm. 2014) versus 1-12 turtles/ha in southwestern Ontario (Davy 2013; Gillingwater unpub. data; OMNRF unpub. data).

3) Many historical sites occur throughout southwestern Ontario where little habitat remains. Therefore, it seems reasonable to assume that few, if any, turtles still occur at some of these sites. For example, surveys conducted in the early 2000s at nine historical sites in the region found no turtles and in some cases, no habitat remaining (Gillingwater and Piraino 2002). Even intensive surveys (~7000 person-hours over 6 years) at a newly discovered extant site only found 6 turtles (Hopkins pers. comm. 2014), suggesting that small habitat patches in the agricultural southwest have limited potential to support populations.

4) Even large patches of suitable habitat (355-3650ha) in protected areas in southwestern Ontario seem to maintain none or small numbers of Spotted Turtles despite large survey efforts over multiple years (Browne 2003; Gillingwater and Piraino 2004; Gillingwater and Piraino 2007; McKenzie *et al.* 2014).

Overall, a reasonable estimate for the total Canadian population size likely lies somewhere between 2000-3000 adults (Endangered for Criterion C) given the above considerations. This estimate is 1000 individuals larger than the previous estimate in order to specifically account for the likelihood of unknown subpopulations and/or larger subpopulations at sites with low or no sampling efforts. Caution should be exercised in assuming a Canadian population size larger than 3000 given the evidence of decline in many subpopulations across the range **[see POPULATION SIZES AND TRENDS - Fluctuations and Trends].**

Fluctuations and Trends

The Natural Heritage Information Centre (NHIC) currently recognizes 109 sites for Spotted Turtles in Ontario (Oldham pers. comm. 2014). Most sites are based on one to a few incidental sightings. Of the 109 sites, only 25 (~23%) are currently known to be extant, while three (~3%) are considered extirpated and 81 (~74%) are considered historical (i.e. no records in at least 20 years). Often, a historical rank is more indicative of a lack of survey effort by experienced observers at the right time of year, rather than of extirpation at these sites, especially in areas where suitable habitat still exists (Oldham pers. comm. 2014). However, the significant rise in the number of historical sites since the last status assessment (from 32 to 81) is definitely noteworthy (especially given the number of new studies on the species since the previous report) and identifies an important need for dedicated surveys at these sites to ground-truth whether real decline has actually occurred. The small increases in the number of sites (104 to 109) since the last status assessment are considered negligible (Oldham pers. comm. 2013) and are likely the result of greater search effort since the up-listing of the Spotted Turtle to Endangered in 2004 (Litzgus pers. comm. 2014). It is difficult to discuss trends in Spotted Turtle sites without knowing how many historical or extirpated sites have been searched (Oldham pers. comm. 2013).

In southwestern Ontario in the late 1800s and early 1900s, the Spotted Turtle was considered common (Garnier 1881; Nash 1906; Patch 1919; Logier 1939; Mills 1948). By the 1960s and 1970s, Spotted Turtles were included in accounts of rare or endangered Ontario reptiles (Oldham 1991). The species appears to remain abundant in only a few localized pockets in Ontario and appears to be extirpated from Cedar Creek (Oldham pers. comm. 2014), the Ingersoll area (Oldham pers. comm. 2014), Toronto area (Oldham pers. comm. 2014), MacGregor Point Provincial Park (Marks pers. comm. 2014), Point Pelee National Park (Browne and Hecnar 2002; McKay pers. comm. 2003) and Pelee Island (Porchuk pers. comm. 2003).

According to Park naturalists, at the time that MacGregor Point Provincial Park opened in the late 1970s, there was a healthy subpopulation of a few hundred Spotted Turtles; however, the subpopulation was quickly decimated within the first few years of Park operations. The rapid decline was attributable to loss of habitat associated with the infilling and draining of wetlands to create campgrounds and to prevent the flooding of access roads. More than a decade of intensive spring surveys (up to 2800 person-hours/year) found only six individuals which were recaptured 6-7 times each; four of these individuals were eventually found predated by Raccoons. The species is now considered extirpated from the Park (Marks pers. comm. 2014).

Field surveys at Point Pelee National Park (Patch 1919) in 1913 indicated that the Spotted Turtle was once as common as the Midland Painted Turtle (*Chrysemys picta marginata*); however, a thorough two year mark-recapture survey of turtles in in 2001-2002 failed to locate any Spotted Turtles and the species is now considered extirpated from the Park (Browne and Hecnar 2002; McKay pers. comm. 2003). Likely causes of decline include extensive drainage of swamp and marsh habitat for agriculture from the late 1800s to early 1900s, increased poaching and road mortality from large numbers of visitors to the Park (up to 500,000 annually) and high concentrations of DDT in the soils (Browne 2003).

Historically, Pelee Island consisted of 4-5 separate rocky outcrops surrounding a large interior marsh (Forbes *et al.* 1999; OFO News 2010). In the 1880s, a large-scale project was initiated to drain "Big Marsh", through the construction of a series of dikes, canals and pumping stations around the wetland, in order to create rich farmland and consolidate the "islands" into one (Forbes *et al.* 1999; OFO News 2010). The extensive destruction of wetland habitat has likely resulted in the extirpation of this species from the island. Indeed, no Spotted Turtles have been observed on the island since 1991 (Porchuck pers. comm. 2003).

Two current long-term studies both report significant declines in subpopulations (Litzgus 2012; Gillingwater unpub. data). At a site in Georgian Bay, an unidentified event between 1999 and 2000 caused the mean number of turtle captures during spring surveys to decline by ~50%; this reduced capture rate has remained consistent over the last 14 years (Litzgus 2012). Possible explanations for the decline include poaching, mass mortality during hibernation and dispersal due to sudden habitat change (Litzgus 2012). The most likely of those explanations seems to be sudden habitat change due to Beaver flooding which doubled the water depth and subsequently changed the vegetation and turtle community in one of the main breeding demes (Litzgus 2012). Most of the missing Spotted Turtles have not been found in other breeding demes at the site and there has been no increase in the amount of captures at the closest breeding deme, suggesting that if turtles dispersed from the wetland, many of them died during emigration (Litzgus 2012). This significant decline is especially worrisome considering that it occurred at a relatively pristine site with little human interference. A simple stochastic model for this population projected a high probability of extinction (60%) in 100 years despite the relatively pristine nature of the site and the absence of anthropogenic causes of mortality (Enneson and Litzgus 2009). A metapopulation model reduced the probability of extinction to 18%, suggesting that dispersal between breeding wetlands, including the one flooded by Beaver in 2000, is important for population persistence (Enneson and Litzgus 2009).

A significant decline has also been noted at a southwestern Ontario marsh where a one-day survey conducted from the edge of the wetland in late March of 1989 observed 198 basking Spotted Turtles (NHIC unpub. data). However, much more intensive surveys from 2003-2013 (conducted on foot, by 2-4 surveyors/day, throughout the marsh interior, several days a week from April to May, over a much larger search area) at the same site only found a maximum of 23 turtles/day (Gillingwater unpub. data). Furthermore, spring captures of Spotted Turtles at this site have drastically dropped over recent years (Gillingwater unpub. data). Comparison of capture rates for years with similar amounts of

person search effort at this site found that the average number of spring captures/day was 8.4 turtles during the first survey year, 4.8 during the next three years, and dropped to 0.8-1.0 captures/day during the eighth and tenth survey years in 2010 and 2013, respectively (Gillingwater unpub. data). Alternatively, the average number of spring captures/day/person fell from 2.4 during the first year to 0.26 during the final five years (representing an 89% decline in captures/day/person between 2003 and 2013; Gillingwater unpub. data). The decline in the number of captures over the last 10 years may be partially attributable to habitat changes; however, it is not known if other events have also played a factor. Nonetheless, such a stark change in observable turtles, despite intensive recent surveys suggests a large decline has occurred at this site. This subpopulation is greatly threatened by road mortality, invasive plants and poaching events **[see THREATS AND LIMITING FACTORS]**. Population viability analyses using road mortality estimates (based on radio-telemetry data) and baseline mortality estimates (calculated from a Georgian Bay subpopulation) resulted in an adult survivorship estimate of 0.89 for this southwestern Ontario subpopulation (i.e. 10% of adults die annually; Enneson 2009). This is a conservative estimate given that the baseline mortality model would be lower than what this subpopulation actually experiences due to higher numbers of subsidized predators and greater poaching threats than the Georgian Bay subpopulation (Enneson 2009). However, even this conservative estimate of 10% of adult turtles dying annually produced a decline of 50% over 50 years (Enneson 2009).

A decline has likely occurred at an adjacent marshland that was briefly surveyed in the early 1980s and again in 2012. Eleven days of surveys at this site between June and September of 1981 yielded 24 individuals and a subpopulation estimate of 80 turtles (density 4 turtles/ha; Haggeman 1981), while survey efforts in 1982 reported 95 individuals observed or marked (Dewey *et al.* 1982). However, follow-up surveys at this site over four days in 2012 during early spring (the prime active season for Spotted Turtle) did not result in any observations (Gillingwater 2013), although a couple were incidentally observed in 2013 (K. Yagi pers. comm. 2013). Decline in this subpopulation is suspected to be due to invasive plant species which have largely overtaken and altered the habitat **[see THREATS AND LIMITING FACTORS - Habitat Loss and Degradation Due to Succession and Invasive Plants]**. Similarly, a decline seems to have occurred at another wetland in this region where incidental observations of Spotted Turtles from 1993 onwards have been approximately half the average reported across the previous 30 years; given that the subpopulation occurs in an isolated area, the most reasonable explanation for the decline in observations seems to be habitat loss due to lowered lake levels and the associated severe invasion of non-native *Phragmites* at the site since the 1990s (Mackenzie *et al.* 2014). At another long-term monitored site elsewhere in southwestern Ontario, at least 30 individuals have gone missing since 2008; the cause of the decline is not known for certain but poaching has been confirmed from this locale previously and seems the most plausible explanation (OMNRF unpub. data).

Anecdotal evidence of Spotted Turtle subpopulation declines has also been reported from First Nations people across the species' range (Lickers pers. comm. 2013) and from covert OMNRF enforcement agents who have overheard pet collectors discussing how Spotted Turtles can no longer be found with ease at sites where they were once plentiful (Miller pers. comm. 2013).

The recent declines noted above are expected to continue unless remedial measures are taken (i.e. greater enforcement and penalties for poaching; greater measures to remove or prevent the spread of non-native *Phragmites*; greater measures to install suitable crossing structures and exclusion fencing along roads through Spotted Turtle habitat; and greater legislative habitat protections for Spotted Turtle). The projected percent reduction for the total adult population in Canada is >40% over the next three generations (i.e. 123 years). This is based on an estimated 10% of adults dying annually in a southwestern Ontario subpopulation that is under high anthropogenic pressure (Enneson 2009) and an estimated 5% of adults dying annually in a Georgian Bay subpopulation that is under low anthropogenic pressure (Litzgus 2006; Enneson and Litzgus 2008). A simple stochastic population viability analysis model for nine Ontario Spotted Turtle subpopulations with known sizes suggested that all subpopulations have a >20% probability of quasi-extinction (i.e. the subpopulation still exists but numbers are so low that it is considered non-viable and headed for extinction), and that the probability of six or more of the nine known subpopulations becoming extinct in 100 years is 26% (Enneson and Litzgus 2009).

Rescue Effect

Given the Spotted Turtle's low mobility habits (annual movements generally restricted to <400m) and the degree of isolation among subpopulations, it is likely impossible for a declining subpopulation to be rescued by natural immigration of foreign individuals. Evidence to support this is provided by >30 years' worth of mark-recapture data from a Georgian Bay subpopulation that revealed Spotted Turtles did not move between the northern and southern parts of the study site (Litzgus unpub. data) and that dispersal between breeding demes 2km apart did not occur (Enneson and Litzgus 2009). Further evidence comes from a southwestern Ontario study (>10 years), where no immigration has been observed at sites within 2km of a marked subpopulation (Gillingwater unpub. data). Although rescue effect from immigration is unlikely, the reintroduction of Spotted Turtles to a site by humans may be possible in areas maintaining extensive suitable habitat and limited human interference (such as in the Georgian Bay region).

THREATS AND LIMITING FACTORS

Reasons for continued decline in Spotted Turtles in the future include road mortality and road effects; poaching for the pet, food, and traditional medicine trades; habitat loss due to invasive species and development; wetland modifications; agricultural practices; forestry; increased predation by subsidized predators; climate change; pollution; off-road vehicle intrusions; and mining/quarrying (Lovich 1989; Oldham 1991; Ernst *et al.* 1994; Harding 1997; Burke *et al.* 2000; Ernst and Lovich 2009; Miller pers. comm. 2013) **[see Appendix 1 - COSEWIC Spotted Turtle Threats Assessment Calculator]**. Subpopulation declines have been observed even in protected areas in both the U.S. (Lovich 1989) and Canada **[see POPULATION SIZES AND TRENDS - Fluctuations and Trends]**. The Spotted Turtle is particularly susceptible to habitat destruction and exploitation by pet trade collectors in spring and fall when turtles aggregate at breeding and hibernation sites, respectively. Spotted Turtles, like other turtle species, are considered especially vulnerable to increased adult mortality and over-collection because of slow life histories (i.e. slow growth rates, delayed maturity, and low egg and juvenile survivorship; Oldham 1991; Wilson *et al.* 1999). The low fecundity of Spotted Turtles **[see BIOLOGY: Life Cycle and Reproduction - Fecundity and Reproductive Success]** would further exacerbate this vulnerability. A stage-classified matrix model based on long-term demographic data from a Georgian Bay Spotted Turtle subpopulation revealed that small changes in adult survivorship produced large changes in the growth rate of a subpopulation and that a decrease by as little as 3% in adult survivorship could cause a subpopulation to decline (Enneson and Litzgus 2008).

Road Mortality and Road Effects (Overall Threat Impact = High)

Spotted Turtle subpopulations adjacent to roads are threatened by road mortality (Gillingwater unpub. data; OMNRF unpub. data; Riley *et al.* unpub. data). Given that the number of major roads has greatly increased in southern Ontario over the past 40 years (Fenech *et al.* 2001) it is likely that road mortality of Spotted Turtles has also increased during this time period. Continuing expansion of road networks in central Ontario is expected to have high impacts on Spotted Turtles and their habitat over the next 10 years, especially in light of the recent discovery that certain subpopulations extensively utilize wetland edges and wet ditches within the road right-of-way and that individuals often overwinter and nest within 5-20 m of the road; confirmed habitat at some sites in this region has already been lost to road development (Riley *et al.* unpub. data). Furthermore, roadways have the potential to limit permeability between lakes and coastal wetlands, which could cause habitat loss due to premature aging of marsh habitats from limited natural refresh and scouring effects (Gillingwater pers. comm. 2013). Roads also act as barriers to movement and reduce connectivity in the landscape, thus isolating local subpopulations and increasing their risk of extinction (Forman and Alexander 1998; Trombulak and Frissell 2000; Spellerberg 2002; Forman *et al.* 2003; Steen and Gibbs 2004; Eigenbrod *et al.* 2008; Shepard *et al.* 2008).

Even though 32% of the Spotted Turtle distribution is located within Provincial Parks, the average road density of Provincial Parks within the distribution of Ontario's reptiles was found to be almost twice as high as the provincial average, which would likely cause these areas to act as regional population sinks rather than safe havens (Crowley and Brooks 2005). In particular, 69% of Provincial Parks with Spotted Turtles have up to 50% of the regional road density, 23% have >50% of the regional road density, and 8% have higher road density than the surrounding area (Crowley and Brooks 2005). Although most Spotted Turtle subpopulations occurring within Conservation Reserves are not threatened by roads, only 13% of the Spotted Turtle distribution is located within reserves (Crowley and Brooks 2005); furthermore, at least two reserves maintaining Spotted Turtle are bisected by roads (OMNRF pers. comm. 2014).

Although one study reported that individuals tracked (N=5, representing 31% of estimated subpopulation) from June to late September did not seem to cross a road bisecting the wetland (Seburn 2012), other subpopulations adjacent to roads are known to experience high annual losses of individuals (Gillingwater unpub. data, Riley *et al.* unpub. data). Observations at one protected area bisected by a road between 2003 and 2007 found 3-9 adults dead on road annually; however, actual road mortality levels would have been even higher given that these were incidental observations recorded during travel to the research site and only during early spring rather than through the full active season for Spotted Turtles (Gillingwater unpub. data). Using radio-telemetry data from this subpopulation, the estimated probability of an adult Spotted Turtle crossing and being killed on the road was 7.7% (Enneson 2009). Wildlife passages were recently installed at this site in 2012 and are being monitored for effectiveness and use. Snapping Turtles have been confirmed using the passages and it is possible that Spotted Turtles are also using the new crossing structures (Gillingwater pers. comm. 2013). Since the installation of fencing and culverts, only three Spotted Turtle mortalities have been reported along this road between 2012 and 2013 (including one adult, one juvenile and one hatchling; OMNRF pers. comm. 2014).

A recently discovered subpopulation occurring alongside a busy road was monitored between 2012 and 2014; a total of 20 Spotted Turtles (including six juveniles) were confirmed dead on the road across all years, representing 22% of captured individuals (Riley *et al.* unpub. data; Morin *et al.* unpub data). Railroads may also pose a threat to this subpopulation (Riley *et al.* pers. comm. 2013). Another road with two historical incidental observations of Spotted Turtles (one of which was a roadkill from 1968; NHIC data 2013) was visited in 2010 and at that time two freshly roadkilled adults were found within 200m of each other; suggesting that a substantial subpopulation may occur at this site and that it has long been impacted by road mortality (Davy pers. comm. 2014).

In a study of parameters that influence road mortality of several taxa in southwestern Ontario, posted road speed limit was the dominant positive predictor of roadkill, followed by maximum daily temperature and habitat diversity, while distance from wetlands was the major negative predictor (Farmer and Brooks 2012). Beaudry *et al.* (2008) found that the number and arrangement of roads and associated traffic volumes were significant factors affecting the extinction risk for local populations. For turtles, adult females are especially vulnerable to road mortality as they are more likely to be found crossing roads than are males or juveniles, and they often nest along road shoulders (Gibbs and Steen 2005; Steen *et al.* 2006; Szerlag and McRobert 2006); this may be why several aquatic freshwater turtle subpopulations near roads or in road-dense areas report significantly male-biased sex ratios (Saumure 1995; Gillingwater and Piraino 2004; Steen and Gibbs 2004; Aresco 2005; Gibbs and Steen 2005; Steen *et al.* 2006).

Given the low tolerance of most freshwater turtle species to adult mortality (Doroff & Keith 1990; Brooks *et al.* 1991; Congdon *et al.* 1993, 1994; Gibbs and Shriver 2002), in conjunction with the documented evidence of significant numbers of annual adult road mortality from some subpopulations in Ontario, it logically follows that subpopulations adjacent to roadways (and likely railways) have and will continue to experience decline. Efforts to mitigate this mortality risk by way of installing culverts and other crossing structures along roadways and railways have proven successful for Spotted Turtles in Massachusetts and Virginia (Donaldson 2005; Pelletier *et al.* 2005; Kaye *et al.* 2006) and thus, crossing structures should be considered for all Spotted Turtle subpopulations that occur adjacent to such infrastructure.

Pet, Food, and Traditional Medicine Trade (Overall Threat Impact = High)

Data collected from the U.S. Fish and Wildlife Service Law Enforcement Management Information System (LEMIS) reveals that the legal trade of this species almost tripled between 1999 (344 individuals exported) and 2010 (989 individuals exported); overall, 7881 individuals were exported during this twelve year period (LEMIS 2011). According to LEMIS (2011) 16% of these exports were wild-caught and 80% were captive-bred; however, given that this species was not CITES-listed during that period, it is possible that the “captive-bred” individuals were bred from wild-caught adults or were collected from the wild and then reared in captivity (CITES 2012). Indeed, this reported high level of captive breeding contrasts starkly to that reported earlier by Reed and Gibbons (2002) who estimated that only 16% of 1848 individuals exported between 1996-2000 were captive-bred while 57% were wild-caught; the remaining 23% were unknown or undeclared.

Illegal sales of wild-caught Spotted Turtles from Ontario have been observed on various websites over the years. In the late 1990s OMNRF received reports of a U.S. site selling Spotted Turtles that appeared to be marked individuals from an Ontario subpopulation (Miller pers. comm. 2013). OMNRF has also received reports of Spotted Turtles for sale at the Reptile Expo on several occasions (the latest in 2011) and several Spotted Turtles and other rare species were seized in one case (Miller pers. comm. 2013). Lawful sales of captive bred Spotted Turtles range from $150 each for babies, $165-$490 each for adults, and up to $1000-2000 for a breeding pair (Miller pers. comm. 2013). In the

late 1990s and early 2001, a large number of Ontario Spotted Turtles were collected from various sites by individuals in the reptile industry to establish a breeding program to supply the commercial pet industry. Declines were reported in two monitored southwestern Ontario Spotted Turtle subpopulations during this same period (Miller pers. comm. 2013). The demand for Spotted Turtles in the pet industry has become greater with their increasing rarity (Miller pers. comm. 2013). The commercial pet trade has been cited as the cause for decline in over 50% of this species' range and even large subpopulations of 300-1100 individuals have been completely wiped out in a few short years at a few sites within the U.S. (CITES 2000). Casual collection for non-commercial uses (i.e. for personal pets) also poses a large threat to subpopulations. U.S. researchers have found increased collection of turtles within recreational areas (Lovich 1987; Ernst *et al.* 1994; Garber and Burger 1995; Graham 1995); a Connecticut study reported a rate of non-commercial take as high as one Wood Turtle for every 19 permits issued to visitors (Garber and Burger 1995). Thus, it seems reasonable to assume that small numbers of Ontario Spotted Turtles are lost annually to non-commercial poaching from within Provincial and National Parks or protected areas that maintain recreational hiking trails, campgrounds and/or day-use areas for visitors; at least 12 protected areas in Ontario are prone to this risk.

Since 2005, there have also been several reports of illegal turtle harvesting to supply the food and traditional medicine industries within the Greater Toronto Area (GTA) and investigations have revealed that Spotted and Blanding's Turtles are targeted species that are used for consumption (Miller pers. comm. 2013). The demand for turtles to support these industries has been continually growing in North America as greater numbers of immigrants continue their traditional practices in Canada (Miller pers. comm. 2013). OMNRF enforcement continues to receive information suggesting that Spotted Turtle and other turtles are being smuggled out of Ontario and there has been a steady growth and expansion in the commercial sales of rare species (Miller pers. comm. 2013). The traffickers in this industry are very organized and their networks range worldwide (Miller pers. comm. 2013).

At least 23 of 109 Ontario subpopulations (21%) are at high risk of poaching due to ease of site access (Seburn pers. comm. 2013; Rasmussen pers. comm. 2013; Gillingwater pers. comm. 2013; Riley *et al.* pers. comm. 2013; A. Yagi pers. comm. 2013; Davy pers. comm. 2014; Miller pers. comm. 2014). Poaching events have only been confirmed from two subpopulations; however, there have been four convictions and at least seven additional occurrences of commercialization of Spotted Turtle since 2005 (Miller pers. comm. 2014). Having direct access to subpopulation genetic data would greatly assist enforcement officials in obtaining more convictions and higher penalties for collectors (Miller pers. comm. 2014).

Poachers often gain knowledge of and access to Spotted Turtle sites by contacting researchers and actively volunteering in monitoring programs (Miller pers. comm. 2014). Even if volunteers do not have intentions of poaching themselves, they often provide collectors with a means to figure out the whereabouts of the site when they post photos or discussions of their efforts on open source social media networks; photos often have recognizable landscape features or are accompanied by other clues on the web page that can assist in identifying the site (Miller pers. comm. 2014). This has been an increasing problem with the rise of social media (Miller pers. comm. 2014). This issue could be addressed by meticulous screening of volunteer applicants and preparation of written agreements outlining what information is prohibited to share on social media or with the general public.

Habitat Loss Due to Invasive Plants (Overall Threat Impact = High to Medium)

Since the 1990s, the distribution of the exotic plant *Phragmites australis australis* across southern Ontario has increased exponentially because of expanding road networks, declining Great Lakes water levels, and warming temperatures (Wilcox *et al.* 2003; Jodoin *et al.* 2008; Catling and Mitrow 2011; Gilbert 2012). *Phragmites australis australis* is an aggressive and competitive plant that grows rapidly and displaces naturally diverse vegetation communities with dense mono-cultural stands (Wilcox *et al.* 2003; Gilbert 2012). Given the height (>5m), density (>95%) and rapid expansion (~10 cm/day) of *Phragmites* stands (Wilcox *et al.* 2003; Jodoin *et al.* 2008; Gilbert 2012), this invasive plant poses several problems for turtles and their habitats. For instance, turtle nesting sites can be quickly overtaken within a few short weeks, causing nests to become shaded and overgrown with plant roots, thereby reducing incubation temperatures and hatching success (Bolton and Brooks 2010). Reduced incubation temperatures may be further problematic for species, such as the Spotted Turtle, that display TSD as this could skew subpopulation sex ratios if nest sites continually become shaded during the incubation period (Vogt and Bull 1984; Janzen 1993; Janzen and Morjan 2001; Kolbe and Janzen 2002). Furthermore, mortality of hatchlings overwintering in the nest chamber increases when greater vegetation cover limits snow accumulation and thus reduces insulation from cold temperatures (Weisrock and Janzen 1999). The density and height of *Phragmites* stands also limits turtle basking and movement opportunities (Gillingwater pers. comm. 2013; Misfud 2013) and reduces the availability of habitat (Gilbert 2012; Gillingwater pers. comm. 2013; Misfud 2013). Researchers report that few to no turtles are found in *Phragmites*-dominated areas compared to non-*Phragmites*-dominated areas that are surveyed with the same effort (Davy pers. comm. 2014; Gillingwater pers. comm. 2014), and that small numbers of both Spotted Turtles and other turtle species have been observed stuck and/or dead within dense stands of *Phragmites* (Davy pers. comm. 2014; Mackenzie *et al.* 2014). The presence of large dead stands of *Phragmites* also increases the potential of fire hazards within wetlands (Gilbert 2012).

The invasion of this plant species began in both the extreme southwest and southeast regions of the province in the 1950s, and has rapidly spread inward from both areas since the 1990s. *Phragmites* now occurs continuously between the two regions and has recently spread northward into central Ontario (Catling and Mitrow 2011) **[see Figure 5]**. The distribution of this invasive plant is expected to increase substantially, likely expanding throughout all of southern and central Canada in as little as a decade **[see Figure 6]**. Large alterations to Spotted Turtle habitat have already been observed at sites in Kent, Essex, Lambton, and Norfolk counties over the last 10-20 years (Gillingwater pers. comm. 2013) and Spotted Turtle observations have greatly declined at some sites that have been largely overtaken by this invasive plant **[see POPULATION SIZES AND TRENDS - Fluctuations and Trends]**; however, the degree to which *Phragmites* is to blame needs to be investigated (Gillingwater pers. comm. 2013). At one of these southwestern Ontario sites during the early 2000s, invasive *Phragmites* only occurred in small patches as part of a larger wetland habitat mosaic, and some radio-tagged Spotted Turtles were even observed to choose these *Phragmites* stands for summer dormancy habitat on occasion (Gillingwater unpub. data); however, within <10 years, *Phragmites* has completely altered the structure of the wetland, turning large portions of the shallow graminoid marsh (i.e. the preferred habitat of Spotted Turtle) into a dense impenetrable mono-cultural stand with little suitable habitat left for turtle basking, foraging, or movement (Gillingwater unpub. data); *Phragmites* increased by 48% per year between 1999 and 2006 (Badzinkski *et al.* 2008) and has spread significantly further since 2006 (Gillingwater pers. comm. 2013).

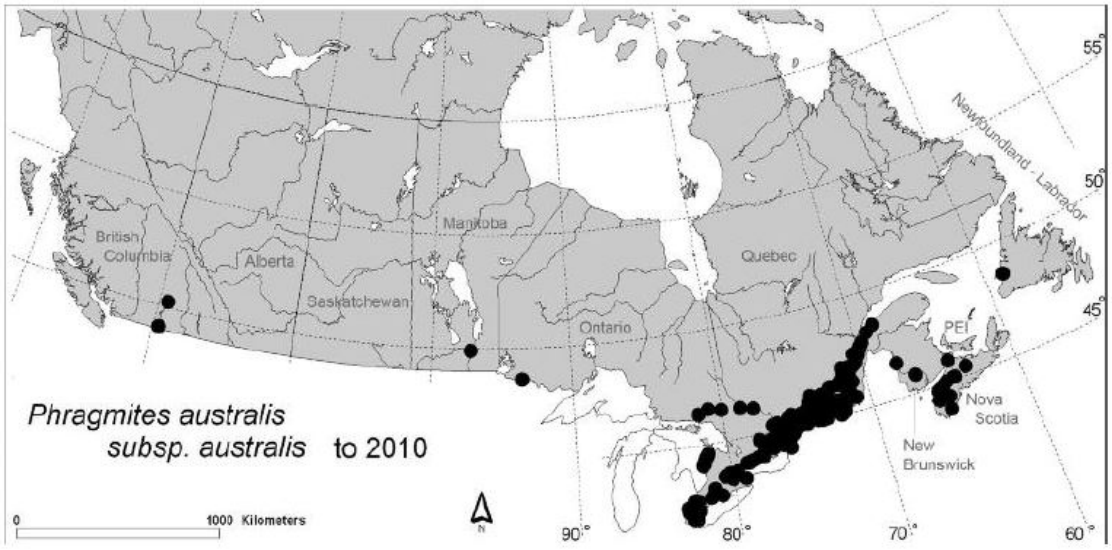

Figure 5. Current distribution of invasive *Phragmites australis australis* (Catling and Mitrow 2011).

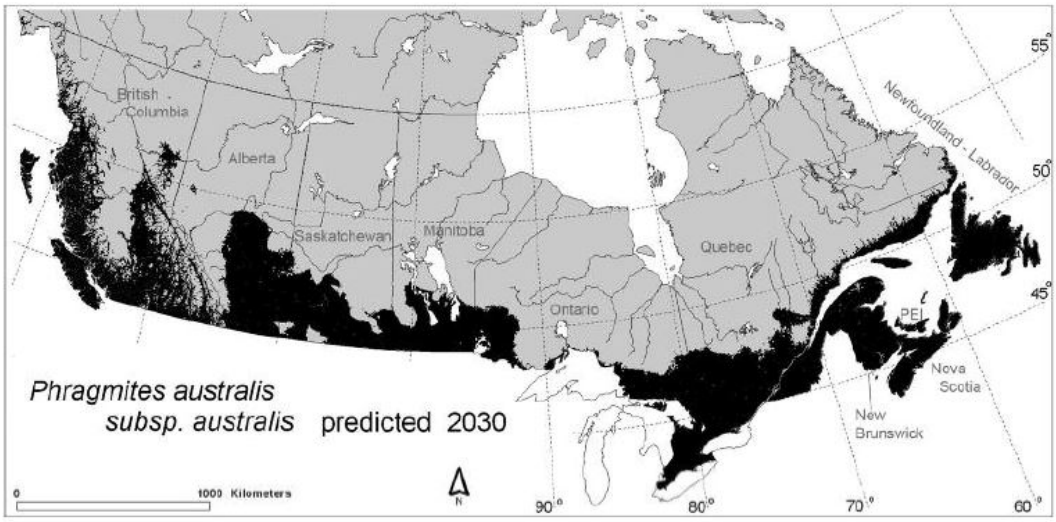

Figure 6. Minimal predicted distribution of invasive *Phragmites australis australis* by 2030 (Catling and Mitrow 2011).

Although it has been reported that *Phragmites* is not an issue at other Spotted Turtle sites despite being common (Crowley pers. comm. 2014; Davy pers. comm. 2014), these sites are known to still maintain large areas of suitable wetland habitat, and thus, given the known aggressive and competitive nature of this invasive plant, it is possible that *Phragmites* is still in the process of overtaking these sites, and that they will eventually suffer the same fate. At one of these sites, concentration areas of Spotted Turtles have shifted over the last 10 years (Davy pers. comm. 2014), suggesting that preferred habitat areas may have already been overtaken by the invasive plant and that turtles have been forced to disperse into less suitable habitats. It has also been suggested that relatively undisturbed wetlands in central Ontario are likely not as susceptible to the spread of this invasive species given its tendency to spread into disturbed areas; however, even isolated/undisturbed areas in southwestern Ontario have been overtaken by this plant (Gillingwater pers. comm. 2014; Mackenzie *et al.* 2014). At one protected area with little human disturbance, the abundance of invasive *Phragmites* increased by 34% per year between 1999 and 2006 (Badzinkski *et al.* 2008) and has continued its rapid expansion since then (Mackenzie *et al.* 2014).

Burning, cutting, drowning, and smothering are all potential removal options for *Phragmites*; however, chemical treatments may be necessary in more dire circumstances. The application of glyphosate-based herbicide in combination with mowing and burning has proven successful at greatly reducing the abundance of *Phragmites* in wetlands overtaken by it (average % coverage within sample plots was reduced from 64% to 1.4% within one year after treatment; Gilbert 2012). Unfortunately, there is no open wetland habitat type that is immune to invasion of this plant (Gilbert pers. comm. 2013). With the continuing expansion of roads throughout central Ontario it is likely that *Phragmites* will become an increasing threat for subpopulations that are as of yet remote and unaffected by this invasive plant. Thus a province-wide *Phragmites* control program should be established

immediately and ‘at-risk’ habitats need to be targeted as first priority (Gilbert 2012). Otherwise, it is difficult to see how the Spotted Turtle will avoid large decline with the extensive loss of suitable habitat predicted to occur from the spread of this invasive plant.

Residential and Commercial Development (Overall Threat Impact = Medium)

Some subpopulations in the Georgian Bay/Bruce Peninsula region are threatened by shoreline cottage development which has likely already caused a loss of habitat (Enneson and Litzgus 2009; Crowley pers. comm. 2013). There are currently new subdivisions being developed regularly in the southern Georgian Bay region and it is expected that over the next decade much wetland drainage will occur to accommodate this increasing urbanization (Brooks pers. comm. 2014). OMNRF districts have reported losses of habitat at 17 coastal wetlands along Lake Huron over the last 20 years from shoreline modification, clearing for agricultural and urban encroachment, and dredging/channelization for marina development or other uses (Environment Canada and OMNRF 2003). In the early 2000s, southern Georgian Bay was reported as the fastest developing area in all of Ontario (Watters 2003). MacKinnon *et al.* (2005) reported that high density developments were replacing low density residences and non-intensive agricultural areas. Incremental losses of coastal wetland habitats due to cottage and marina development continued at some Spotted Turtle sites in southern Ontario through the 1990s and are expected to continue into the future (Petrie 1998; Gillingwater pers. comm. 2014).

From 1982 to 2002, wetland loss in southern Ontario was still occurring at a rate of approximately 3500 ha/year (an average annual loss of 0.17%; Ducks Unlimited 2010). Given that the assessment only included wetlands ≥10 ha, this is a conservative estimate and thus annual wetland loss in southern Ontario is even more substantial (Ducks Unlimited 2010), and especially impactful on Spotted Turtles given their preference for small wetlands which were not included in the assessment.

Natural System Modifications (Overall Threat Impact = Low)

Spotted Turtle mortality can result from wetland modifications. For instance, many dead turtles were located in a protected wetland when dredging took place during the hibernation period. A total of 14 Blanding’s Turtles and one Spotted Turtle were observed partially buried in the dredged sediment but it is highly likely that many more turtles of both species were killed and completely buried out of view; this section of the wetland was a “hotspot” for Spotted Turtle activity and a known hibernation area (Gillingwater and Piraino 2004). In 2012-2013, at an adjacent wetland, newly dredged ponds resulted in the loss of Spotted Turtle habitat (Gillingwater pers. comm. 2013). Wetland dredging and waterfowl habitat creation is likely conducted within several protected wildlife management areas where Spotted Turtles occur. Elsewhere in Ontario, Spotted Turtles have been killed by, or are at risk of mortality by, roadside ditching and the draining or infilling of wetlands and drainage canals (Rasmussen pers. comm. 2013; A. Yagi pers. comm. 2013). One study reported that deep waters created by Beaver damming altered plant assemblages and may have been the cause of Spotted Turtle disappearance from the area (Litzgus 2012). However, another study reported that the placement of controls on Beaver dams can cause

drought conditions in wetlands and has resulted in wildfires and Spotted Turtle mortality (A. Yagi pers. comm. 2013). Prescribed burns at this site during spring have also caused Spotted Turtle mortality (A. Yagi pers. comm. 2014). Another study reported that the intended “trimming” of a Beaver dam within a Provincial Park during winter not only resulted in complete destruction of the dam, but also of turtle overwintering habitat; water levels dropped 2m leaving only puddles behind and resulting in the death of many turtles (Davy pers. comm. 2014). Although Spotted Turtles do not occur at this site, Beaver dam removals or other activities that alter the hydrology of hibernation sites during winter are a mortality threat for all turtle species (Litzgus pers. comm. 2014). Given that Spotted Turtle is positively associated with shallow Beaver wetlands and that a large portion of the Spotted Turtle population is expected to occur through central Ontario where Beaver is common, it is likely that the removal of Beaver dams affects a good portion of the Spotted Turtle population. Reductions in the water table have also been reported to degrade Spotted Turtle habitat in the U.S. (Harding 2002; Harms 2008) while dredging of shallow marsh areas to improve waterfowl habitat has resulted in the disappearance of Spotted Turtles from certain sites in the U.S. (Oldham 1991).

Mortality Due to Agricultural Practices (Overall Threat Impact = Low)

Adult female Spotted Turtles from at least one site in southwestern Ontario have been killed by, or at risk of being killed by, agricultural machinery when nesting in fields adjacent to wetlands (A. Yagi pers. comm. 2013). It is likely that other subpopulations adjacent to agricultural lands are also at risk of annual adult mortality from agricultural practices. Overgrazing by livestock has also been reported as a threat to this species (COSEWIC 2004).

Logging and Wood Harvesting (Overall Threat Impact = Low)

Forestry operations can cause direct mortality of adult and hatchling turtles due to being crushed by logging equipment and can also cause destruction of vernal pool and hibernation habitat (Natural Heritage and Endangered Species Program 2007). Wetland harvesting during winter months should only be done under completely frozen conditions; to protect hibernating turtles felling should only be completed by hand and temporary bridges should be used to cross frozen wetlands (Natural Heritage and Endangered Species Program 2007). To protect vernal pools, >75% canopy cover should be maintained within the surrounding 30m and skid roads should be located at least 30m away (Natural Heritage and Endangered Species Program 2007).

Subsidized Predators (Overall Threat Impact = Unknown)

Some subpopulations occur in human-influenced landscapes with increased numbers of subsidized predators (i.e. mammals that become more abundant due to increased resources provided by humans; Garrott *et al.* 1993). Studies at Spotted Turtle sites have found up to 80-100% nest depredation rates for other turtle species and it is assumed that nest depredation rates for Spotted Turtle at these sites may be similar (Saumure 1995; Gillingwater and Brooks 2001; Gillingwater unpub. data). A study in Bruce County found that 8 of 11 (73%) of monitored Spotted Turtle nests were destroyed by predators (Rasmussen and Litzgus 2010b). Subsidized predators also feed upon adult and juvenile turtles **[see BIOLOGY - Mortality]**. A stage-classified matrix model predicted that headstarting efforts to increase egg survivorship are an inefficient conservation strategy as this would only increase the subpopulation growth rate if all hatchlings were reared to sexual maturity (Enneson and Litzgus 2008).

Climate Change (Overall Threat Impact = Unknown)

Some researchers have reported that Spotted Turtle wetland habitat at a few sites is slowly disappearing as open water areas fill in with organic matter due to lower water levels (Gillingwater pers. comm. 2013; A. Yagi pers. comm. 2013). Once a habitat becomes overgrown with later-successional species of plants, it may be unsuitable for Spotted Turtles (Burke *et al.* 2000). As water levels decline, limited waves and currents in wetlands can provide favourable conditions for the invasive plant *Phragmites australis* ssp. *australis* (Wilcox *et al.* 2003) which degrades Spotted Turtle habitat quality and quantity **[see THREATS AND LIMITING FACTORS - Habitat Loss and Degradation Due to Invasive Plants]**. Warmer temperatures are also conducive to the spread of this species (Wilcox *et al.* 2003). Decreases in water depth and bare soil area were associated with the greatest increases in non-native *Phragmites* cover in Great Lakes coastal wetlands (Tulbure and Johnston 2010). Lake Erie has experienced lower than average water levels since 1999 (Mackenzie *et al.* 2014); since that time invasive *Phragmites* has rapidly spread through coastal wetland areas where Spotted Turtle occurs (Badzinkski *et al.* 2008; Mackenzie *et al.* 2014; Gillingwater unpub. data). The coastal wetlands of Georgian Bay have experienced sustained low water levels since the early 2000s (Great Lakes Wetlands website 2011). Climate change models predict a further decline in water levels of 1m and reduced fluctuations between years by 2036; this loss of natural water level fluctuations threatens coastal wetland habitats and the species that depend on these dynamic systems (Great Lakes Wetlands website 2011). Lowered water levels and harsher winters resulting from climate change may exacerbate overwintering mortality through increasing the occurrence of anoxic and freezing conditions within hibernation sites **[see BIOLOGY - Mortality]**.

According to King and Niiro (2013) climate change models predicted that 25-50% of current known localities for Spotted Turtle would become climatically unsuitable by 2050. Although the overall area of climatic suitability for Spotted Turtle was expected to increase in the future (including expansion further north and east in Ontario), given the low dispersal capabilities of this species it is highly unlikely to colonize new areas naturally and will likely require management efforts to facilitate colonization of currently unoccupied areas.

For species whose sex is determined by temperature during embryonic development (Temperature-Dependent Sex Determination or TSD), including the Spotted Turtle, some speculate that rising global temperatures may skew subpopulation sex ratios (Janzen 1994b). For Spotted Turtles in particular, incubation temperatures above 27°C predominantly produce females while temperatures of 30°C produce only females (Ewert and Nelson 1991; Ewert *et al.* 2004a). Given that warmer temperatures produce more females, climate change may lead to even greater road mortality numbers for this species since more females tend to be hit on roads than males **[see THREATS AND LIMITING FACTORS - Road Mortality and Road Effects]**.

Pollution (Overall Threat Impact = Unknown)

The Spotted Turtle is very sensitive to pollution and toxicants and disappears rapidly with declining water quality (NYSDEC 1998). Agricultural runoff has been shown to carry pesticides and fertilizers into Spotted Turtle wetland habitats (Harding 2002; NYSDEC 2012). Subpopulations occurring in cranberry bogs likely experience heavy exposure to several pesticides (Lazell 1976; Belmore 1978; 1980). A Spotted Turtle nest collected from a southwestern Ontario marsh in the late 1970s was found to have the highest levels of DDT and PCBs of any turtle species in the area; all hatchlings died soon after emergence (Campbell 1978). Coastal wetlands in southern Georgian Bay are affected by heavy nutrient and sediment loading; excessive amounts of urban/agricultural phosphates and agricultural runoff enter the bays from surrounding watersheds (Severn Sound Remedial Action Plan, 1993a). At some Spotted Turtle sites, herbicides have been dumped into lakes to clear waters of vegetation and make them more suitable as swimming areas for people; it is not known whether this affects adjacent Spotted Turtle marsh habitats (Davy pers. comm. 2014).

Human Intrusions and Disturbance (Overall Threat Impact = Unknown)

At least two Spotted Turtle subpopulations are threatened by off-road vehicles. Spotted Turtles will nest along ATV trails (Gillingwater and Piraino 2004) and will utilize flooded ATV trails as wetland habitat (Rasmussen pers. comm. 2013). ATV activities are occurring despite restrictions and trespassing on protected areas (Gillingwater pers. comm. 2014). ATV trails also increase accessibility to sites for both poachers and predators (Gillingwater pers. comm. 2014) and raise the risk of invasion by *Phragmites australis* ssp. *australis*, which is known to spread in areas of anthropogenic disturbance (Wilson *et al.* 2003).

Mining and Quarrying (Overall Threat Impact = Negligible)

Continued peat mining threatens at least two Spotted Turtle subpopulations (Davy pers. comm. 2014; A. Yagi pers. comm. 2014) and at least one subpopulation is threatened by a proposed quarry development within close proximity (~4km), as it would bring road development to the area and potential water hydrology changes through the contiguous wetland system (Bythe pers. comm. 2014).

Number of Locations

The term 'location' defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations (IUCN 2010, 2011).

The most serious plausible threats to all Canadian Spotted Turtle subpopulations are road mortality, poaching and habitat loss **[see Threats and Limiting Factors and Appendix 1 - Threats Assessment Calculator]**. Any of these three threatening events could potentially affect all individuals occurring within 10km of each other. Therefore, it is estimated that ~20-30 Spotted Turtle locations occur throughout the range.

There is an inferred continuing decline in the number of locations, especially within southwestern Ontario where there is a lack of remaining habitat and a large number of historical sites.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

The Spotted Turtle is protected as an 'Endangered' species under the federal *Species at Risk Act* (S.C. 2002, C.29) and the Ontario *Endangered Species Act* (S.O. 2007, ch.6), and as a 'species likely to be designated Threatened or Vulnerable' under the Québec *Loi sur les espèces menacées ou vulnérables* (*Act Respecting Threatened or Vulnerable Species;* R.S.Q. 1989, ch. E-12.01). The Spotted Turtle only receives general habitat protection under the ESA 2007; its habitat still needs to be legally defined under these provincial and federal acts.

In Canada, the Spotted Turtle receives further protection from harm and exploitation under the Ontario *Fish and Wildlife Conservation Act* (1997) and the Québec *Loi sur la conservation et la mise en valeur de la faune* (2002). It is also provided legal protection where it occurs in national wildlife areas, provincial and national parks, and conservation areas. Furthermore, its habitat is protected under the Provincial Policy Statement of the *Ontario Planning Act* (1990). In the United States, the Spotted Turtle is not currently listed under the U.S. Federal *Endangered Species Act*; however, it is listed in at least 10 of the 22 states in which it occurs.

In March 2013, CITES (Convention on the International Trade in Endangered Species) added the Spotted Turtle to Appendix II, so that its international trade is now regulated (CITES 2013).

Non-Legal Status and Ranks

The Spotted Turtle was designated by COSEWIC as 'Special Concern' in 1991 and was subsequently up-listed to 'Endangered' upon status reassessment in 2004. This was confirmed in the 2014 reassessment. The global conservation status rank of the Spotted Turtle is G5 ('secure') with a minimum of 10,000 individuals estimated across at least 500 subpopulations range-wide. The national conservation status rank of the Spotted Turtle is N5 ('secure') in the U.S. and N3 ('vulnerable') in Canada. Its provincial conservation status rank is S2 ('imperiled') in Ontario (up-listed from S3 due to information provided in this report; Oldham pers. comm. 2014) and S1 ('critically imperiled') in Québec. The conservation status of this species throughout the U.S. ranges from S1 to S5 (NatureServe 2013). **See Table 1** for a summary of conservation status ranks.

In 2011, the IUCN Red List assessed the Spotted Turtle as Endangered A2cde+4ce, indicating that it is facing a very high risk of extinction in the wild due to population reductions of ≥50% (over 10 years or three generations) from a decline in area of occupancy and/or habitat quality, exploitation for the pet trade, and effects from introduced taxa (van Dijk 2011). Its General Status Rank in Canada, Ontario, and Québec is 'At Risk' (Wild Species 2010).

It is surprising that the global and U.S. conservation status ranks (NatureServe 2014) are still considered 'secure', given evidence of its decline and rarity across the range, and in light of its recent IUCN status assessment of Endangered.

Habitat Protection and Ownership

The Spotted Turtle has been reported from at least 149 protected areas throughout Ontario including: 26 First Nations communities; 90 conservation agency-owned properties; and 33 provincial and national parks, reserves and management areas (NHIC 2013; McCarter pers. comm. 2013; Pulfer pers. comm. 2013; Lickers pers. comm. 2013); however, most of these subpopulations are historical, declining, likely extirpated, or have statuses that are currently unknown [see **POPULATION SIZES AND TRENDS - Abundance; POPULATION SIZES AND TRENDS - Fluctuations and Trends; THREATS AND LIMITING FACTORS - Road Mortality and Road Development**].

Table 1. Spotted Turtle conservation status ranks.

Location	Rarity Rank	Legal Rank/Protection
Countries		
Canada	N3	Endangered
United States	N5	N/A
Provinces		
Ontario	S2	Endangered
Québec	S1	Species Likely to be Designated Threatened or Vulnerable
States		
Connecticut	S4	N/A
Delaware	S3	N/A
District of Columbia	S1	Protected
Florida	S3?	N/A
Georgia	S3	Unusual/Protected
Illinois	S1	Endangered
Indiana	S2	Endangered
Maine	S3	Threatened
Maryland	S5	N/A
Massachusetts	S4	Species of Conservation Interest/Protected
Michigan	S2	Threatened
New Hampshire	S3	Threatened
New Jersey	S3	Special Concern
New York	S3	Special Concern
North Carolina	S3	N/A
Ohio	S3	Threatened
Pennsylvania	S3	N/A
Rhode Island	S5	Protected
South Carolina	S5	Threatened
Vermont	S1	Endangered
Virginia	S4	N/A
West Virginia	S1	Species of Concern

Legend:
N = National Rank; S = State or Provincial Rank; 1 = Critically Imperiled; 2 = Imperiled;
3 = Vulnerable; 4 = Apparently Secure; 5 = Secure

Sources:
CITES 2013; NatureServe 2014

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

A special thanks to Scott Gillingwater (UTRCA), Christina Davy (Trent University), Megan Rasmussen (OMNRF), Julia Riley (Laurentian University), the First Nation communities of Georgian Bay, Jackie Litzgus (Laurentian University), David Seburn (ecological consultant), Anne Yagi (OMNRF), Jennifer McCarter (NCC), Tanya Pulfer (Ontario Nature), Victor Miller (OMNRF), Mike Oldham (NHIC), Yvonne Hopkins, Henry Lickers (Akwesasne Department of Environment) and Bird Studies Canada for providing detailed communications, unpublished data and reports, and published articles. Further acknowledgements are extended to Michael Oldham and Jackie Litzgus who prepared the previous Spotted Turtle status reports, in 1991 and 2004 respectively; these documents provided the basis for this update report.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Teresa Piraino is an ecological consultant with MMM Group Limited in Kitchener, Ontario. She has 15 years' experience conducting Species at Risk research and wildlife surveys throughout southern and central Ontario. Over the years she has gained in-depth field research experience with many of Ontario's reptiles, including the Blanding's, Midland Painted, Northern Map, Spiny Softshell, Snapping and Spotted Turtle, as well as the Eastern Foxsnake, Eastern Hog-nosed Snake and Queensnake. Her main research interests are reptile behavioural ecology and movement patterns. Teresa sits as an advisor to the Ontario Turtle Conservation Group and as an executive member on the National Queensnake Recovery Team. She has authored the COSEWIC Northern Map Turtle Update Status Report (2012) and the OMNRF Queensnake Occurrence Survey Protocol (2013), and has co-authored the OMNRF 'Landmanager's Guide To Conserving Habitat for Forest Birds in Southern Ontario' (2011), the COSEWIC Blanding's Turtle Update Status Report (in prep.) and the IUCN Chelonian Research Monographs: Spotted Turtle Species Account (in prep.). Teresa earned an Honour's Bachelor degree in Environmental Anthropology/Political Ecology from the University of Western Ontario.

Appendix 1. COSEWIC Spotted Turtle Threats Assessment Calculator

THREATS ASSESSMENT WORKSHEET

Species or Ecosystem Scientific Name	Spotted Turtle
Element ID	
Date (Ctrl + ";" for today's date):	22/04/2014
Assessor(s):	Dave Fraser, Jim Bogart, Teresa Piraino (author), Jackie Litzgus, Ron Brooks, Dave Seburn, Katharine Yagi, Christina Davy, Marie-France Noel, Joe Crowley, Vivian Brownell, Anne Yagi and Scott Gillingwater (Angèle Cyr from COSEWIC Secretariat noted comments)
References:	

Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	2	1
C	Medium	1	2
D	Low	2	2
Calculated Overall Threat Impact:		Very High	Very High

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
1.1	Housing & urban areas	C	Medium	Restricted (11-30%)	Extreme (71-100%)	High (Continuing)	Most development has already occurred in southwest Ontario; however, incremental losses of habitat are still occurring in coastal wetland areas in the southwest due to cottage and marina development. Furthermore, urban/cottage/marina development is increasing in the Georgian Bay/Bruce Peninsula region.
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Commercial/Industrial development is unlikely to occur in Spotted Turtle habitat due to protections afforded under the Endangered Species Act 2007.
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Creation of trails and boardwalk systems at Spotted Turtle locales may lead to a loss of habitat. One site may be affected.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2	Agriculture & aquaculture	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)	
2.1	Annual & perennial non-timber crops	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)	Although most large wetlands in southern Ontario were drained by the 1960s, small wetlands (<10ha in size) are still being lost at a conservative rate of 0.17% annually due to agriculture and development. At least 2 populations occurring adjacent to agriculture experience or are threatened by annual adult mortality due to agricultural practices and machinery as well as associated drain cleaning. If turtles are doing well in northern Ontario, then this threat is negligible. Although several populations occur in the agricultural south, most of these seem to be isolated from agricultural activities.
2.2	Wood & pulp plantations						Negligible.
2.3	Livestock farming & ranching						Negligible.
2.4	Marine & freshwater aquaculture						Negligible.
3	Energy production & mining		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
3.1	Oil & gas drilling						Negligible.
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	2 sites are currently affected by peat mining and at least 1 site is threatened by a proposed aggregate mine.
3.3	Renewable energy						Endangered Species Act will likely protect Spotted Turtle habitat from development of wind or other renewable energy farms. ESA doesn't completely prevent such farms but may avoid identified Spotted Turtle habitat.
4	Transportation & service corridors	B	High	Large (31-70%)	Serious (31-70%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.1	Roads & railroads	B	High	Large (31-70%)	Serious (31-70%)	High (Continuing)	Road development and expansion is the greatest ongoing threat to Spotted Turtle habitat. Known Spotted Turtle habitat is currently being lost to road development in the Georgian Bay region. Furthermore, populations adjacent to roads are known to experience high levels of road mortality: (i) a conservative estimate of 3-9 road kills annually across 5 years for a southwestern Ontario subpopulation of ~370 individuals and (ii) 20 roadkills (32% of captures) over 3 years for a Georgian Bay subpopulation.
4.2	Utility & service lines						Negligible.
4.3	Shipping lanes						Negligible.
4.4	Flight paths						Negligible.
5	Biological resource use	C	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	B	High	Large (31-70%)	Serious (31-70%)	High (Continuing)	Any locality information that is released to the public puts the population at risk to poaching. The commercial pet trade has been cited as the cause for decline in over 50% of this species' North American range and even large populations in the U.S. of 300-1100 individuals have been wiped out in a few short years post release of location information. Since 2005, Spotted Turtle has been increasingly harvested for the commercial food and traditional medicine trades. At least 23 of 109 Ontario sites (21%) are considered at high risk of poaching due to ease of site access.
5.2	Gathering terrestrial plants						Negligible.
5.3	Logging & wood harvesting	D	Low	Small (1-10%)	Moderate - Slight(1-30%)	High (Continuing)	Spotted Turtles are at risk of direct mortality from being crushed by forestry equipment. Forestry operations can destroy vernal pool habitat. This threat would impact Spotted Turtles across the range.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources						Negligible. This species occurs in shallow wetlands where fishing is unlikely to occur.
6	Human intrusions & disturbance		Unknown	Large (31-70%)	Unknown	High (Continuing)	
6.1	Recreational activities		Unknown	Large (31-70%)	Unknown	High (Continuing)	ATV use crushes nesting areas. Some hunting activities cause new nesting sites. Increases in accessibility from site to site is opening access by predators also. This is considered under poaching threat. ATV activities are occurring despite restrictions and trespassing on protected areas.
6.2	War, civil unrest & military exercises						Negligible.
6.3	Work & other activities		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Negligible. Incidental by-catch in traps from researchers; however, most would be released and incidence of accidental mortality is expected to be very low.
7	Natural system modifications	D	Low	Small (1-10%)	Moderate - Slight(1-30%)	High (Continuing)	
7.1	Fire & fire suppression	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Prescribed burns carried out during the spring have caused death to some individuals at 1 locality (at least 2 deaths out of ~140 individuals).
7.2	Dams & water management/use	D	Low	Small (1-10%)	Moderate - Slight(1-30%)	High (Continuing)	Removing Beaver dams during winter can also cause mortality of overwintering turtles whereas putting controls on Beaver dams during the summer can lead to drought and fire (see 7.1). Spotted Turtles often occur in Beaver influenced wetlands. Ditching for roads is also a threat (see 4.1).
7.3	Other ecosystem modifications	D	Low	Small (1-10%)	Moderate - Slight(1-30%)	High (Continuing)	Dredging of wetlands during winter for maintenance purposes or to create waterfowl habitat, can lead to mortality of overwintering turtles. Dredging and waterfowl habitat creation likely occurs within many protected management areas.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8	Invasive & other problematic species & genes	BC	High - Medium	Large (31-70%)	Extreme - Moderate (11-100%)	High (Continuing)	
8.1	Invasive non-native/alien species	BC	High - Medium	Large (31-70%)	Extreme - Moderate (11-100%)	High (Continuing)	The invasive plant *Phragmites australis* ssp. *australis* has already overtaken several southwestern Ontario Spotted Turtle sites and is expected to spread throughout southern Ontario over the next 20 years. No wetlands are immune to invasive *Phragmites* and climate change is helping to increase its rate and extent of spread. Some Spotted Turtles and other turtle species have been found stuck or dead within dense stands. Lake Erie coastal wetlands, even those that are isolated from anthropogenic disturbance, have been rapidly overtaken by this invasive plant in the last 10 years. Observations of Spotted Turtles in these areas have dropped >50-90%. The coastal wetlands of Georgian Bay are likely to be invaded by this species with the continued drop in water levels due to climate change. Invasive *Phragmites* limits turtle movement and basking opportunities; it reduces nesting habitat availability; it lowers nest incubation temperatures, nest success, and survival of hatchlings overwintering in the nest chamber; and it increases the risk of fire and drought in wetlands. Once *Phragmites* becomes established in dense mono-cultural stands the habitat is rendered unusable and is equivalent to habitat loss.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.2	Problematic native species		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs)	Some populations occur in human-influenced landscapes with increased numbers of subsidized predators (i.e. mammals that become more abundant due to increased resources provided by humans). Turtle studies in these areas have found up to 80-100% nest depredation rates for other turtle species and it is assumed that Spotted Turtle nests experience similar rates of depredation. One Spotted Turtle monitoring study reported that 8 of 11 nests (73%) were depredated.
8.3	Introduced genetic material						Negligible.
9	Pollution		Unknown	Small (1-10%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Small (1-10%)	Unknown	High (Continuing)	Coastal wetlands in southern Georgian Bay are exposed to excessive amounts of urban phosphates. The same is likely true for Lake Erie coastal wetlands.
9.2	Industrial & military effluents						Negligible.
9.3	Agricultural & forestry effluents		Unknown	Small (1-10%)	Unknown	High (Continuing)	Coastal wetlands in southern Georgian Bay and Lake Erie are exposed to excessive amounts of agricultural phosphates and run-off.
9.4	Garbage & solid waste						Negligible.
9.5	Air-borne pollutants						Negligible.
9.6	Excess energy						Negligible.
10	Geological events						
10.1	Volcanoes						Negligible.
10.2	Earthquakes/tsunamis						Negligible.
10.3	Avalanches/landslides						Negligible.
11	Climate change & severe weather		Unknown	Restricted – Small (1-30%)	Unknown	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.1	Habitat shifting & alteration		Unknown	Restricted – Small (1-30%)	Unknown	High (Continuing)	Overwintering mortality has been reported at some sites and one current study reports an ongoing overwintering mortality rate of 1-2 dead turtles/year since 1999. Lowered water levels and harsher winters resultant from climate change may exacerbate overwintering mortality through increasing the occurrence of anoxic and freezing conditions within hibernation sites. Lowered water levels in coastal wetlands causes premature drying and succession leading to habitat loss. Lower water levels and warmer temperatures are also conducive to the spread of invasive *Phragmites* which causes habitat degradation and loss.
11.2	Droughts						Warming temperatures and lowered water levels can lead to drought conditions within wetlands and increases the rate of spread of invasive *Phragmites.* Drought has led to fire and mortality of Spotted Turtles at one site. The presence of large dead stands of *Phragmites* increases the potential of fire hazards within wetlands.
11.3	Temperature extremes						Spotted Turtle is temperature sex dependent and higher temperatures produce more females. It has been speculated that this may skew population sex ratios; however, given that this species' range occurs through to the southern U.S. this threat is considered negligible.
11.4	Storms & flooding						Negligible.