COSEWIC
Assessment and Status Report

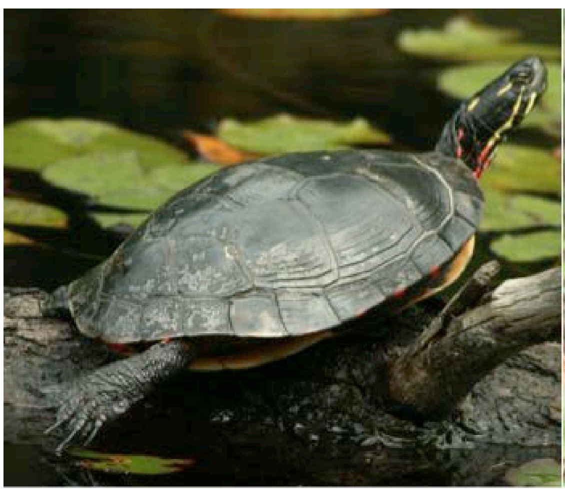
on the

Midland Painted Turtle
Chrysemys picta marginata

and the

Eastern Painted Turtle
Chrysemys picta picta

in Canada

SPECIAL CONCERN
2018

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. 2018. COSEWIC assessment and status report on the Midland Painted Turtle *Chrysemys picta marginata* and the Eastern Painted Turtle *Chrysemys picta picta* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xvi + 107 pp. (http://www.registrelep-sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Production note:
COSEWIC acknowledges Patrick Moldowan for writing the status report on Midland Painted Turtle and Eastern Painted Turtle *Chrysemys picta marginata* and *C. p. picta* in Canada. This report was overseen by Jim Bogart and subsequently by Tom Herman, Co-chairs of the COSEWIC Amphibians and Reptiles Specialist Subcommittee (A&R SSC). Modifications to the status report after acceptance of the provisional report were overseen by Tom Herman, based on comments from jurisdictions, experts, A&R SSC, and COSEWIC members.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la Tortue peinte du Centre (*Chrysemys picta marginata*) et la Tortue peinte de l'Est (*Chrysemys picta picta*) au Canada.

Cover illustration/photo:
Photo: (Left) Midland Painted Turtle, *Chrysemys picta marginata*, by Patrick Moldowan and (Right) Eastern Painted Turtle, *C. p. picta*, by Scott Gillingwater.

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COSEWIC
Assessment Summary

Assessment Summary – April 2018

Common name
Midland Painted Turtle

Scientific name
Chrysemys picta marginata

Status
Special Concern

Reason for designation
The loss of >70% of wetlands in southern Ontario over the past 200 years (<6 turtle generations) has very likely resulted in significant regional declines in both abundance and distribution of this species, although quantitative data on declines are limited. The species is subject to a suite of continuing threats, including road mortality, habitat degradation and loss, invasive species, and subsidized predators, which are unlikely to diminish in the future. The 'slow' life history of turtles, characterized by exceedingly late maturation, high adult survival, and long generation time, increases vulnerability and limits population resilience to these threats. The species may become Threatened if these threats are neither reversed nor managed with demonstrable effectiveness.

Occurrence
Ontario, Québec

Status history
Designated Special Concern in April 2018.

Assessment Summary – April 2018

Common name
Eastern Painted Turtle

Scientific name
Chrysemys picta picta

Status
Special Concern

Reason for designation
This widespread species is subject to a suite of continuing threats, including road mortality, habitat degradation and loss, invasive species, and subsidized predators, which are unlikely to diminish in the future. Although data on declines of this species are limited, the 'slow' life history of turtles, characterized by late maturation, long lifespan, and long generation time, increases vulnerability constrains resilience to these threats. The species may become Threatened if these threats are neither reversed nor managed with demonstrable effectiveness.

Occurrence
Québec, New Brunswick, Nova Scotia

Status history
Designated Special Concern in April 2018.

COSEWIC
Executive Summary

Midland Painted Turtle
Chrysemys picta marginata

and the

Eastern Painted Turtle
Chrysemys picta picta

Wildlife Species Description and Significance

Painted Turtle (*Chrysemys picta*) is a small to medium-sized freshwater turtle widespread across North America. In eastern Canada and the northeastern United States, two subspecies are recognized: Midland Painted Turtle (*C. p. marginata*) and Eastern Painted Turtle (*C. p. picta*). Painted Turtles play multiple ecological roles in aquatic ecosystems, including nutrient cycling and seed dispersal, and are of cultural importance for Aboriginal peoples of Canada. In addition, Painted Turtles have been the subject of numerous comparative life history studies and are frequently used as model organisms in experimental studies. The species' large geographic range, gregarious basking behaviour, and easily recognizable colours and patterns have made it a flagship species to naturalists, biologists, and the general public.

Distribution

Painted Turtle has one of the largest and most northerly geographic ranges of freshwater turtles of North America, largely owing to their adaptability and cold tolerance. In southern Canada, the species is found in a non-continuous (Canadian) distribution from British Columbia east to New Brunswick and Nova Scotia. Western Painted Turtle (*C. p. bellii*), the range of which extends from British Columbia to northwestern Ontario, was recently re-assessed by COSEWIC (2016). The range of Midland Painted Turtle extends from Ontario and western Québec south to the Great Lakes-Ohio Valley states. Eastern Painted Turtle is found in New Brunswick, Nova Scotia, and the Atlantic coastal states east of the Appalachian Mountains. A broad but poorly delineated zone of intergradation exists between Midland and Eastern Painted Turtles in Québec.

Habitat

Painted Turtles occupy slow moving, relatively shallow and well-vegetated wetlands (e.g., swamps, marshes, ponds, fens, bogs, and oxbows) and water bodies (e.g., lakes, rivers, creeks, and streams) with abundant basking sites and organic substrate. These turtles are found in association with submergent aquatic plants, which are used for cover and feeding. The species is semi-tolerant of human-altered landscapes and may occasionally be found occupying urban ponds and lands subject to anthropogenic disturbance (e.g., farm ponds, impoundments, water treatment facilities). Suitable nesting habitat includes open, often south-facing, and sloped areas with sandy-loamy and/or gravel substrate usually within 1200 m of aquatic active season habitats. Painted Turtles overwinter in shallow water with deep sediment.

Biology

With slow growth, late age at maturity, low juvenile survival but high post-maturity survival, long lifespan, and low annual reproductive investment, Painted Turtles exemplify the bet-hedging life history strategy consistent among turtles. Low temperatures and short growing seasons constrain annual growth of individuals in northern populations. Nest and juvenile survival are low and often highly stochastic due to predation. However, adult males and females demonstrate exceptionally high annual survivorship (97-98%), which is important for achieving high lifetime reproductive potential and maintaining population stability. The lifespan of Painted Turtles exceeds 60 years in the wild, although maximum age and maximum reproductive lifespan remain unknown. Midland Painted Turtles exhibit a generation time of 29-44 years for subpopulations in Canada, and it is likely similar for Eastern Painted Turtles. Life history data show that the Painted Turtle, like all other turtle species in Canada, is vulnerable to chronic increases in adult mortality. Mating occurs in spring and autumn, nesting in late spring and summer, and young hatch in autumn. Owing to the evolution of physiological tolerance of low temperatures and low oxygen, hatchlings are capable of overwintering on land in their natal nests, and adults may spend half the year submerged in wetlands with very low dissolved oxygen while inactive during hibernation. Despite the scope of research conducted on Painted Turtles across the species' range, there is still a great deal unknown about their basic biology, especially for Eastern Painted Turtles in Atlantic Canada.

Population Sizes and Trends

Population densities of Painted Turtles can reach high values but are also subject to considerable regional variability and some temporal fluctuation. Sex ratios are also highly variable among populations and may be influenced by differential mortality between the sexes and/or environmental conditions during egg incubation. In Canada, localized population declines have been observed, including in areas of protected habitat, though subpopulations in more remote areas are likely stable. There are insufficient historical and contemporary data across the range of Midland and Eastern Painted Turtles to evaluate subpopulation statuses and estimate sizes and trends for local, regional, and national subpopulations.

Threats and Limiting Factors

Midland and Eastern Painted Turtles are subject to a myriad of threats including, but not limited to: road mortality, habitat loss, subsidized predators, introduced plant and animal species, climate change, fisheries by-catch, pollution, disease, and collection. The many threats that reduce adult survival and recruitment destabilize the species' otherwise adaptive bet-hedging strategy. Rapid environmental changes brought on by humans undermine the long-term scale over which turtles have evolved their life history characters. Limiting factors include slow reproductive rate and low temperatures that limit reproductive success.

Protection, Status and Ranks

Painted Turtle is recognized as a species of Least Concern by the International Union for Conservation of Nature Red List and populations are considered secure across most of North America. Midland and Eastern Painted Turtles are afforded legal protection from being harassed, injured, killed, captured, maintained captive, and exported in all Canadian provinces in which they occur.

TECHNICAL SUMMARY - Midland Painted Turtle

Chrysemys picta marginata

Midland Painted Turtle

Tortue peinte du Centre

Range of occurrence in Canada (province/territory/ocean): Ontario, Québec

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	Generation time = Age at Maturity + [1/annual mortality] ~30 years (southern subpopulations). ~45 years (central-northern subpopulations). Three generations = ~90-135 years [See **BIOLOGY** for values that inform generation time estimates]
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, inferred decline from wetland loss and projected decline from ongoing threats. There is limited evidence of population-level declines in the southern portion of Canada where threats are extreme; however, absence of baseline data limits knowledge of population declines over the past three generations; see **THREATS AND LIMITING FACTORS**. No quantitative analyses of regional or range-wide abundance and population status available.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown. No quantitative analyses of regional or range-wide abundance, population status, or projections available.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown. Insufficient baseline data over past 3 generations (90-135 years). No quantitative analyses of regional or range-wide abundance and population status are available. A historic decline in mature individuals is likely in the highly developed regions of southern Canada (Carolinian, Great Lakes/St. Lawrence), particularly southern Ontario and southwestern Quebec. Lower density subpopulations in central-northern regions (Canadian Shield) are more likely to have remained stable.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown. No quantitative analyses of regional or range-wide abundance and population status are available.

[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown. No quantitative analyses of regional or range-wide abundance and population status available. There is evidence of population-level declines, including decline in number of mature individuals, in the southern portion of Canada; however, an absence of baseline data limit knowledge of population declines over the past three generations (90-135 years); Threats Calculator results indicate a possible ~3-70% population reduction (per Table 4 of Threats Calculator Guidelines). See **THREATS AND LIMITING FACTORS**.
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No, threats not clearly reversible. b. Yes, threats largely understood. See **Threats Calculator**. c. No, threats ongoing.
Are there extreme fluctuations in number of mature individuals?	No. Life history constrains population growth rates, and declines (if any) are likely to occur steadily over an extended period of time. Declines are therefore difficult to detect.

Extent and Occupancy Information

Estimated extent of occurrence	521,200 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	≫ 2000 km²
Is the population "severely fragmented" i.e. is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No. b. No.
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	Unknown. Road mortality is probably the single greatest threat across the species' range, but varies both within and among the wetland complexes that encompass individual subpopulations. This multi-scaled variation makes it difficult to ascertain number, but intuitively it is presumed to be large (>>10).
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes. Projected based on ongoing threats of habitat loss and degradation.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No.
Is there an [observed, inferred, or projected] decline in number of "locations"?	No.

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

Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes. Observed, inferred, and projected decline in area, extent, and quality of habitat.
Are there extreme fluctuations in number of subpopulations?	No. Life history constrains population growth rates. Declines, if any, are likely to occur steadily over an extended period of time.
Are there extreme fluctuations in number of "locations"?	No. Relatively short dispersal distance and small range size limit fluctuation in number of locations.
Are there extreme fluctuations in extent of occurrence?	No. Relatively short dispersal distance and small range size limit fluctuation in extent of occurrence.
Are there extreme fluctuations in index of area of occupancy?	No. Relatively short dispersal distance and small range size limit fluctuation in area of occupancy.

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
	Unknown.
Total	Number of adults not known, but likely > 10,000

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	No quantitative analyses of regional or range-wide abundance, population status, or projections available.

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Was a threats calculator completed for this species and if so, by whom?

Yes; completed as collaborative effort of Patrick Moldowan (report writer), Jim Bogart (Facilitator and COSEWIC Reptile and Amphibian Committee Chair), Bev McBride (COSEWIC Secretariat), Ron Brooks, Jackie Litzgus, Matthew Keevil, Joe Crowley, Isabelle Picard, Yohann Dubois, Connie Browne, Jeffie McNeil, Mary Sabine, Wayne Weller (Appendix II).

Overall Threat Impact High (high range) and Medium (low range).

i. Roads (4.1) – major source of mortality during dispersal and seasonal movements, nesting on roads/shoulders, and nest compaction on roadside nests; increased traffic volume, and to lesser extent road expansion will exacerbate problem. Predicted impact: Medium-Low (Scope Large-Restricted, Severity Moderate)

ii. Invasive Non-Native/Alien Species (8.1) - Common Reed and Canary Reed Grass displacing turtles from wetland habitat and encroaching on nesting habitat. Red-eared Sliders (*Trachemys scripta*) and other non-native turtles as competitors and disease/parasite vectors. Asian carp and sport fish introductions (bass, muskellunge, pike, etc.) as source of mortality for young turtles. Predicted impact: Low (Scope Restricted, Severity Slight)

iii. Residential and commercial development (1.1,1.2) - eliminating habitat. Predicted impact: Low (Scope Small, Severity Serious)

iv. Fishing and Harvesting Aquatic Resources (5.4) – by-catch of turtles likely grossly under-reported. Predicted impact: Low (Scope Small, Severity Moderate-Slight)

v. Recreational Activities (6.1) – boating and fishing source of mortality, injury (hook ingestion), and frequent disturbance of basking; beach recreation disturbs nesting and contributes to nest failure from erosion/soil compaction; off-road vehicle use source of mortality and nest destruction.

Predicted impact: Low (Scope Small, Severity Slight) vi. Problematic Native Species (8.2) - Subsidized (nest) predators in urban and semi-urban areas a major threat. Recent isolated cases of Common Raven depredation of nesting female Painted Turtles. Predicted impact: Low (Scope Small, Severity Slight) vii. Logging and Wood Harvesting (5.3) – degradation of aquatic habitat due to adjacent terrestrial harvesting activity. Predicted impact: Low (Scope Small, Severity Slight)

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Secure status in adjacent states (Michigan, New Hampshire, Vermont).
Is immigration known or possible?	Possible, although unlikely given development and natural barriers along the Canada-United States border.
Would immigrants be adapted to survive in Canada?	Yes.
Is there sufficient habitat for immigrants in Canada?	Yes.
Are conditions deteriorating in Canada?[+]	Yes. See **THREATS AND LIMITING FACTORS.**
Are conditions for the source population deteriorating?[+]	Possible, although Painted Turtle populations in adjacent U.S. states (Michigan, New Hampshire, Vermont) considered Secure.
Is the Canadian population considered to be a sink?[+]	No.
Is rescue from outside populations likely?	Possible, but unlikely. (see **Rescue Effect**).

Data Sensitive Species

Is this a data sensitive species? No.

Status History:

COSEWIC: Designated Special Concern in April 2018.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** not applicable.
Reasons for designation: The loss of >70% of wetlands in southern Ontario over the past 200 years (<6 turtle generations) has very likely resulted in significant regional declines in both abundance and distribution of this species, although quantitative data on declines are limited. The species is subject to a suite of continuing threats, including road mortality, habitat degradation and loss, invasive species, and subsidized predators, which are unlikely to diminish in the future. The ‘slow’ life history of turtles, characterized by exceedingly late maturation, high adult survival, and long generation time, increases vulnerability and limits population resilience to these threats. The species may become Threatened if these threats are neither reversed nor managed with demonstrable effectiveness.	

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

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. However, Threats Calculator results indicate a possible approx. 3-70% population reduction (per Table 4 of Threats Calculator Guidelines).
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO and IAO greatly exceed threshold values.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Precise population size is unknown but exceeds 10,000 adults.
Criterion D (Very Small or Restricted Population): Not applicable. Population is neither very small nor very restricted.
Criterion E (Quantitative Analysis): Insufficient data available to perform analysis.

TECHNICAL SUMMARY - Eastern Painted Turtle

Chrysemys picta picta

Eastern Painted Turtle

Tortue peinte de l'Est

Range of occurrence in Canada: Québec, New Brunswick, Nova Scotia

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	Generation time = Age at Maturity + [1/annual mortality] 30 years (southern subpopulations). 45 years (central-northern subpopulations). Three generations = ~90-135 years [see **BIOLOGY**; life history characters for Eastern Painted Turtle in Canada have not been studied, so estimates were informed by data for Midland Painted Turtle.]
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown. An absence of baseline data limits knowledge of population declines over the past three generations. No quantitative analyses of regional or range-wide abundance and population status available
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown. An absence of baseline data limits knowledge of population declines over the past three generations 90-135 years. No quantitative analyses of regional or range-wide abundance or population status available.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown. An absence of baseline data limits knowledge of population declines over the past three generations (90-135 years). Threats Calculator results indicate a possible 3-30% population reduction (per Table 4 of Threats Calculator Guidelines). see **THREATS AND LIMITING FACTORS**. No quantitative analyses of regional or range-wide abundance and population status available.
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No, threats not clearly reversible. b. Yes, threats are partly understood (see **Threats Calculator**). c. No, threats ongoing.

Are there extreme fluctuations in number of mature individuals?	No. Life history constrains population growth rates, and declines are likely to occur steadily over extended period of time. Declines are therefore difficult to detect.

Extent and Occupancy Information

Estimated extent of occurrence	87,845 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	1,100 km²
Is the population "severely fragmented" i.e. is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No. b. No.
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	Unknown. Road mortality is probably the single greatest threat across the species' range but varies both within and among the wetland complexes that encompass individual subpopulations. This multi-scaled variation makes it difficult to ascertain number, but intuitively it is presumed to be large (>>10)
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, projected if threats continue
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown.
Is there an [observed, inferred, or projected] decline in number of "locations"?	Unknown.
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, inferred and projected decline in quality of habitat, based on continuing threats
Are there extreme fluctuations in number of subpopulations?	No. Life history constrains population growth rates. Declines are likely to occur steadily over an extended period of time. Fluctuations and/or declines are therefore difficult to detect.
Are there extreme fluctuations in number of "locations"?	No. Relatively short dispersal distance and small range size limit fluctuation in number of locations.
Are there extreme fluctuations in extent of occurrence?	No. Relatively short dispersal distance and small range size limit fluctuation in extent of occurrence.
Are there extreme fluctuations in index of area of occupancy?	No. Relatively short dispersal distance and small range size limit fluctuation in area of occupancy.

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

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
	Unknown.
Total	Number of adults not known, but probably exceeds 10,000.

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	No quantitative analyses of regional or range-wide abundance, population status, or projections available.

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Was a threats calculator completed for this species and if so, by whom?

Yes; as collaborative effort of Patrick Moldowan (report writer), Tom Herman (Facilitator and COSEWIC Reptile and Amphibian Committee Chair), Bev McBride (COSEWIC Secretariat), Connie Browne, Jeffie McNeil, and Mary Sabine (Appendix II).

Overall Threat Impact Medium.

i. Roads (4.1) – major source of mortality during dispersal and seasonal movements, nesting on roads/shoulders, and nest compaction on roadside nests; increased traffic volume especially on forestry and cottage access roads, and to lesser extent road expansion, will exacerbate problem. Predicted impact: Low (Scope Large, Severity Slight)

ii. Annual and Perennial Non-Timber Crops (2.1) – degradation of aquatic habitat due to adjacent terrestrial agricultural operations. Predicted impact: Low (Scope Restricted, Severity Slight)

iii. Housing and urban areas (1.1) – Cottage/seasonal (second) home development along shoreline habitats in both New Brunswick and Nova Scotia eliminating and degrading habitat. Predicted impact: Low (Scope Small, Severity Moderate)

iv. Logging and Wood Harvesting (5.3) – degradation of aquatic habitat due to adjacent terrestrial activity especially in light of increased harvesting in southwest NS, although extent of impact is uncertain. Predicted impact: Low (Scope Restricted-Small, Severity Slight)

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Stable status in adjacent states (Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut).
Is immigration known or possible?	Possible.
Would immigrants be adapted to survive in Canada?	Yes.
Is there sufficient habitat for immigrants in Canada?	Yes.
Are conditions deteriorating in Canada?[+]	Unknown. See **THREATS AND LIMITING FACTORS.**

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

Are conditions for the source population deteriorating?[+]	Possible, although Painted Turtle populations in adjacent U.S. states (Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut) considered Secure.
Is the Canadian population considered to be a sink?[+]	No.
Is rescue from outside populations likely?	Possible, with human intervention (see **Rescue Effect**).

Data Sensitive Species

Is this a data sensitive species? No.

Status History

COSEWIC: Designated Special Concern in April 2018.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** not applicable
Reasons for designation: This widespread species is subject to a suite of continuing threats, including road mortality, habitat degradation and loss, invasive species, and subsidized predators, which are unlikely to diminish in the future. Although data on declines of this species are limited, the ‘slow’ life history of turtles, characterized by late maturation, long lifespan, and long generation time, increases vulnerability constrains resilience to these threats. The species may become Threatened if these threats are neither reversed nor managed with demonstrable effectiveness.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. However, Threats Calculator results indicate a possible approximately 3-30% population reduction (per Table 4 of Threats Calculator Guidelines).
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. While IAO is below threshold values for Threatened, only 1 subcriterion (b) is met (i.e. continuing declines in quality of habitat and number of mature individuals). Subciterion (a) and (c) are not met, there are >10 locations, severe fragmentation cannot be demonstrated, and population fluctuations are not extreme. IAO is an underestimate based mainly on incidental observations.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Precise population size is unknown but could exceed 10,000 adults distributed in numerous subpopulations, the sizes of which are unknown.
Criterion D (Very Small or Restricted Population): Not applicable. Population is neither very small nor very restricted.
Criterion E (Quantitative Analysis): Insufficient data available to perform analysis.

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

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
(2018)

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

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

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

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

Environment and Climate Change Canada
Canadian Wildlife Service

Environnement et Changement climatique Canada
Service canadien de la faune

Canada

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

COSEWIC Status Report

on the

Midland Painted Turtle
Chrysemys picta marginata

and the

Eastern Painted Turtle
Chrysemys picta picta

in Canada

2018

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

There are two species of Painted Turtle (genus *Chrysemys*) according to Crother (2012): Southern Painted Turtle (*C. dorsalis* Agassiz 1857) and Painted Turtle (*C. picta* Schneider 1783), with the latter divided into three subspecies, Western Painted Turtle (*C. p. bellii* Gray 1831), Midland Painted Turtle (*C. p. marginata* Agassiz 1857), and Eastern Painted Turtle (*C. p. picta* Schneider 1783) (Starkey *et al.* 2003; TTWG 2014). The Western, Midland, and Eastern subspecies cannot be distinguished using mitochondrial genome sequences based on specimens from the United States and western Canada (Starkey *et al.* 2003; Jensen *et al.* 2015). In contrast, the Southern Painted Turtle demonstrates 1.5-2.4% mitochondrial genome sequence divergence from all other Painted Turtles and forms a monophyletic sister group (Starkey *et al.* 2003; Jensen *et al.* 2015), though not all researchers necessarily recognize the Southern Painted Turtle as a distinct species (TTWG 2014; ITIS 2015). The species' name is derived from Greek "*chrysos*" meaning gold, "*emys*" meaning "freshwater tortoise", and Latin "*pictus*" meaning painted, in reference to the species' pattern and colouration.

Class: Reptilia
- Order: Testudines
  - Suborder: Cryptodira
    - Superfamily: Testudinoidea
      - Family: Emydidae
        - Subfamily: Deirochelyinae
          - Genus: *Chrysemys*
            - Species: *C. dorsalis*
            - Species: *C. picta*
              - Subspecies: *C. p. bellii, C. p. marginata, C. p. picta*

Morphological Description

Midland and Eastern painted turtles have a smooth carapace with head and throat marked with brilliant yellow striping transitioning to red on the neck and forelimbs (Ernst and Lovich 2009). The tail is typically marked with yellow or red stripe(s). The marginal scutes are marked with bright red dorsally and ventrally. The skin and carapace of both subspecies can range from olive to black (Cook 1984; Ernst and Lovich 2009). Numerous sexual dimorphisms have been described for painted turtles, including a larger female body size and carapace height, elongate male forelimb claws, and larger male pre-cloacal tail length (Ernst and Lovich 2009). Painted Turtles possess bicuspid tomiodonts (tooth-like cusps) on the upper beak that flank a V-shaped notch (Moldowan *et al*. 2016), a feature distinguishing them from other freshwater turtle species in Canada.

The Midland and Eastern subspecies are distinguished by the degree of carapace scute disalignment, width of the light-coloured banding on the anterior portions of the carapace scutes, and plastron pattern/colouration (Figure 1; Bishop and Schmidt 1931; Hartman 1958; Ultsch *et al.* 2001). On the Eastern Painted Turtle, the front edges of the costal and vertebral scutes form a straight (or nearly so) row (Bishop and Schmidt 1931; Conant and Collins 1998). The anterior edges of the carapace (costal-vertebral) scute rows are marked with olive-yellow, forming broad colour bands across the carapace (Bishop and Schmidt 1931; Conant and Collins 1998). In contrast, the costal and vertebral scutes of Midland Painted Turtles are found in an alternating arrangement across the carapace and rarely exhibit the light olive band along the leading edge (Bishop and Schmidt 1931; Conant and Collins 1998). The plastron of Eastern Painted Turtles is an immaculate yellow mostly absent of patterning (although a small plastron blotch may be present), whereas Midland Painted Turtles feature a dark blotch along the midline of the plastron that varies in size, shape, and intensity (Bishop and Schmidt 1931; Conant and Collins 1998). Juveniles and occasionally adults of both subspecies may exhibit a medial red stripe running the length of the carapace.

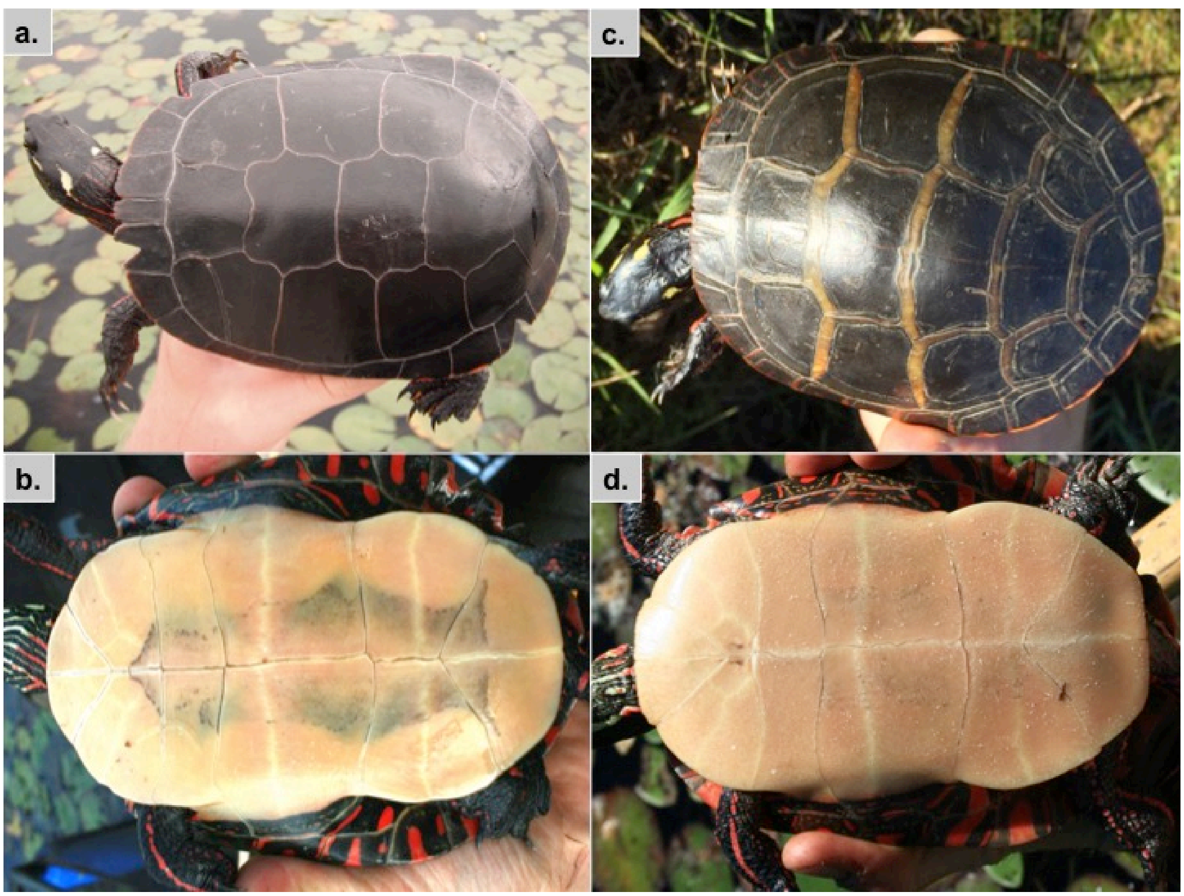

Figure 1. Morphology of Midland Painted Turtle (*Chrysemys picta marginata*) a. carapace and b. plastron; Eastern Painted Turtle (*C. p. picta*) c. carapace and d. plastron. Note differences in carapace scute alignment, banding along the anterior edge of carapace scutes, and size/intensity of plastron blotch (see **Morphological Description**). Photos: a. Matthew Keevil, b. and d. Patrick Moldowan, and c. Kelsey Marchand.

Adult body size varies considerably among Painted Turtles but there is an overall increase with latitude (Rhodin and Mittelhauser 1994; Lindeman 1997; Litzgus and Smith 2010). Painted Turtles are unlikely to be confused with other native turtle species; however, their resemblance to introduced Red-eared Slider (*Trachemys scripta* ssp.) and cooters (*Pseudemys* spp.) may lead to misidentification. Body size data have been compiled for Midland and Eastern Painted Turtles in eastern Canada and selected U.S. populations (Appendix I, Table A1). The size record for Eastern Painted Turtles ranges from 185-190 mm (Ultsch *et al.* 2000) up to 207 mm straight midline carapace length (Browne and Sullivan 2017).

Population Spatial Structure and Variability

Recent large-scale genetic studies of Painted Turtles (Starkey *et al.* 2003; Jensen *et al.* 2015) have largely or wholly neglected the assessment of individuals in Ontario, Québec, and Maritime provinces. Molecular studies demonstrate that Midland Painted Turtles and Eastern Painted Turtles are not genetically distinct in areas of the northeastern United States (Starkey *et al.* 2003; Jensen *et al.* 2015). The two subspecies readily interbreed and form a seemingly broad, albeit poorly defined, intergradation zone in Québec (see **DISTRIBUTION**). See **Morphological Description**, **Designatable Units,** and **DISTRIBUTION** for information regarding population spatial structure.

Designatable Units

Two designatable units (DUs) are proposed for Painted Turtles in eastern Canada: i) Midland Painted Turtle in south-central Ontario and Québec, and ii) Eastern Painted Turtle in Québec, New Brunswick, and Nova Scotia. These two DUs are proposed on the basis of:

1. Subspecies or varieties: Traditional taxonomic classification has recognized Midland and Eastern Painted Turtle in eastern North America; however, recent analyses suggest a lack of genetic distinctiveness between these subspecies and have questioned their validity (see **Population Spatial Structure and Variability**). However, to date, sampling in these studies (Starkey *et al.* 2003; Jensen *et al.* 2015) has overlooked the Canadian range of these two subspecies, limiting inference about the taxonomic status of these subspecies in Canada. Until Canadian specimens are assessed, the traditional subspecific status of these two designatable units in Canada cannot be refuted and is retained.

2. Discrete and evolutionarily significant populations: The two subspecies are hypothesized to have originated from distinct glacial refugia prior to the colonization of Canada (see **DISTRIBUTION**). Presently, the two subspecies largely occupy different COSEWIC-designated amphibian and reptile faunal provinces (Green 2003). These provinces in part reflect glacial history, and the post-glacial recolonization patterns of herpetofauna in Canada. Midland Painted Turtle is present in the Carolinian, Great Lakes/St. Lawrence, and Canadian Shield faunal provinces and Eastern Painted Turtle is present in the Appalachian/Atlantic Coast faunal province (COSEWIC Operations and Procedures Manual (Nov 2016), Appendix F5,

Figure 3a). A broad but poorly defined zone of intergradation exists between Midland Painted Turtles and Eastern Painted Turtles in the southern regions of the eastern townships of Québec (Weller pers. comm. 2015) and may extend further east. Painted Turtles in Maritime Canada can demonstrate characteristics of both Midland and Eastern subspecies (Cook 1984; Gilhen 1984; Ultsch *et al.* 2001; NSM 2015), leading to further question of the geographic range of intergrade forms. Additional research on the distribution, morphology, ecology, and genetics is necessary in order to properly delineate the zone of intergradation between Midland and Eastern Painted Turtles in Canada.

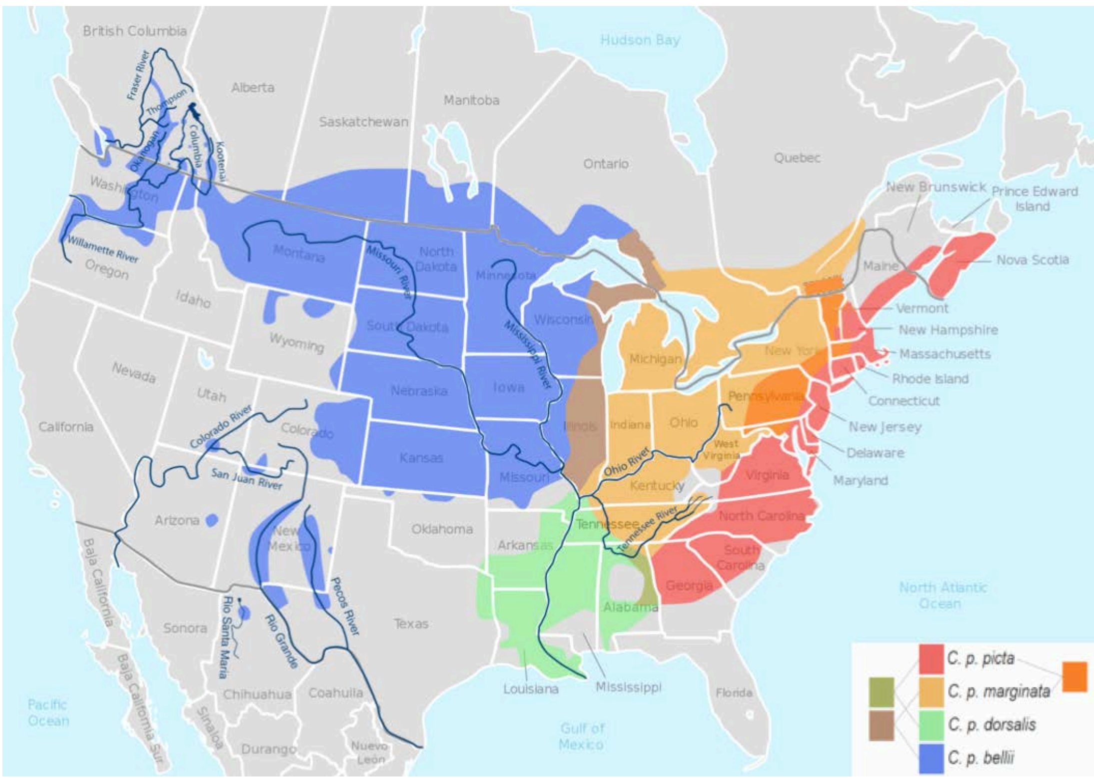

Figure 2. Painted Turtle (*Chrysemys* spp.) geographic distribution across North America. Respective areas of intergradation demonstrated with colour overlay. The ambiguous zone of intergradation for Midland and Eastern Painted Turtles in Québec is delineated with a dashed outline. Map sourced from Wikipedia (2015) with edits by Ian Adams (pers. comm. 2016) for the Western Painted Turtle range in British Columbia and Alberta and Patrick Moldowan (2016) for the Midland and Eastern Painted Turtle range in eastern Canada (including additions to reflect the research of Weller *et al.* (2010) and Weller (pers. comm. 2016) in northwestern Ontario and southern Québec, Wright and Andrews (2002) in Vermont, and C. Browne (pers. comm. 2016) in New Brunswick). Legend inset courtesy Canadian Wildlife Service Québec.

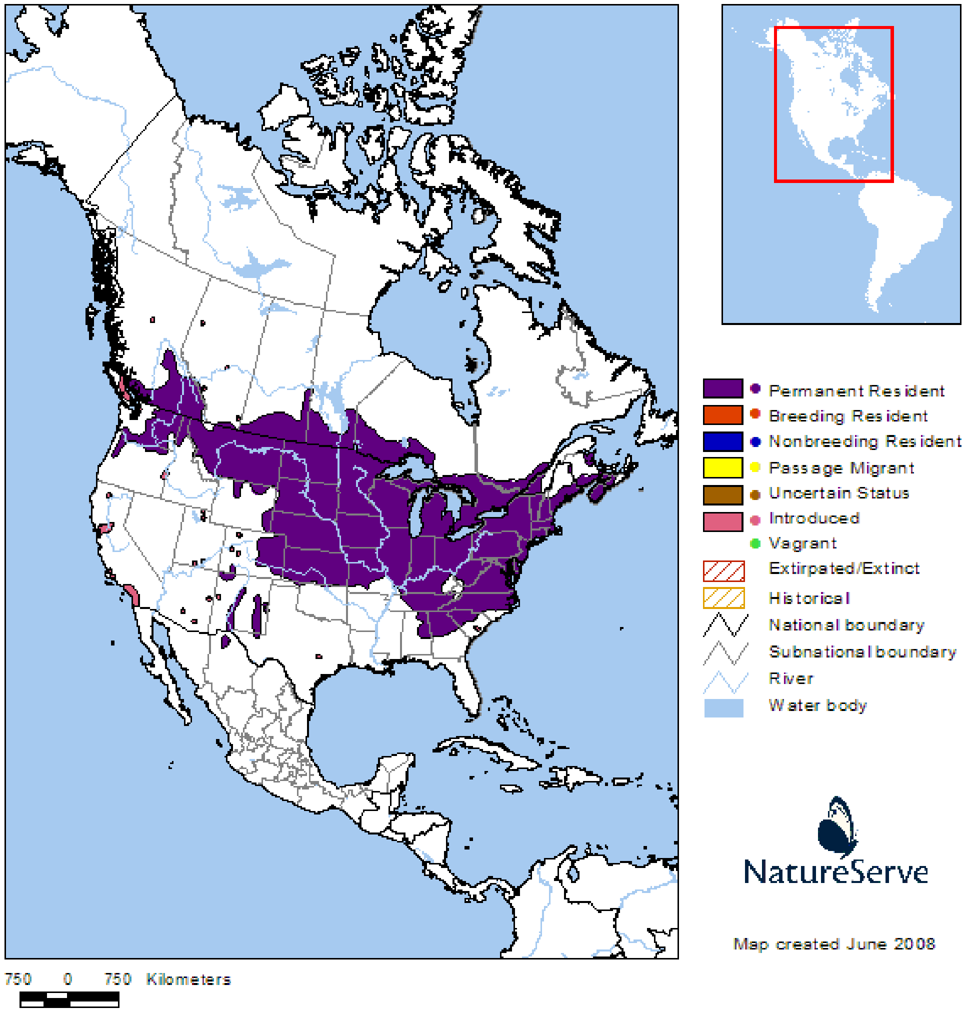

Figure 3. Painted Turtle (*Chrysemys picta*) geographic distribution across North America. Note that subspecific designations are not represented. Map from NatureServe (2016) based on data current as of 2008.

Intergrades of Midland-Western Painted Turtle in northwestern Ontario and of Midland-Eastern Painted Turtle in Québec, occurring due to natural hybridization, are eligible for inclusion as part of the wildlife species being assessed by COSEWIC (COSEWIC 2010).

Special Significance

Painted Turtles fulfill multiple ecological roles in aquatic ecosystems, including nutrient cycling and seed dispersal (see **Interspecific Interactions**) and are of cultural importance for Canadian Aboriginal peoples. Shells and ornaments made from Painted Turtles have been found in abundance in Aboriginal burial and midden sites across Ontario and eastern North America (Johnson 1960, 1968; Emerson and Noble 1966; Rhodin and Bulter 1997; Pearce 2005). Bones and shells of Painted Turtles, modified for use as utensils, ceremonial objects (e.g., rattles), and religious objects, have been recovered from prehistoric and historic Aboriginal sites (Pearce 2005; Holman 2012). Ontario is home to an extensive collection of Iroquoian ceremonial rattles made of Painted Turtles and art featuring turtle effigies dating from at least the 13th century (Pearce 2005). Shells of Painted Turtles have been recovered among Algonquin artifacts from Morrison Island in the Upper Ottawa River dating to 5,500 years ago (Clermont and Chapdelaine 1998). Painted Turtles may have been an important food item among Aboriginal people of North America, as evidenced by damage to preserved bones consistent with cooking (Holman 2012).

In addition, Painted Turtle is an important model species in multiple fields of biological study, such as developmental biology, environmental toxicology, ecology, and comparative life history biology (Valenzuela 2009; Shaffer *et al.* 2013; Cordero 2014). (Western) Painted Turtle was the first turtle, and second reptile, to have its genome sequenced, providing new evolutionary insights into longevity, sex determination, physiological capabilities, and phylogenetics (Shaffer *et al.* 2013). Conspicuous colouration and gregarious basking make Painted Turtles an easily recognizable flagship turtle species throughout Canada and North America. The iconic species is a relatable educational mascot among naturalists, scientists, and members of the public, and appears in the logo of the Canadian Herpetological Society.

DISTRIBUTION

Global Range

Painted Turtle has the largest geographic range among freshwater turtles of North America (Figures 2 and 3; Hecnar 1999; Reed and Gibbons 2003; Ernst and Lovich 2009). The length and temperature of the growing season, necessary for full term embryonic development, limits the northern distribution of the species (Bleakney 1958a; St. Clair and Gregory 1990; Holman and Andrews 1994; Brooks 2007). The range of Midland Painted Turtle extends from Ontario and Québec south to the Great Lakes-Ohio Valley states (Figure 2). Across its distribution, Midland Painted Turtle occupies ecozones characterized by mixed deciduous-coniferous forests and mixed wood plains with warm-hot continental climates (Bailey 1997, 1998). Eastern Painted Turtle is found in Québec (possibly intergrades with Midland), New Brunswick, Nova Scotia, and the Atlantic Coastal states east of the Appalachian Mountains, south to Georgia (Figure 2). In Atlantic Canada and along the Atlantic Coastal Plain of the United States, Eastern Painted Turtle is found in regions of mixed deciduous forest, broadleaved-coniferous evergreen forest and coniferous open woodland with warm-hot continental and subtropical climates (Bailey 1997, 1998). In Canada, Midland Painted Turtle occupies the Carolinian, Great Lakes/St. Lawrence, and Canadian Shield faunal provinces, whereas Eastern Painted Turtle is found in the Appalachian/Atlantic Coast faunal province as recognized by COSEWIC. The provincial and state occupancy of Midland Painted Turtle and Eastern Painted Turtle is listed below (Figures 2 and 3; Ernst and Lovich 2009; Van Dijk 2013; TTWG 2014; NatureServe 2016):

- Midland Painted Turtle: Ontario, Québec; Alabama, Illinois, Indiana, Kentucky, Michigan, New York, Ohio, Pennsylvania, Tennessee, and West Virginia. Intergradation with Eastern Painted Turtle occurs in Québec. Intergradation with Western Painted Turtle occurs in northwestern Ontario.

- Eastern Painted Turtle: Québec, New Brunswick, Nova Scotia; Alabama, Connecticut, Delaware, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Vermont, Virginia, West Virginia. Intergradation with Midland Painted Turtle occurs in Québec.

Introduced Painted Turtle populations are found in Spain, Germany, Philippines, and Indonesia (Van Dijk 2013). Midland and Eastern Painted Turtles have also been introduced outside their native range in countries where the subspecies naturally occurs (see discussion below of introduced populations in New Brunswick and western Canada; Figure 3).

Canadian Range

Three Painted Turtle subspecies are found across southern Canada in a non-continuous (Canadian) distribution from British Columbia east to New Brunswick and Nova Scotia (Figures 2 and 3). Fossil, geologic, and inferential genetic evidence suggest that Painted Turtles repeatedly colonized eastern Canada during interglacial periods of the Pleistocene with most recent colonization following the retreat of the Laurentide Ice Sheet <10,000 years ago (Bleakney 1958a,b; Holman and Andrews 1994; Starkey *et al.* 2003; McAlpine 2010). Painted Turtle and Snapping Turtle (*Chelydra* serpentina) are hypothesized to be among the first species to move northward following glacial retreat given their cold tolerance and representation in glacial fauna sediments (Holman and Andrews 1994). Following the most recent glacial period ending *circa* 10,000 years before present, Midland Painted Turtle is hypothesized to have migrated northward from a Mississippi Valley refugium into the Great Lakes and St. Lawrence River system (Bleakney 1958a,b). By contrast, Eastern Painted Turtle spread over New Brunswick and Nova Scotia from a glacial refuge along the Atlantic Coastal Plain of the present-day United States (Bleakney 1958a,b; Rhodin and Butler 1997; Starkey *et al.* 2003, but see thorough review by Ultsch *et al.* 2001). Painted Turtles are the most common reptile appearing in late Pleistocene and Holocene deposits of Michigan (Holman and Fisher 1993; Holman 2012). The fossil remains of Painted Turtles have been found in close association with those of Mastodon (*Mammut americanum*), dating to 80,000 to 70,000 years before present, in central Nova Scotia (Holman and Andrews 1994; Holman and Clouthier 1995). Painted Turtles have been recovered regularly during archaeological digs in Michigan spanning 8000-350 years before present (Holman 2012) suggesting their presence in Ontario during this period. The species is also reportedly abundant in archaeological dig sites in Ontario dating to the late Archaic Period, approximately 2000-1000 years ago (Pearce 2005). Discussion of the provincial distribution of Midland Painted Turtle and Eastern Painted Turtle follows.

Ontario (Figure 4):

Records from the Ontario Reptile and Amphibian Atlas indicate that Midland Painted Turtle is widely distributed in the province, occurring in at least 1400 10 km^2 observation squares (compared with the other most widely distributed turtle species in Ontario: Snapping Turtle (1425 squares) and Blanding's Turtle (*Emydoidea blandingii*) (782 squares); current as of 01 April 2017). Midland Painted Turtle is found throughout southern and central Ontario. The subspecies has been reported as common and widespread in southwestern Québec (Desroches pers. comm. 2015), Prince Edward County, Ontario (Christie 1997), eastern Ontario (designated as the area from Pembroke south to Kingston and east to the St. Lawrence River), and St. Lawrence Lowlands (Bleakney 1958a). Toner (1936) reported that the subspecies is "very common in every permanent body of water in [Leeds and Frontenac counties, Ontario]". Williams (1942) failed to observe Midland Painted Turtles during surveys of Manitoulin Island but reported the species as very common in ponds of nearby Cloche Island (contemporary records from the Ontario Reptile and Amphibian Atlas confirm that Midland Painted Turtle is present on Manitoulin Island). In northwestern Ontario, Midland Painted Turtle reaches its distributional limit in southern Algoma district (Mills 1948; Logier and Toner 1955) where this subspecies forms intergrades with Western Painted Turtle (Weller *et al.* 2010; Weller pers. comm. 2015). Putative Western-Midland intergrades have been identified along the southeastern shore of Lake Superior as far north as White River, Ontario (Weller pers. comm. 2015). In northeastern Ontario, the subspecies has been observed in north Nipissing district (Lake Timagami/Temagami; Logier and Toner 1955), southern Timiskaming district as far north as the town of Cobalt (Weller 2009), and more recently there are records from Timmins (ORAA 2016).

Québec (Figure 4):

The geographic distribution of Midland and Eastern Painted Turtles in Québec is unclear and conflicting reports limit our current understanding. Across Québec, Painted Turtles are purported to be Midland, Eastern, and/or Midland-Eastern intergrades (*C. p. marginata* x *C. p. picta*). Some recognize only Midland Painted Turtles in Québec (Laurendeau pers. comm. 2015). For others, subspecific distinction is not made in the province (AARQ 2015). The following is a summary of the current state of knowledge on Midland and Eastern Painted Turtles in Québec based on published records and reputable personal communications.

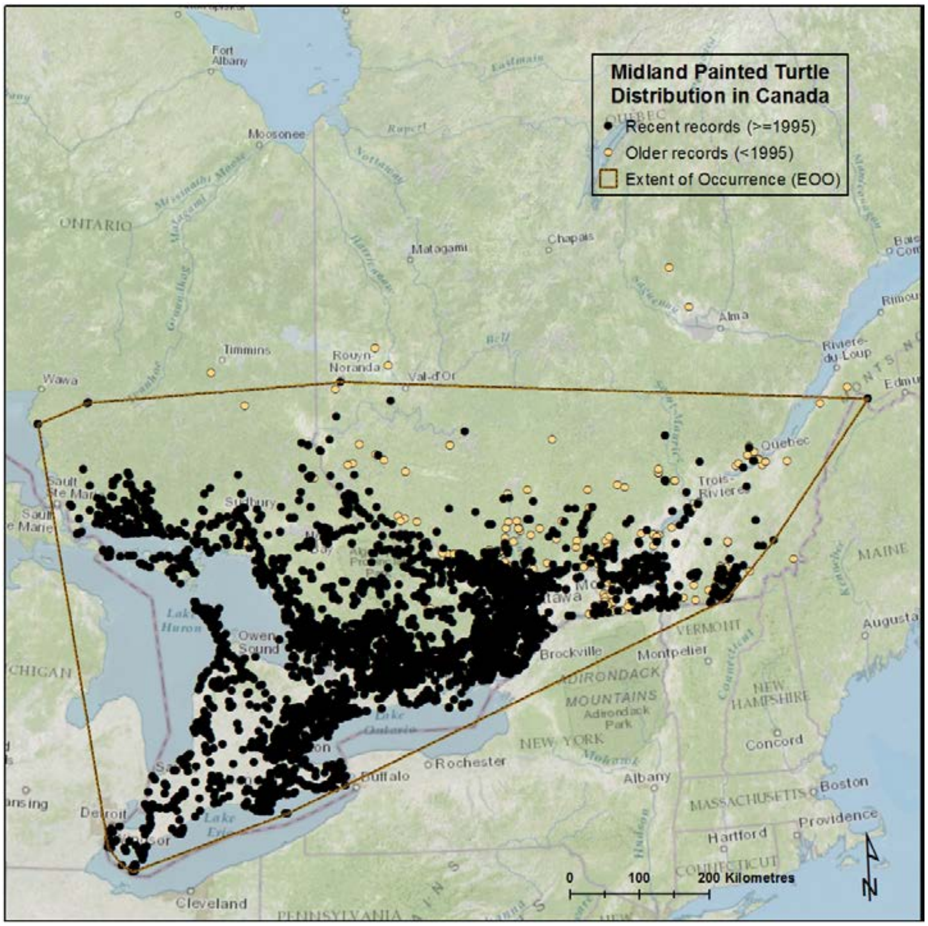

Figure 4. Geographic distribution of Painted Turtle (*Chrysemys picta*) in Ontario (*C. p. marginata*) and Québec (*Chrysemys picta* spp.), Canada. Note that the range boundary and zone of intergradation between *C. p. marginata* and *C. p. picta* in Québec are poorly known (see **DISTRIBUTION**) and not delineated on the map. Data used for Ontario map courtesy of the Ontario Reptile and Amphibian Atlas (Ontario Nature) and Natural Heritage Information Centre. Data for Québec map courtesy Centre de données sur le patrimoine naturel du Québec (Ministère des Ressources naturelles et de la Faune), Jean-François Desroches, and Isabelle Picard. Records of Midland-Western Painted Turtle intergrades (*C. p. marginata* x *C. p. bellii*) from Algoma district and eastern shore of Lake Superior, Ontario, not shown. Map produced by Alain Filion, Canadian Wildlife Service.

Midland Painted Turtle extends into western Québec (Mills 1948; Logier and Toner 1955, 1961). Historical records suggest Midland Painted Turtles and Eastern Painted Turtles form intergrades between the south St. Lawrence River and Lake Champlain (Mills 1948). An intergradation zone along the St. Lawrence River, if confirmed, would be consistent with a recognized intergradation zone further south in the Hudson River Valley of eastern New York/New England (Bishop and Schmidt 1931; Hartman 1958; Rhodin and Butler 1997) and Vermont (Wright and Andrews 2002). Preliminary evidence suggests that the Midland-Eastern Painted Turtle intergradation zone extends north along the St. Lawrence River and along the Ontario-Québec border (Weller, pers. comm. 2015). Morphological assessments of Painted Turtles across southern Ontario (watershed zones 1-7 and 9-10; Figure 5) using measures of carapace scute disalignment, width of banding on leading edge of carapace scutes, and plastron figure coverage, demonstrate characteristics consistent with Midland Painted Turtle. However, in extreme eastern Ontario (watershed zone 8) and extreme southwestern Québec (watershed zone 11), Painted Turtles demonstrate characters intermediate between Midland and Eastern subspecies. Moving eastward in Québec (watershed zones 12 and 13; Figure 5) morphological characters more strongly reflect those of Eastern Painted Turtle (Weller pers. comm. 2015). Additional observations suggest that Midland Painted Turtles or Midland-type turtles occur in Québec at least as far east as Magog with turtles of an intermediate Midland-Eastern types occurring in the Eastern Townships of the province (Desroches pers. comm. 2015). The reported occurrence of Midland Painted Turtles east to Québec City, with a few subpopulations identified near Rivière-du-Loup (Seburn and Brooks 2007), is believed to be in error, or at least represents Midland-Eastern intergrades. Recent range maps that suggest Midland Painted Turtle maintains a continuous distribution from southern Ontario to eastern Québec (Starkey *et al.* 2003; Jensen *et al.* 2015) are misleading and appear to result from an overall poor sampling effort in (eastern) Québec. Much-needed Midland and Eastern Painted Turtle intergradation research by W.F. Weller and J.-F. Desroches is ongoing in Québec (Weller pers. comm. 2015).

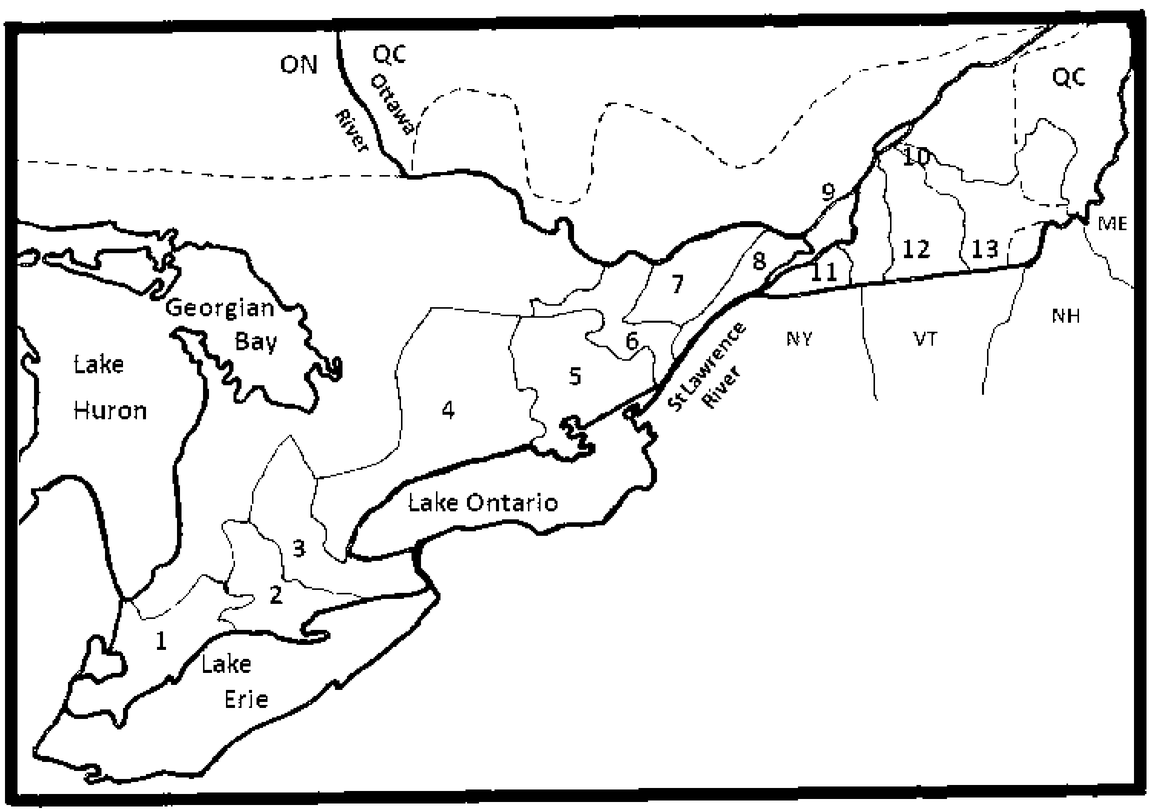

Figure 5. Watershed zones of southern Ontario and western Québec used in the identification of Midland and Eastern Painted Turtle intergradation (*Chrysemys picta marginata* x *C. p. picta*). Watershed zone 10 corresponds to the area south of Lac St. Pierre. Map courtesy W.F. Weller.

Mild climatic conditions of the Gatineau Valley have permitted the range of the Painted Turtle to extend over 100 km further north than the surrounding area (Bleakney 1958a). Historically, Painted Turtles have been rare in the Gatineau Valley, and absent from southeastern Québec, southern Laurentian Mountains, north shore of the Gulf of St. Lawrence, and Lac Saint-Jean/Saguenay Valley (Bleakney 1958a). In eastern Québec, few records extend north of Québec City along the south shore of the St. Lawrence River (Figure 4). This species is absent from the Gaspé Peninsula (Bleakney 1958a). Although historical records indicate Painted Turtles existing at low densities in the Beaupré region, Québec (Bider and Matte 1994), surveys by Desroches and Banville (2002) in 1998 failed to find any individuals. Trapido and Clausen (1938), citing Provancher (1874, 1875), report Eastern Painted Turtles as very rare in (eastern) Québec.

Nova Scotia (Figure 6):

During a post-glacial warming period(s), Eastern Painted Turtle is hypothesized to have colonized Nova Scotia via New Brunswick (Bleakney 1958a). Fossil remains from central Nova Scotia indicate that Painted Turtles were present during interglacial periods approximately 70,000-80,000 years ago (Holman and Clouthier 1995). The Eastern Painted Turtle population in Nova Scotia is believed to be an isolated relict, having persisted in a maritime climate refugium during a cooling period approximately 5,000-3,000 years ago (Bleakney 1952).

Early researchers mention Eastern Painted Turtle in Nova Scotia but provide few population-specific details (Mills 1948; Cagle 1954; Logier and Toner 1955). A historical record from Jones (1865) reported that Painted Turtles were abundant in small lakes, ponds, and ditches in Nova Scotia. Today, Eastern Painted Turtles are apparently widespread and abundant in southwestern and south-central Nova Scotia but scarce in the northeast (Gilhen 1984; Seburn and Brooks 2007). Bleakney (1952, 1958a, 1963) reported Eastern Painted Turtles as abundant from the south-central area of Nova Scotia and eastern portions of Kejimkujik National Park (“ubiquitous”, Bleakney 1963), and common in the Annapolis Valley, Musquodoboit Valley, Gay River Valley, and West River Saint Mary’s (Guysborough County). Eastern Painted Turtle has recently been recorded in the Lake Rossignol Wilderness Area, just south of Kejimkujik National Park (Frances *et al*. 2012). Bioclimatic and land cover models support these observations and predict a high probability of Eastern Painted Turtle occurrence only in the southwestern half of Nova Scotia where there are relatively higher annual temperatures, moderate to high forest cover, and large rivers and lakes (Tingley and Herman 2009). Eastern Painted Turtle is not found on Cape Breton Island or Prince Edward Island.

New Brunswick (Figure 6):

The population centre for Eastern Painted Turtle in New Brunswick is reputed to be the Grand Lake region with small subpopulations in Charlotte, Kings, York and Kent counties, and Rockwood Park in Saint John County (Seburn and Brooks 2007; Browne and Sullivan 2015; McAlpine pers. comm. 2015). Eastern Painted Turtle subpopulation in Rockwood Park is in the centre of the city of Saint John and may represent an isolated relict subpopulation or a site of (re)introduction (Browne pers. comm. 2015). Bleakney (1958a) noted the “isolated presence” of Eastern Painted Turtles in the lower Saint John River Valley and Grand Lake area. Between 1966-1975, individuals were reportedly common in the Grand Lake area (A. Madden cited in McAlpine and Godin 1986).

Although underreported, Eastern Painted Turtle apparently maintains a continuous distribution throughout the lower Saint John River and Oromocto River floodplains (Sabine pers. comm. 2016). However, it does not appear to be abundant anywhere in the province (Browne pers. Comm. 2018). The comparatively harsh climate of New Brunswick limits Eastern Painted Turtles to the southern area of the province (Bleakney 1952; McAlpine 2010). Eastern Painted Turtles reported in the Pokemouche River (Gloucester County; McAlpine and Godin 1986) and Campbellton are now known to be introduced subpopulations (Seburn and Brooks 2007; McAlpine 2010). Records from the extreme north and northeast of the province likely represent introduced animals (McAlpine pers. comm. 2015).

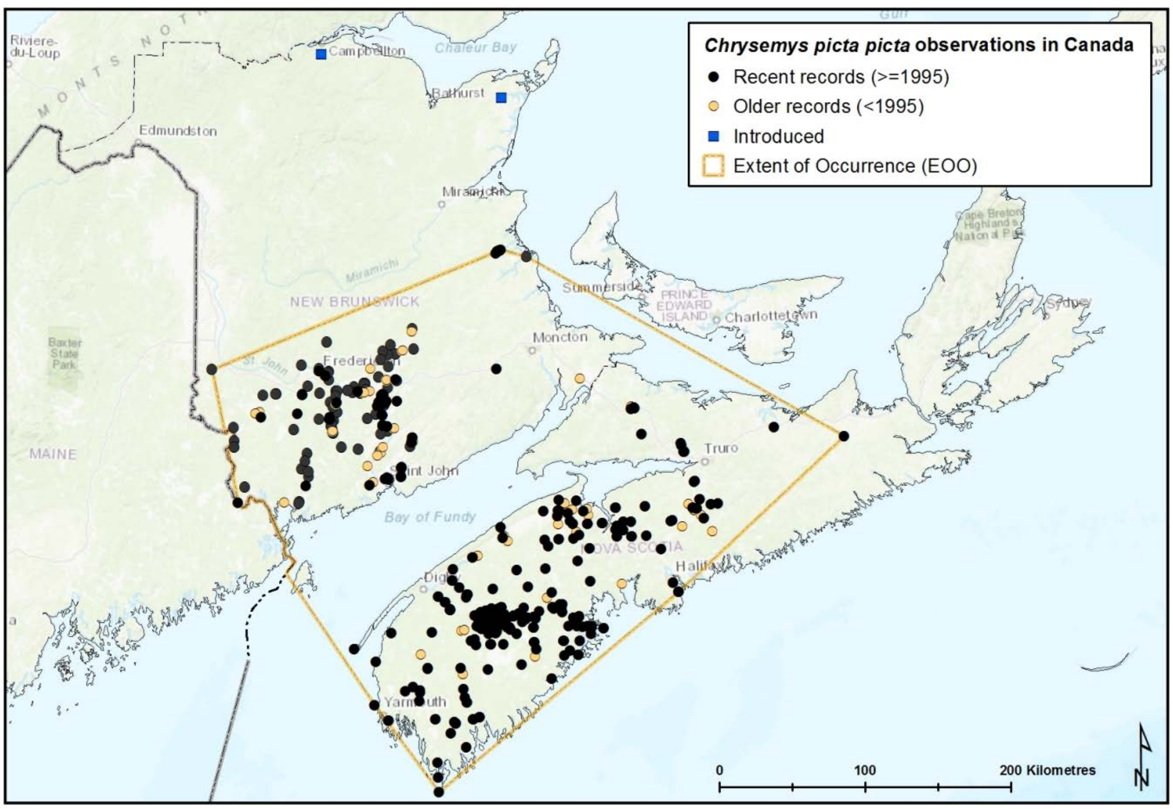

Figure 6. Geographic distribution of Eastern Painted Turtle (*Chrysemys picta picta*) in New Brunswick and Nova Scotia, Canada. Map produced by Jenny Wu (COSEWIC Secretariat) with data provided by the Atlantic Canada Data Conservation Centre, New Brunswick Museum (Don McAlpine), Constance Browne, New Brunswick Energy and Resource Development (Mary Sabine), Department of National Defence CDSG (CFB) Gagetown (Deanna McCullum), and researchers at Acadia University (Jose Lefebvre and Jeffie McNeil).

Introduced Subpopulations in Western Canada:

Morphological and genetic analyses have identified an introduced subpopulation of non-Western Painted Turtles resembling Midland and Eastern subspecies at Burnaby Lake, Burnaby, British Columbia (Jensen *et al.* 2014; Welstead per. comm. 2015). The subpopulation, possibly introduced in the 1960s, is currently estimated at 20-30 individuals with approximately 30 individuals having already been removed. Subspecific intergrades between the introduced Midland and/or Eastern Painted and the locally threatened Western Painted Turtle have been identified. Intergrades demonstrate a 58-92% Midland Painted Turtle genetic influence (Welstead per. comm. 2015). A single introduced Midland or Eastern Painted Turtle (subspecific identification uncertain) has been captured on South Pender Island in the Gulf of Georgia, British Columbia. These extralimital introductions have been excluded from the assessment (COSEWIC 2010).

Extent of Occurrence and Area of Occupancy

The estimated extent of occurrence (EOO) and index of area of occupancy (IAO) were calculated using occurrence records from provincial and academic databases (see **COLLECTIONS EXAMINED**). For Midland Painted Turtle, the EOO is an estimated 521,200 km^2 and IAO is estimated to be much greater than 2000 km^2 (the exact value for IAO could not be calculated but the value exceeded thresholds; A. Filion pers. comm. 2015). Given a poor understanding of range boundaries and the zone of intergradation between Midland and Eastern Painted Turtles in Québec, all Québec records were considered to be of the Midland Painted Turtle designatable unit. As a consequence, EOO and IAO calculations for “Midland Painted Turtles” represent all records across Ontario and Québec and thereby may artificially inflate EOO and IAO values. For Eastern Painted Turtles in New Brunswick and Nova Scotia, the EOO is estimated 87,845 km^2 and IAO is an estimated 1,100 km^2. Values for EOO and IAO for Eastern Painted Turtle are likely underestimated because 1) observational records for this subspecies in New Brunswick may be underreported and 2) subspecific status and zone of intergradation between Midland and Eastern Painted Turtles in Québec are unknown. The total regional, provincial (subpopulation), and range-wide population sizes of Midland and Eastern Painted Turtles in Canada are unknown.

Distribution-wide Search Effort and Sources of Distribution Data

Provincial herpetofaunal surveys and museum collections have been instrumental in documenting the geographic distribution of Painted Turtles in Canada. Most observations are incidental or recorded whilst conducting surveys for other wetland species. Painted Turtles are conspicuous given their tendency to bask, often in groups, under sunny conditions. Opportunistic reporting has drastically increased in recent years with citizen science atlas initiatives and outreach programming. However, perceptions of commonness likely lead to underreporting. In addition to reported occurrences, distributional patterns and limits of Painted Turtles, among other herpetofauna, in Canada have been informed by climatic data (e.g., Bleakney 1958a; Brooks 2007; Tingley and Herman 2009; McAlpine 2010).

Distribution of the Midland Painted Turtle is well characterized across southern Ontario and southwestern Québec through a combination of directed study and observational reporting (e.g., Ontario Herpetofaunal Summary and Ontario Reptile and Amphibian Atlas, ORAA). In Ontario, knowledge of the range of *C. p. marginata* would benefit from surveys along the northern range in Algoma, Sudbury, Nipissing, and Timiskaming districts. Historical records exist in these areas (ORAA, unpublished); although with the launch of the ORAA, additional sampling has occurred in this general area, the specific historical records are in need of updated verification. Research at the interface of Western-Midland Painted Turtle in northwestern Ontario (Algoma district) is ongoing (Weller pers. comm. 2015) and will be important for understanding the historical and contemporary distribution of the two groups, their biology, life history, habitat use, and threats.

Across southern Québec, additional research is necessary to delineate the zone of intergradation and range boundaries of Midland and Eastern Painted Turtles. Extensive habitat and population surveys are required in Québec to better understand Painted Turtle biology and distribution, especially in seemingly disjunct northern populations (Figure 4). Outside of the Saint John River floodplain zone and Rockwood Park, the distribution of Eastern Painted Turtle in New Brunswick is poorly described with most records being incidental (C. Browne pers. comm. 2016). Dedicated study of Eastern Painted Turtle in Atlantic Canada is yet to be completed. Desroches and Picard (2006a) successfully solicited public observations of turtle sightings, including Painted Turtles, in southern Québec by publishing short newspaper advertisements. These solicitations resulted in new active and nest site records and range extensions for multiple species (Desroches and Picard 2006a).

HABITAT

Habitat Requirements

Habitat characteristics and use by Midland and Eastern Painted Turtles are considered for three critical periods: active season, nesting, and overwintering.

Active season: Midland and Eastern Painted Turtles occupy slow moving, relatively shallow, and well-vegetated wetlands and water bodies with abundant basking sites and organic substrate (Ernst and Lovich 2009). These turtles can be found primarily in swamps, marshes, ponds, fens, and bogs (Logier 1939; Gilhen 1984; Ernst and Lovich 2009), as defined by the Canadian Wetland Classification System (NWWG 1997). In addition, lakes, rivers, oxbows, and creeks are frequented, but large, open, and deep bodies of water are avoided. Eastern Painted Turtles along the Atlantic Coast rarely enter brackish water (Ernst and Lovich 2009). Eastern Painted Turtles in the Grand Lake area, New Brunswick, are in greatest abundance in soft-bottomed wetlands with extensive floating vegetation (e.g., *Brasenia schreberi, Nymphaea odorata, Nuphar variegata*) and Pickerelweed (*Pontederia cordata*), abundant basking areas (e.g., lily tubers, fallen trees, logs), and shallow water (<50 cm depth) with deep soft mud (>100 cm depth; Gillingwater pers. comm. 2015). Eastern Painted Turtles may be found in high densities in shallow kettle ponds, vernal pools, riparian marshland, and stream habitats, while found in relatively low densities in impoundments and bogs (Cook *et al.* 2007). Juvenile and adult Midland Painted Turtles of both sexes utilize a mix of edge and open water microhabitats (Rowe and Dalgarn 2010). Juveniles, including yearlings and hatchlings, prefer shallower water, perhaps for foraging and the avoidance of aquatic predators, transitioning to deeper water as they grow larger (Congdon *et al*. 1992). Ephemeral ponds provide high quality foraging areas important for early growth of young turtles (Moldowan *et al.* 2015). Painted Turtle abundance is positively associated with shoreline vegetation (but not herbaceous emergent vegetation) and organic substrate, the latter of which probably offers increased plant growth, foraging opportunities, and suitable overwintering sites relative to inorganic substrates (Marchand and Litvaitis 2004; Rizkalla and Swihart 2006). Painted Turtles are often associated with submergent aquatic plants including *Nuphar*, *Nymphaea*, *Potamogeton*, and *Pontederia* (Bleakney 1958a; Gilhen 1984), which offer cover and feeding opportunities (Moldowan *et al*. 2015). Connectivity of wetland habitat patches through aquatic and terrestrial corridors is important to facilitate regular immigration-emigration and nesting movements (Zweifel 1989; Cosentino *et al*. 2010; see **Life Cycle and Reproduction** and **Dispersal and Migration**). Painted Turtles demonstrate fidelity to basking and foraging sites (Emlen 1969; Algonquin Park Turtle Project, unpublished), nesting sites (Christens and Bider 1987; Rowe *et al*. 2005; Algonquin Park Turtle Project, unpublished), and overland routes to and from nesting sites (Christens and Bider 1987).

Painted Turtles are semi-tolerant of human-altered landscapes. At Point Pelee National Park, Midland Painted Turtle densities were high in human-made ponds and close to roads (Browne 2003). High population abundances have been recorded at Ontario sites with degraded wetlands and moderate to high road densities (DeCatanzaro and Chow-Fraser 2010). The loss of upland habitat for nesting and overland movements can influence Painted Turtle abundance (Marchand and Litvaitis 2004). The species is known to occupy farm ponds, sewage treatment facilities, impoundments, and polluted waters (Rizkalla and Swihart 2006; Ernst and Lovich 2009). Painted Turtles may be locally abundant at sites surrounded by a diversity of land uses, but populations are negatively impacted by land use intensity and large-scale landscape modification (e.g., agriculture, residential development; Rizkalla and Swihart 2006).

Nesting: Painted Turtles nest in areas with an open canopy, often with a southern exposure, such as the shorelines of lakes and wetlands, beaver dams, and sand dunes (Ernst and Lovich 2009; Gillingwater and Piraino pers. comm. 2015; Litzgus pers. comm. 2015). Females appear to prefer sloped nest sites, although the degree of canopy and ground vegetation coverage varies widely (Schwarzkopf and Brooks 1987; Riley *et al*. 2014b). Preferred nesting substrate is sand, loam, clay, and/or gravel (Christens and Bider 1987; Ernst and Lovich 2009; Riley *et al*. 2014b). Midland Painted Turtles will also utilize human modified habitats for nesting, including railway embankments, (active) dirt logging roads, and unpaved road shoulders (Schwarzkopf and Brooks 1985; Hughes 2003; Riley *et al.* 2014a; see **THREATS and LIMITING FACTORS, Road mortality**). Midland Painted Turtles will use artificial nest sites (Paterson *et al.* 2013). Females demonstrate high nest site fidelity, often selecting areas from 10 cm to 10 m from past nest site locations (Christens and Bider 1987; Rowe *et al*. 2005; Algonquin Park Turtle Project, unpublished).

Terrestrial migration distance and nest distance from aquatic habitat ranges from less than 100 m to greater than 1200 m (Semlitsch and Bodie 2003; Steen *et al.* 2012). At an Ontario study site, the mean distance between nest and nearest water was 78 m ± 243 m (minimum = 1.0 m; median = 11.0 m; maximum = 1233.0 m; Steen *et al.* 2012). In their first 24-hours, hatchling Midland Painted Turtles may seek refuge in grass, woody debris, and leaf litter near the nest before travelling to water (Riley *et al.* 2014b).

Overwintering: Adult, juvenile, and some hatchling Painted Turtles (see **BIOLOGY**, **Physiology and Adaptability**) overwinter in wetlands and the shallow bays of lakes. Most hatchlings overwinter in the natal nest cavity. Little research is available describing the physical microhabitat characters of overwintering sites in Canada, or elsewhere. Adult Painted Turtles overwinter in shallow water on the substrate surface or buried, an apparent trade-off between predator exposure and oxygen availability (St. Clair and Gregory 1990; Crocker *et al.* 2000; MRWMP 2006; Rollinson *et al.* 2008). Overwintering habitat of Midland Painted Turtles in southern Ontario did not differ greatly from active season habitat; however, a narrower range of sites was used for overwintering, such as shallow water (average = 0.32 m ± 0.08 m), deep sediment (average = 0.79 m ± 0.15 m), and cold sediment temperatures (average = 4.1°C ± 0.75°C, Taylor and Nol 1989; see **BIOLOGY, Physiology and Adaptability**). Whereas adult Painted Turtles only use aquatic habitats for overwintering, hatchlings may use terrestrial or aquatic habitats (see **BIOLOGY, Physiology and Adaptability**).

Habitat Trends

Midland Painted Turtles in the southernmost regions of Ontario and Québec (Carolinian and southern Great Lakes/St. Lawrence faunal provinces) have experienced widespread habitat change over the last three generations (87-134 years, see **BIOLOGY**). Between 1800-2002, southern Ontario has experienced a conservatively estimated 72% wetland loss (Figure 7; Whillans 1982; Snell 1987; DUC 2010). Wetland loss in southwestern Ontario, Niagara, Toronto, and parts of eastern Ontario exceeds 85% (DUC 2010). Marshland area along the Canadian shoreline of Lake Ontario declined by an estimated 57% between 1798 baselines and the late 1970s (Whillans 1982). Between 1983-2002 the rate of wetland loss greatly decelerated but still resulted in the cumulative loss of 3.5% of pre-settlement wetland land (DUC 2010). Given the affinity of Painted Turtles for wetlands (see **HABITAT**) and their potentially high density in these habitats (see **Demography**, Table 1), the loss of wetlands in southern Ontario may be a suitable proxy for large-scale population decline in this region (e.g., akin to the estimated quantitative decline of Blanding's Turtle concurrent with large-scale wetland loss in southern Ontario, as per the 2016 Blanding's Turtle COSEWIC report (COSEWIC 2016)).

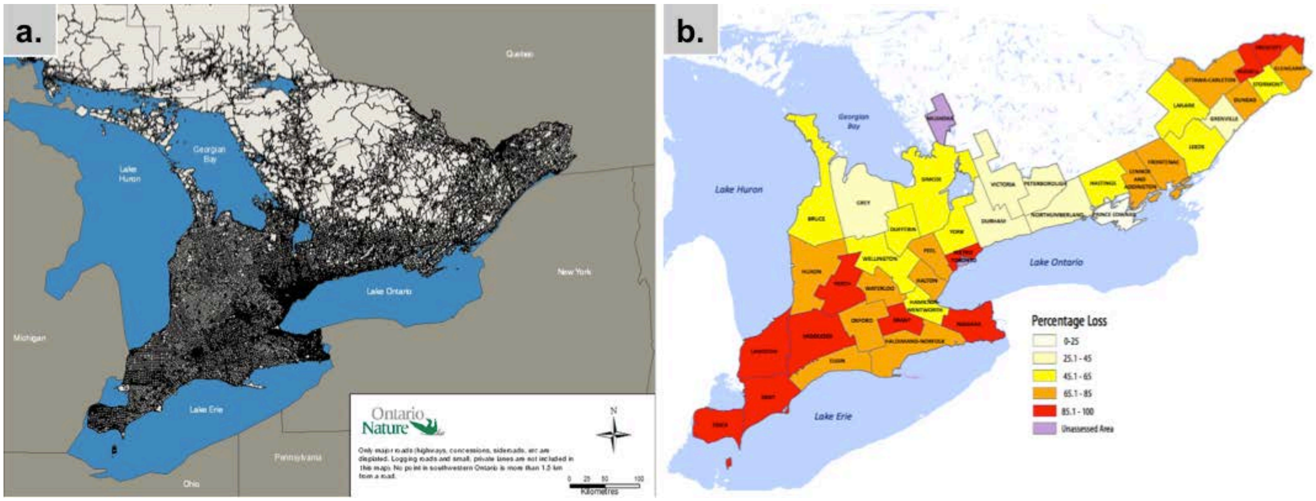

Figure 7. Southern Ontario a. road network, and b. wetland loss by county (1800-2002). Images: a. Ontario Nature (2015), b. Ducks Unlimited Canada (2010).

Table 1. Population density and biomass estimates of Painted Turtle (*Chrysemys picta* ssp.) subpopulations in eastern Canada and the northeastern United States.*These are long, narrow canals, with a high wetland edge to surface area ratio, which partially explains the high densities at these sites. **The unusually high density at Wolf Howl Pond, Algonquin Provincial Park (Ontario), is likely due to the small size of the water body, and, of greatest importance, access to nearby high quality nesting habitat. Experimental manipulation (e.g., nest protection) may also account for exceptionally high Painted Turtle densities at Wolf Howl Pond.

Density (turtles/ha)	Biomass (kg/ha)	Area (ha)	Water body	Year	Location	Source
498.5*	--	--	North DeLaurier	2001-2002	Point Pelee National Park, Ontario	Browne 2003
248.5*	--	--	South DeLaurier			
65.2*	--	--	East North Canal			
12.2	--	--	Marsh Boardwalk			
2.7	--	--	East Cranberry			
12.5	--	--	Bush Pond			
2.6	--	7.7	Mew Lake	2012	Algonquin Provincial Park, Ontario	M. Keevil and Algonquin Park Turtle Project, unpublished
10.3	--	10.4	Whitefish Lake	2012		
96.8**	--	1.9	Wolf Howl Pond	2008-2011		
15.7	--	4.8	Wolf Howl Pond East	2008-2011		
9.77	--	9.2	West Rose Lake	2008-2011		
64.7*	--	1.7	Wolf Howl Pond	1995	Algonquin Provincial Park, Ontario	Koper and Brooks 1998
109.0*	--	1.9	Wolf Howl Pond	1990-2002	Algonquin Provincial Park, Ontario	Samson 2003
103.2*	--	1.9	Wolf Howl Pond	1998-2002		
11.5	--	9.2	West Rose Lake	1990-2002		
11.2	--	9.2	West Rose Lake	1998-2002		
289	--	0.41	StoneyCroft Pond, McGill University	1966-1975	Sainte-Anne-de-Bellevue, Québec	Mallet 1975

Density (turtles/ha)	Biomass (kg/ha)	Area (ha)	Water body	Year	Location	Source
276	--	0.41	StoneyCroft Pond, McGill University	1966-1970	Sainte-Anne-de-Bellevue, Québec	Bider and Hoek 1971
37.1	--	2.4	Curtis Pond	2001-2009	Estrie, Québec	Picard and Desroches 2010
36.4	--	4	Campbell Bay	2004	Outaouais, Québec	Desroches and Picard 2007
9.9	--	3	Breckenridge			
26.8	--	3	Schwartz			
		150.85	Ponds and Marsh	2007	Cherry River Marshes, Magog, Québec	Picard 2014
40	--	0.85	Ponds	2010		
		150.85	Marsh	2013		
7.5-7.8	--	7.4-7.7	Not specified	2016	Rockwood Park, New Brunswick	Browne, pers. comm. 2016
89.5	16.6	4.0	East Marsh	1975-1983	E.S. George Reserve, Michigan	Congdon *et al.* 1986
41.6	7.4	0.6	George & Burt Ponds			
134.4	24.2	7.3	Southwest Reserve	1953-1955	E.S. George Reserve, Michigan	Sexton 1959; Congdon *et al.* 1986
25.5	4.6	7.3	Southwest Reserve	1968-1973	E.S. George Reserve, Michigan	Wilbur 1975b; Congdon *et al.* 1986
39.9	7.2	7.3	Southwest Reserve	1975-1983	E.S. George Reserve, Michigan	Congdon *et al.* 1986
575.7	73.6	4.1	Sherriff's Marsh	1964-1966	Kalamazoo County, Michigan	Gibbons 1968b; Congdon and Gibbons 1989
827.7	154.0	4.1	Sherriff's Marsh	1980-1989	Kalamazoo County, Michigan	Fraser *et al.* 1991
24.6	--	3.0	Lincoln Pond	1970-1972	Edmund Niles Huyck Preserve, New York	Bayless 1975
136.8	23.5	--	Pond 1-6	1963-1981	Long Island, New York	Zweifel 1989
239	106.4	8.0	White Oak Bird Sanctuary	1965-1967	Lancaster County, Pennsylvania	Ernst 1971b

Wetland loss has likewise been high in western Québec. Wetland monitoring along the St. Lawrence River has shown a history of wetland loss, principally between 1940-1970, and recovery spanning 1970 onward (see thorough reviews by National Wetlands Working Group 1988 and Martin and Létourneau 2011). Between 1990-1991 and 2000-2002, wetland area in southwestern Québec experienced sizable gains and losses (Martin and Létourneau 2011).

Habitat degradation, even in protected areas, is continuing due to road access and invasive species (see **THREATS AND LIMITING FACTORS**) in the Carolinian and southern Great Lakes/St. Lawrence faunal provinces. Habitat quality is likely more stable in central Ontario and central Québec (Canadian Shield faunal province) where human populations have stabilized or are in decline (see **THREATS AND LIMITING FACTORS, Habitat Loss**).

Data on historical wetland loss in Atlantic Canada are lacking (Mitsch and Gosselink 2015). Overall, Eastern Painted Turtle does not appear to have experienced a human-induced range contraction caused by habitat loss in Atlantic Canada, though historical baseline data are limited (McAlpine 2010). Human population growth rates in New Brunswick have demonstrated a small decline in recent years, while Nova Scotia's population has shown a slight increase with both provinces projected to follow their respective population trend through to 2030 (Vasseur and Catto 2008). In the future, maintaining protected areas will be important for Eastern Painted Turtles (see **Habitat Protection or Ownership**). The city of Saint John, New Brunswick's largest city, surrounds the small Eastern Painted Turtle subpopulation of Rockwood Park and the relatively large subpopulation at Grand Lake is subject to low impact recreational activities. For the short-term future, habitat for Eastern Painted Turtles in New Brunswick and Nova Scotia over most of the range appears to be stable. However, forest harvesting in southern Nova Scotia, where Eastern Painted Turtle reaches its highest densities, is ongoing and slated to increase, and may result in loss of wetland habitat.

The full extent of habitat loss is unknown across the large range of Midland and Eastern Painted Turtles on account of deficient baseline data on habitat and species' range. Large-scale wetland restoration efforts are undoubtedly ongoing (often for waterfowl) and could provide habitat for Painted Turtles, though data on the location and scale of such efforts are not available.

BIOLOGY

Demography and Life History Overview

In a robust turtle population, the number of individuals represented in adult age/size classes greatly exceeds those in juvenile age/size classes because adults naturally demonstrate high post-maturity survival, longevity, low annual reproductive investment, and long reproductive lifespan (*i.e.*, a bet-hedging life history strategy; Stearns 1992). Turtle populations, including those of Painted Turtles, have slow recruitment due to low but variable reproductive investment, nest survival, and juvenile survival (Wilbur 1975b; Zweifel 1989; see **Survival and Longevity**). Thus, imbalances in age and/or sex structure of a population can persist for extended periods due to slow recruitment (Zweifel 1989). Adult to juvenile population ratios are reported as 2.6:1 in Québec (Mallet 1975), 1.03:1 in New Brunswick (Browne and Sullivan 2017), 5:1 in New York (Bayless 1975), and 4:1 in Pennsylvania (Ernst 1971b). Among 29 sampled ponds in New Hampshire there were an estimated 0.81 ± 0.12 SD (range: 0.60-1.00) adults for each juvenile (Marchand and Litvaitis 2004). Even in well-studied subpopulations, individual Painted Turtles may disappear from captures for extended periods (6-12 years between captures in Algonquin Provincial Park, Keevil and Riley 2012; Keevil and Moldowan 2013), making conclusions about mortality or emigration difficult (see **Survivorship and Longevity**).

Survivorship and Longevity

Life tables and survivorship data for Painted Turtle populations are available for Ontario (Samson 2003), Québec (Mallet 1975), Michigan (Sexton 1959a; Wilbur 1975b; Frazer *et al.* 1991), New Brunswick (Browne and Sullivan 2017) and New York (Zweifel

1989). To summarize, Painted Turtles experience high and stochastic mortality rates at the egg and juvenile stages but very high adult survival, consistent with a bet-hedging life history strategy (Congdon and Tinkle 1982; Midwood *et al*. 2015).

Painted Turtle nest survival rates are generally low and often highly stochastic (~2-30%; Wilbur 1975b; Tinkle *et al.* 1981; Christens and Bider 1987; Browne 2003; Samson 2003; Rowe *et al.* 2005). Nests are frequently destroyed within the first 48 hours of egg laying (Tinkle *et al.* 1981; Rowe *et al.* 2005; Wirsing *et al*. 2012), though predation pressure may persist throughout incubation and peak again during the hatching period (Riley and Litzgus 2014). Nest predation rates for Midland Painted Turtle at Point Pelee are generally high (80-100%, Kraus 1991; 87%, Whitehead 1997; 73%, Browne 2003; 33%, Phillips and Murray 2005). Population models for Midland Painted Turtles at Point Pelee demonstrate tolerance to nest predation rates of 70%, but predation (alone) at 90% would result in population declines and extirpation within an estimated 800 years (Browne 2003). Predators are responsible for most nest failure, although flooding, desiccation, infertility, and low incubation temperatures may also contribute to nest loss (Tinkle *et al.* 1981; Phillips and Murray 2005). In the absence of predation, hatch rate is typically high (e.g., 92% in Québec, Christens and Bider 1987), but also variable (69-79% in Algonquin Provincial Park, Riley and Litzgus 2013).

Estimated annual survivorship is highly variable between subpopulations, sexes, and sampling intervals in Painted Turtles. Adult male survivorship is typically less than that of adult females, though adults of both sexes may demonstrate exceptionally high survival (Congdon *et al.* 2003; Samson 2003). Long-term research in Michigan has demonstrated annual adult female survivorship ranging from 29-84% and annual adult male survivorship from 64-86% (Sexton 1959a; Wilbur 1975b; Frazer *et al.* 1991). A study in New York state reported adult female annual survivorship of 86-100% compared to 54-98% in males (Zweifel 1989). The best available data on Painted Turtle survivorship comes from 25 years of continuous data collected in Algonquin Provincial Park. Average annual adult survivorship in these monitored subpopulations is conservatively estimated to be 98%; however, a more rigorous estimate of apparent survivorship, which would incorporate estimates of the proportion of individuals that are still alive, but not captured (e.g., those that emigrated to other areas, loss to occasional collection), would result in an even higher and more accurate survivorship estimate (Koper and Brooks 1998; Samson 2003; Keevil pers. comm. 2015; Brooks pers. comm. 2017). Survival from year 1 to sexual maturity (midplastron length of approximately 90 mm in Ontario Painted Turtles) is 30.3% in Algonquin Provincial Park (Samson 2003). Survival of middle-age adult and older-age adult groups of female Midland Painted Turtles does not differ, suggesting a long (reproductive) lifespan (>50 years; Samson, unpublished data; Brooks pers. comm. 2017) and negligible senescence (Congdon *et al*. 2003). These data clearly show that Painted Turtle is just as vulnerable to chronic increases in adult mortality as any other turtle species in Canada.

Midland Painted Turtles that are a minimum of 50 years of age are known from long-term mark-recapture study in Algonquin Provincial Park (Keevil and Riley 2012). Zweifel (1989) conservatively estimated three female Eastern Painted Turtles to be 25 years of age in his 18-year long study in New York. Studies in Michigan have documented individuals of at least 35 years of age (Frazer *et al.* 1991) and more than 55 years of age (Congdon *et al.* 2003). A female Eastern Painted Turtle of approximately 50 years of age was recaptured in Maryland (Siess 2005). Mallet (1975) estimates the maximum longevity of mature male and female Painted Turtles in Québec to be 119 and 199 years, respectively. Longevity estimates for Painted Turtle of up to 61 years (Van Dijk 2013 for the International Union for the Conservation of Nature; Midwood *et al.* 2015) is likely an underestimate (limited by the availability of long-term studies), especially for Canadian subpopulations.

Generation time, the average age of parents of a cohort, represents a measure of turnover rate of breeding individuals in a population (COSEWIC 2014). Generation time may be calculated as age at maturity + [1/annual adult mortality rate]. Samson (2003) provides the most thorough analysis of age at maturity and survivorship of Painted Turtles in Canada from long-term population study (1978-2002) in Algonquin Provincial Park, Ontario (Table 2). Using Samson's (2003) maturity and survival estimates, with values intermediate between the sexes: 11.2 years at maturity + 1/(0.03 annual adult mortality) = 44.5 years generation time. Reducing age at maturity to 9 years, reflecting well-studied Painted Turtle subpopulations in Michigan and multi-population estimates (Midwood *et al.* 2015, Table 2), and mortality of 0.05 produces a generation time estimate of 29 years. Given the long reproductive lifespan and yet unknown maximum (albeit high) longevity of Painted Turtle, this latter estimate should be considered a minimum generation time for Canadian Painted Turtle populations. The IUCN estimates generation time as 20 years (Van Dijk 2013), but like the IUCN estimate of longevity, this generation time is likely an underestimate with respect to the life history of northern populations.

Table 2. Reproductive characters of Painted Turtle (*Chrysemys picta* ssp.) subpopulations in eastern Canada and the northeastern United States. A range of values for each variable presented in parentheses, if available. *Life history parameters estimated from literature review. **Carapace length given for sexual maturity measurements. ***Clutch size estimated from oviductal eggs and may therefore be an underestimate (*i.e.*, ovulation incomplete or some eggs already deposited).

Male:female mid-plastron length at sexual maturity (mm)	Male:female age at sexual maturity (years)	Mean Clutch Size (range)	Location	Source
		6.8 (5-9)	Long Point, Ontario	Weller, unpublished
85-90:113-117			Lake Erie locales, Ontario	Davy, unpublished
89:126	4:6	7.25 (7-9)	Wye Marsh, Ontario	Balcombe and Licht 1987
--:131-155			Prince Edward County, Ontario	Logier 1941
		7.2 (6-9)	Nogies Creek, Ontario	Whillans and Crossman 1977
	9:12	8	N/A	Midwood *et al.* 2015*
94.1:121.6 (83-105:118-123)		8.5	Sainte-Anne-de-Bellevue, Québec	Mallet 1975**
	--:>6	9.2 (5-12)	Ste.-Anne-de-Bellevue, Québec	Christens and Bider 1986, 1987

Male:female mid-plastron length at sexual maturity (mm)	Male:female age at sexual maturity (years)	Mean Clutch Size (range)	Location	Source
--:13.1 --:(12.1-14.2)	8.3:14.1 (7-10:12-15)	7.08	Algonquin Provincial Park, Ontario	Samson 2003
		8.6 (5-11)	Nova Scotia	Powell 1967
		6-11	Nova Scotia	NSM 2015
99-105:119-128	4:6	6.6 (5-8)	E.S. George Reserve, Michigan	Wilbur 1975b
90:152		4.7 (2-7)	Douglas Lake, Cheboygan County, Michigan	Cagle 1954
80: -- (71-85:118-125)	6:>12 (6-7:--)	6.1-6.6 (6-9)	Sherriff's Marsh, Kalamazoo County, Michigan	Gibbons 1968a
81 : 117 (-- :116-125)	4:-- (3-5:7-10)	6.1-6.6 (6-9)	Wintergreen Lake, Kalamazoo County, Michigan	Gibbons 1968a
		7.6 (2-11)	E.S. George Reserve, Michigan	Congdon and Tinkle 1982
--:111	4-5:9-13		E.S. George Reserve, Michigan	Congdon *et al.* 2003
		4.7 (2-7)	Northern Peninsula, Michigan	Cagle 1954***
		4.7 (4-6)	Lancaster County, Pennsylvania	Ernst 1971b
		6.75 (4-10)	Central Massachusetts	Rhodin and Butler 1997

Population Sex Ratio:

Subpopulations often approach a sex ratio of 1 male : 1 female, though highly variable sex ratios are present in Canada and across the species' range (Ernst 1971b, Table 3). Males mature at younger ages and at smaller sizes than females (Sexton 1959a; Samson 2003), which can lead to males being more readily identified because of their obvious secondary sex characteristics (Ernst and Lovich 2009). Population sex ratio biases can arise through natural environmental conditions via temperature-dependent sex determination (see **Life Cycle and Reproduction**) or anthropogenic disturbance (e.g., subsidized predators, road mortality; see **THREATS AND LIMITING FACTORS**). However, attributing a causal mechanism responsible for population sex biases is difficult given the occasionally strong and variable sex biases seen in natural populations (see **THREATS AND LIMITING FACTORS, Road Mortality, limitations**).

Table 3. Sex ratio of Painted Turtle (*Chrysemys picta* ssp.) subpopulations in eastern Canada and the northeastern United States. Note that capture method can result in biased population sex ratio estimate and so has been noted here for clarity.

Population sex ratio (M:F)	Capture method	Water body	Location	Source
5.7:1	Hoop trap	Hillman Marsh Conservation Area	Leamington, Ontario	Browne 2003
4.7:1 1.1:1 1.5:1	Hoop trap Basking trap Hand	Numerous water bodies	Point Pelee National Park, Ontario	Browne and Hecnar 2007
0.85:1	Wetland transects on foot with dipnetting	Rondeau Provincial Park	Rondeau Provincial Park, Ontario	S. Gillingwater, unpublished (2000-2001)
3.7:1	Wetland transects on foot with dipnetting	Big Creek National Wildlife Area	Big Creek National Wildlife Area, Ontario	S. Gillingwater, unpublished (2003)
3.1:1	Hoop/fyke trap	Western Lake Ontario	Hamilton and Burlington, Ontario	DeCatanzaro and Chow 2010
1.3:1	Hoop/fyke trap	Southeastern Georgian Bay	Georgian Bay, Ontario	DeCatanzaro and Chow 2010
0.69:1	Dipnet from boat and shore	Wye Marsh	Midland, Ontario	Balcombe and Licht 1987
3.67:1	Hoop trap	Nogies Creek Fish Sanctuary	Peterborough, Ontario	Whillans and Crossman 1977
0.32:1	Overall (hoop trap, dip net, and hand)	Wolf Howl Pond	Algonquin Provincial Park, Ontario	Koper and Brooks 1998
0.29:1	Overall (hoop trap, dip net, and hand)	Wolf Howl Pond	Algonquin Provincial Park, Ontario	Samson 2003
0.80:1.0	Wading behind blind with dipnet ambush (as per Bider and Hoek 1971)	Stoneycroft Pond	Sainte-Anne-de-Bellevue, Québec	Mallet 1975
1.1:1 2.1:1 0.66:1	Overall (using hoop trap with fyke, dip net, and basking trap)	Campbell Bay Breckenridge Schwartz	Outaouais, Québec	Desroches and Picard 2007
0.9:1	Hoop trap with fyke	Curtis Pond	Estrie, Québec	Picard and Desroches 2013
1.1:1 (2007) 1.1:1 (2010)	Hoop trap with fyke (opportunistic hand, dipnet)	Isolated ponds and Cherry River	Magog, Québec	Picard 2014
2.2:1 (2007) 9.8:1 (2013)	Hoop trap with fyke (opportunistic hand, dipnet)	Main waterbody and Cherry River Marshes	Magog, Québec	Picard 2014
0.5:1	Hoop trap and dip net	Undisclosed	Rockwood Park, New Brunswick	Browne and Sullivan 2017
1.24:1	Overall (hoop trap, dipnet, hand, basking trap, seine, drift fence)	Overall (Southwest Swamp, Fishhook Marsh, Crane Pond, Ditch, Cattail Marsh)	E.S. George Reserve, Michigan	Sexton 1959a
1:1	Overall (hoop trap, wire trap, dipnet, hand, diving)	Sherriff's Marsh	Kalamazoo County, Michigan	Gibbons 1968b
2.4:1 0.94:1 1.4:1	Hand capture Basking trap Overall ratio	Lincoln Pond	Rensselaerville, New York	Bayless 1975
1.08:1	Overall (hoop trap, dip net, and hand)	Havemeyer Estate	Dix Hills, Long Island, New York	Zweifel 1989
1:1	Overall (hoop trap, dip net, and hand)	Pond at White Oak Bird Sanctuary	Lancaster County, Pennsylvania	Ernst 1971b

Growth:

Growth of hatchlings and juveniles is relatively rapid and can be related to habitat productivity, diet quality, and conspecific density (Gibbons 1967; Ernst 1971a; Keevil pers. comm. 2015). At maturity, growth rate rapidly declines. In Michigan, a growth rate of 1 mm/year is seen in young adult Midland Painted Turtles slowing to 0.3 mm/year in older adults (Congdon *et al.* 2003). Growing season for Midland Painted Turtle in northern Michigan (Cagle 1954) and central Ontario (Keevil pers. comm. 2015) is restricted to June and July. Delayed maturity in northern subpopulations relative to southern populations results in an increasing size at maturity with latitude (Ernst 1971a; Moll 1973; Samson 2003; Table 2). Body size is more important than age in reaching sexual maturity (Christens and Bider 1986; Samson 2003). Age at maturity can be at least 50% higher in northern subpopulations (e.g., Algonquin Provincial Park) compared to southern conspecifics (in southern Michigan; Samson 2003). This feature of Painted Turtle life history has large implications for population persistence in the face of additive adult mortality and/or chronic nest/recruitment failure, especially in northern subpopulations. Painted Turtles demonstrate indeterminate growth, a trait that is important for increasing reproductive output later in life (Congdon *et al.* 2003).

Life Cycle and Reproduction

Activity patterns:

Painted Turtles can spend over half the year inactive under winter conditions (see **Physiology and Adaptability**). The onset of hibernation coincides with cooling air and water temperatures, the timing of which varies with latitude and regional climate (approximately mid-September to mid-October). During early winter months, Midland Painted Turtles may make short distance movements under surface ice whilst searching for a suitable overwintering site (Rollinson *et al.* 2008). The active season begins as ice cover retreats (Cagle 1954; Sexton 1959a; Ernst 1971b), the timing of which varies with latitude and regional climate (approximately early-late April to May). At the onset of the active season, Painted Turtles may travel (sometimes overland; see **THREATS AND LIMITING FACTORS, Road Mortality**) from overwintering sites to other habitats used during the active season. Feeding and breeding activities occur in the spring when turtles are able to raise body temperatures above 15-20°C (Sexton 1959a; Ernst 1971b). Basking occurs in the morning and throughout the day, interrupted by bouts of foraging (Mallet 1975; Lefevre and Brooks 1995; Edwards and Blouin-Demer 2007; Rowe and Dalgarn 2009). Nocturnal activity (movement) has been reported (Gilhen 1984; Rowe 2003). Females bask frequently and for a longer duration prior to nesting (Krawchuk and Brooks 1998) and during follicular development in the autumn (Carrière *et al.* 2008). Time spent basking is equal between males and females in mid-summer (Lefevre and Brooks 1995). The nesting season for Painted Turtles in eastern Canada spans late May to early July (see **Reproduction**). Sampling period can have a large influence on measured Painted Turtle population demographics due to sex- and age-specific activity patterns (Ernst 1971b; Mitchell 1998; Moldowan 2014). In Canada, the active season may range from as little as four months in northern regions (e.g., early May to early September) up to six months (e.g., early April through early October) in southern Ontario.

Reproduction:

Spring is purported to be the primary breeding period for Painted Turtles (Sexton 1959a; Gibbons 1968a; Krawchuk and Brooks 1998; Ernst and Lovich 2009), although behavioural observations (Moldowan 2014) and reproductive physiology studies (Gibbons 1968a; Gist *et al.* 1990) have demonstrated reproductive activity in late summer and autumn. In central Ontario (Moldowan 2014) and southern Québec (Picard 2014), male Midland Painted Turtles remain active later in the season compared to females, presumably seeking mating opportunities. Female Painted Turtles are capable of long-term sperm storage and clutches may demonstrate multiple paternity (McTaggart 2000; Hughes 2011; McGuire *et al.* 2011, 2014).

Nesting phenology may be related to temperatures in the previous winter (Schwanz and Janzen 2008), while clutch frequency is related to previous autumn temperature (during the period of follicular development, Rollinson and Brooks 2007b). Eggs are retained in the oviduct four to five weeks prior to nesting (Powell 1967). In Ontario (Browne 2003; Riley *et al*. 2014b), Québec (Christens and Bider 1987), and Michigan (Congdon and Gatten 1989), nesting season spans 20 to 40 days, typically from late May until early July, with peak activity in mid-June. The nesting season for Eastern Painted Turtles in Nova Scotia is an estimated minimum of three weeks in duration, but may span late May through early July (Powell 1967). Nesting occurs primarily in the afternoon and early evening (Christens and Bider 1987), though morning nesting activity has been documented (Tinkle *et al.* 1981; Christens and Bider 1987; Congdon and Gatten 1989). Nesting activity typically increases during periods of rainfall (Balcombe and Licht 1987; Algonquin Park Turtle Project, unpublished). Females demonstrate repeatable travel corridors when moving overland to and from nest sites (Christens and Bider 1987). For discussion of nest success see **Longevity and Survival** and **THREATS AND LIMITING FACTORS, Subsidized predators**.

Annual clutch frequency and clutch sizes vary among subpopulations and individuals. Midland and Eastern Painted Turtles have a typical clutch size of 3-17 eggs (mean = 7.6 eggs) and 1-11 eggs (mean = 4.9 eggs), respectively (Ernst and Lovich 2009). The annual reproductive potential of females in Michigan and Ontario is up to 13-14 eggs (Gibbons 1968a; Samson 2003) and 16-18 eggs in Québec (Christens and Bider 1986), which is contingent on a female laying two clutches of eggs. In a Québec study, 40-80% of young females (7-11 years of age) reproduced each year, whereas nearly all females older than 11 years reproduced each year (Christens and Bider 1986; Ernst and Lovich 2009). An estimated 43-82% (Schwarzkopf and Brooks 1986; Samson 2003) of females reproduce once annually in Algonquin Provincial Park. Approximately 50-70% of female Midland Painted Turtles in Michigan reproduce once in a given year (Tinkle *et al.* 1981; Congdon and Tinkle 1982).

Frequency of second clutches shows high variability between subpopulations and years: 17% from the Upper Peninsula of Michigan (Snow 1980), 6-10% (Tinkle *et al.* 1981; Congdon and Tinkle 1982) and 6-40% in southeastern Michigan (average = 23%, McGuire *et al.* 2011), and 5-32% in Québec (average = 18%, Christens and Bider 1986). Snow (1980) reported 17% (and up to 33%, based on indirect evidence) of Western-Midland intergrades laying two clutches annually in the Upper Peninsula of Michigan. In Algonquin Provincial Park, <0.1-19% (average = 13%, Samson 2003), 12-13% (Schwarzkopf and Brooks 1986), or an estimated 20-30% (Rollinson and Brooks 2007b) of females will nest twice a year. Female Painted Turtles have also been recorded laying up to two clutches annually in Nova Scotia (Powell 1967). The frequency of single and double clutch nesting is unknown for Eastern Painted Turtles in Canada. The production of a second clutch can lead to large inter-annual variation in reproductive output within a population and represents a major component of lifetime reproductive output (Congdon *et al.* 2003). Fecundity generally increases with female body size and age through the production of larger eggs, larger clutch sizes, and increased reproductive frequency (Ernst 1971b; Tinkle *et al.* 1981; Congdon and Tinkle 1982; Rhodin and Butler 1997; Congdon *et al.* 2003; Samson 2003). Egg infertility or failure to develop is not related to age of reproductive females (Congdon *et al.* 2003).

Incubation of Painted Turtles eggs is approximately 65-80 days (Ernst 1971b) with durations ranging up to 83-97 days in Algonquin Provincial Park (Riley and Litzgus 2013). Below-ground incubation spans from time of nesting (typically from late May until early July, with peak activity in mid-June) through late August to early October, depending on local environmental conditions. Painted Turtles exhibit temperature dependent sex determination with incubation temperatures ≤26°C producing males, temperatures ≥29°C producing females, and a mix of both sexes at intermediate temperatures (Bull and Vogt 1981; Schwarzkopf and Brooks 1987). Hatchlings may emerge from nest chambers in the autumn and spend the winter aquatically or overwinter terrestrially in the natal nest chamber (see **Physiology and Adaptability**). Spring hatching may be synchronized following rainfall (Lovich *et al.* 2014). Hatchling Midland Painted Turtles (Algonquin Park Turtle Project, unpublished) and Eastern Painted Turtles (Bleakney 1963) can delay emergence from the nest chamber as late as June and July following the year they hatch.

Physiology and Adaptability

Hatchling Painted Turtles are capable of supercooling and are freeze-tolerant (Storey *et al.* 1988; Costanzo *et al.* 1995, 2004, 2008; Packard and Packard 2004). Hatchling Painted Turtles have a dichotomous overwintering strategy: autumn emergence from the nest with aquatic overwintering, or terrestrial overwintering in the nest chamber with emergence in the spring (Lovich *et al.* 2014; Riley *et al.* 2014b). Hatchling overwintering in the nest is common for Midland Painted Turtles studied in Québec (100%, Christens and Bider 1987), central Ontario (56%-92%, Riley *et al.* 2014b; 100%, Storey *et al.* 1988), and for Eastern Painted Turtles in Nova Scotia (Bleakney 1963). Hatchlings are capable of tolerating sub-zero temperatures (Storey *et al.* 1988, Ultsch 2006), but rely on snow cover to serve as an insulating boundary against low temperatures (Breitenbach *et al.* 1984). Winterkill represents a significant source of mortality for terrestrially overwintering hatchlings. Breitenbach *et al.* (1984) documented 0-80% mortality (average of 19% mortality over five years) of hatchlings overwintering in the nest, and Tinkle *et al.* (1981) reported up to 12% overwinter mortality at a study site in Michigan. Overwintering success in Algonquin Provincial Park nests is 67% ± 8% (Riley *et al.* 2014b).

Laboratory and field research on Painted Turtles has demonstrated extrapulmonary gas exchange, high anoxic tolerance, and capacity to stay submerged without access to aerial oxygen for extended periods (Ultsch 2006). During winter, Painted Turtles select temperatures approaching 0-1°C thereby slowing metabolism, in turn conserving stored energy, and limiting lactate acidosis (Rollinson *et al.* 2008). Short distance movements may take place under ice (Taylor and Nol 1989; St. Clair and Gregory 1990; Rollinson *et al.* 2008). Continuous overwinter submergence may last from 56-117 days (average = 92 days) in southern Michigan (Crawford 1991) and at least 143 days in central Ontario (Rollinson *et al.* 2008).

Dispersal and Migration

Movements can be classified into three general categories: 1) those associated with nesting (e.g., female travel to and from a nesting site, post-hatch movement of neonates away from nest site); 2) those within the active (non-nesting) season home range (e.g., within and between water bodies, movement to and from overwintering sites); and 3) larger-scale movements resulting in lasting changes to home range, such as dispersal, immigration, and emigration (Zweifel 1989).

Females frequently make exploratory overland trips before nesting and some remain on land overnight (Christens and Bider 1987; Congdon and Gatten 1989). In Québec, females selected nest sites ranging from approximately 16 m to over 600 m from their home pond (Christens and Bider 1987). Overland movements of >100-200 m are common, 400-600 m occasional, and travel exceeding 1 km is uncommon (Gibbons 1968a; Whillans and Crossman 1977; Semlitsch and Bodie 2003; Steen *et al*. 2012).

During the active season, daily aquatic movements range from 0-300 m, with mean distances of approximately 60-150 m in Michigan (Sexton 1959a; Rowe 2003; Rowe and Dalgarn 2010). Midland Painted Turtles recaptured in Point Pelee National Park were reported to move, on average, 248 m (± SD = 392 m) and up to 2.3 km during recapture intervals between 2001-2002 (Browne 2003). On Beaver Island, Michigan, home range size of female Midland Painted Turtles was an estimated 1.8 ha and male home range size 2.9 ha (overall: 1.2-2.1 ha, Rowe 2003; Rowe and Dalgarn 2010).

Painted Turtles are capable of long-distance dispersal and immigration. In Algonquin Provincial Park, for example, two male Midland Painted Turtles travelled a minimum aquatic distance of 13.5 km (11.5 km straight-line distance) over a maximum 8-year and 11-year period, respectively (Keevil and Moldowan 2013). Additional observations from the Algonquin Provincial Park study record marked male and female Midland Painted Turtles making movements ranging from minimum aquatic distances of 3.6-9.3 km (2.3-6.2 km straight-line distance) over periods ranging from one to six years (Keevil and Moldowan 2013).

Terrestrial movements by Painted Turtles over small and large spatial scales follow a relatively straight path (Bowne and White 2004; Caldwell and Nams 2006; Roth and

Krochman 2015). A sun and/or magnetic compass is used in navigation (DeRosa and Taylor 1978, 1982; Caldwell and Nams 2006), and may be inhibited during conditions of high cloud cover (DeRosa and Taylor 1982; Bowne and White 2004; but see Emlen 1969). The short distance homing ability of Painted Turtles also suggests that the species may make use of landmarks or a mental map in navigation (Emlen 1969; Ernst 1970; Caldwell and Nams 2006). Recent research has demonstrated the importance of age-specific learning in navigation. Resident juveniles and adults were capable of rapid and highly precise movement to alternative water bodies following draining of their home ponds (Roth and Krochman 2015). Naïve translocated juveniles ≤3 years of age followed the specific paths of the residents (Roth and Krochman 2015), while naïve translocated individuals ≥4 years failed to find alternative water bodies and instead incurred high energetic costs whilst travelling inconsistent and unsuccessful routes.

Interspecific Interactions

Painted Turtles are omnivorous and known to consume a wide variety of invertebrate, vertebrate, algae, and aquatic vascular plant species across their broad geographic range (Ernst and Lovich 2009). Their diet appears to shift with age; young turtles are primarily carnivorous and adults herbivorous. The proportion of diet composed of plant and animal materials varies regionally and seasonally (Ernst and Lovich 2009). Ephemeral ponds provide a high quality food source for juveniles in the form of insect larvae (Moldowan *et al*. 2015). Shells of fingernail clams (Sphaeriidae) are routinely found in the feces of Midland Painted Turtles in Algonquin Provincial Park in spring (Algonquin Park Turtle Project, unpublished). Painted Turtles are seed dispersers of aquatic plants (Moldowan *et al.* 2015) and they feed on carrion (Ernst and Lovich 2009). Midland Painted Turtle participates in a unique symbiotic relationship with Snapping Turtle in which they remove and consume leeches (Krawchuck *et al.* 1997).

Predators of Painted Turtles include: American Mink (*Mustela vison*), River Otter (*Lontra canadensis*), Coyote (*Canis latrans*), Domestic Dog (*Canis familiaris*), Red Fox (*Vulpes vulpes*), Domestic Cat (*Felis catus*), Raccoon (*Procyon lotor*), shrews (*Sorex* spp., *Blarina brevicauda*), Great Blue Heron (*Ardea herodias*), Bald Eagle (*Haliaeetus leucocephalus*), American Crow (*Corvus brachyrhynchos*), Common Raven (*Corvus corax*), American Bullfrog (*Lithobates* [*Rana*] *catesbeiana*), Northern Watersnake (*Nerodia sipedon*), and conceivably Largemouth Bass (*Micropterus salmoides*), catfishes (*Ameiurus* spp.), and pike (*Esox* spp.) among others (Ernst and Lovich, 2009; Gillingwater and Piraino pers. comm. 2015). Mammalian mesopredators, such as Raccoons and Red Foxes, are major nest predators (Ernst and Lovich, 2009; see **THREATS AND LIMITING FACTORS, Subsidized Predators**). Young are susceptible to predation from all of the above-mentioned species, though only American Mink, River Otters, canids (coyotes, domestic dogs), Raccoons, and corvids are threats to adults.

Painted Turtles can occur in high densities and contribute disproportionately to biomass in aquatic ecosystems (Iverson 1982; Congdon *et al.* 1986). The body of turtles, including Painted Turtles, contains two to four times the amount of phosphorus as that stored by freshwater fishes and larval amphibians (Sterrett *et al.* 2015). Thus, the large biomass, robust skeleton, slow growth, and longevity of Painted Turtles contribute to a large and stable standing stock of nutrients (especially phosphorus and carbon) in freshwater ecosystems (Sterrett *et al.* 2015).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Valuable medium- to long-term data on Painted Turtle subpopulations have been collected in Ontario from Point Pelee National Park (1972-1973 and 2001-2002, Browne 2003; Browne and Hecnar 2007) and Algonquin Provincial Park (1978-present, R.J. Brooks and J.D. Litzgus); in southern Québec (2004-present, J.-F. Desroches and I. Picard); and in Michigan at the E.S. George Reserve (1953-1955, O.J. Sexton; 1968-1972, H.M. Wilbur; 1975-1979, D.W. Tinkle and J.D. Congdon; and 1980-2007, J.D. Congdon). These studies have used mark-recapture methods to study Painted Turtle abundance and population trends at various sites. Capture methods include the use of dipnetting, hoop and fyke net trapping, basking traps, visual wetland surveys, and nesting surveys, as outlined for the case studies that follow. The IUCN notes that no specific population data are available for Painted Turtles in Canada (Van Dijk 2013).

Based on site accessibility, habitat complexity, and target versus non-target surveys, the detectability of Painted Turtles can be highly variable. Under ideal conditions the detection of Painted Turtles can often be achieved within a single visit to a site given their conspicuous basking groups and easily recognizable colours and patterns. In contrast, detection of Midland Painted Turtles at a Lake Erie (Ontario) site required 15-130 hours of hoop trapping or 64-163 hours of visual surveys, and a site south on Lake Huron (Ontario) required 44 hours of hoop trapping and 8-10 hours of visual surveys (Davy *et al.* 2015). Over the course of ~250-300 person days at ~8h/day, 102 live Midland Painted Turtle total captures were made at Rondeau Provincial Park (2000-2001) whilst conducting on-foot wetland transects with dipnet (Gillingwater and Piraino pers. comm. 2015). Using the same methodology, 48 live captures were made over ~80 person-days at ~6h/day at the Big Creek National Wildlife Area, Ontario in 2003 (Gillingwater and Piraino pers. comm. 2015). Researchers with the Prince Edward County (Ontario) Reptile and Amphibian Survey counted 178 basking Midland Painted Turtles over a 5 km paddling transect (35.6 turtles/km; Christie 1997). Active searches conducted by wading and from canoe during spring were much more successful than trapping (Giguère 2006). Hand captures resulted in 4.0 captures/search hour at a site on western Montréal Island, Québec (Bider and Hoek 1971). Significantly more Midland Painted Turtles were captured during trapping before 20 May than between 20 May and 20 June in Lake Opinicon, Ontario (Midwood *et al.* 2015), indicating high levels of spring activity in the species (see **Activity**). Baited hoop trapping, basking traps, hand capture (Ream and Ream 1966; Koper and Brooks 1998; Tesche and Hodges 2015), and road surveys (Steen and Smith 2006) can introduce substantial sampling biases that must be considered in population studies. A summary of sampling efforts and methods is presented in Table 4.

Table 4. Trap effort and capture success of Painted Turtle (*Chrysemys picta* ssp.) subpopulations in eastern Canada and the northeastern United States.

Location	Method	Captures (turtles/trap day)	Remarks	Reference
Newboro Lake, eastern Ontario	Tandem hoop traps connected by lead and two wings	0.15 (2009)	Sampling 'ice-off' (early April) to 20 June	Larocque *et al.* 2012a
Lake Opinicon, eastern Ontario (spring)	Tandem hoop traps connected by lead and two wings	0.65 (2010)	Sampling 'ice-off' (early April) to 20 June	Larocque *et al.* 2012a
Lake Opinicon, eastern Ontario (autumn)	Tandem hoop traps connected by lead and two wings	0.32 (2010)	Sampling first Monday of September to 02 October	Larocque *et al.* 2012a
Point Pelee National Park, ON	Baited hoop trap	0.192 (1972)	522 trap days	Browne and Hecnar 2007
Point Pelee National Park, ON	Baited hoop trap	0.143 (2001/02)	3237 trap days	Browne and Hecnar 2007
Algonquin Provincial Park, ON	Baited hoop trap	0.03 (2011) 0.03 (2012)	520 (2011) and 834 trap days (2012); July - August trapping	Keevil and Riley 2012; Keevil and Moldowan 2013
Cherry River Marshes, Magog, QC	Baited fyke nets	0.90 (2007) 0.98 (2010) 1.67 (2013)	112 (2007), 80 (2010), 57 (2013) trap days; July - September trapping	Picard 2014
Lac Saint-François National Wildlife Area, QC	Baited hoop trap	0.2 (2004) 0.5 (2005)	30 (2004) and 18 (2005) trap days; May trapping	Giguère 2006
Vermont, USA	Baited hoop trap	0.16-5.40		Wright and Andrews 2002

Abundance

Population densities of Painted Turtles can reach high values but are also subject to considerable regional variability and temporal fluctuation, even in protected areas. In the Carolinian and Great Lakes/St. Lawrence faunal provinces of southern Ontario and Québec, Midland Painted Turtle densities range from 9.9-289 turtles/ha. Densities of approximately 20-40 turtles/ha appear most typical, although there are exceptionally large estimates of nearly 500 turtle/ha (based on waterbody surface) from Point Pelee National Park (Table 1). In the Canadian Shield faunal provinces of Ontario and Québec, Midland Painted Turtle densities are much lower, typically ranging from 2.6-15.7 (M. Keevil and Algonquin Park Turtle Project, unpublished; Table 1). Density at Rockwood Park, NB in the Appalachian/Atlantic Coast faunal province ranged from 6.5-10 turtles/ha (Browne and Sullivan 2017; Table 1). Painted Turtle densities decrease with increasing latitude (Table 1). Annual temperature, habitat productivity, and accessibility of nesting sites (e.g., Wolf Howl Pond; Table 1), as well as wetland edge to surface area ratio (e.g., Wolf Howl Pond, North and South DeLaurier; Table 1) likely exert a strong influence on population abundance and density. While a few short- and long-term studies have estimated local subpopulation sizes in Ontario and western Québec, no regional or provincial estimates of Painted Turtle population sizes are available in Canada. No abundance or population density data for Eastern Painted Turtles are available from the Maritime Provinces.

Fluctuations and Trends

Medium- to long-term studies of Painted Turtles at sites with low anthropogenic disturbance in Ontario (Samson 2003; Algonquin Park Turtle Project, unpublished) and Québec (Mallet 1975; Picard and Desroches 2010) have demonstrated population stability. A relatively consistent population size, low annual population recruitment, high adult survival, and adult longevity generally characterize minimally impacted populations in Algonquin Provincial Park monitored from 1978 to present (Samson 2003; Algonquin Park Turtle Project, unpublished). In Algonquin Provincial Park, population densities at Wolf Howl Pond range from 103-109 turtles/ha in 1990-2002 (Samson 2003) and 97 turtle/ha in 2013 (Keevil, unpublished; note: a much smaller population estimate of 64.7 turtle/ha at this site by Koper and Brooks (1998) appears anomalous in light of the robust analyses of Samson (2003) and Keevil (unpublished)). At another Algonquin Provincial Park site, West Rose Lake, Samson (2003) estimated 9.7-11.2 turtles/ha in 1990-2003 compared to 11.5 turtles/ha in 2013 (Keevil, unpublished).

In contrast, over a 30-year period, Browne and Hecnar (2007) recorded a decline in catch per unit effort (*i.e.*, relative abundance) for Midland Painted Turtles in Point Pelee National Park, Ontario. Although the habitat is protected from development, this site is located in the most heavily developed region in Canada where many of the other threats affecting this species (e.g., road mortality, predation) are intense. The subpopulation at this site also experienced a significant shift to a male-biased sex ratio, a significant decline in median body size (likely in part due to the increase in male sex ratio bias), and proportionately more juvenile-sized individuals when comparing 1972-1973 and 2001-2002 assessments; increased predation of nesting females, resulting from dense Raccoon populations, may be responsible for the shift in population structure (Whitehead 1997; Browne and Hecnar 2007). Similarly, in the protected E.S. George Reserve, Michigan, long-term research has shown considerable population size fluctuations in Midland Painted Turtles (Table 1). Study between 1953-1957 estimated a density of 134.4 individuals/ha (Sexton 1959a; Congdon *et al.* 1986). Between 1968 and 1973, the same subpopulation yielded density estimates of 25.5 individuals/ha, an equivalent of 80% decline (Wilbur 1975b; Congdon *et al.* 1986). Most recently, between 1975 and 1983, density estimates were 39.9 individuals/ha (Congdon *et al.* 1986).

At sites with minimal anthropogenic disturbance, fluctuation in local subpopulation structure may result from environmental changes leading to emigration or mortality (e.g., drought and pond drying) or mass mortality (winterkill attributable to environmental extremes or predators). Even low levels of additional mortality (5-10%) are expected to lead to gradual and severe population declines over extended time periods that are difficult to detect (e.g., Gamble and Simons 2003; Midwood *et al.* 2015). Population recovery from perturbation is slow on account of the Painted Turtle's "slow" life history. There are insufficient historical and contemporary data across the range of Midland and Eastern Painted Turtles to determine if populations are declining or to estimate the magnitude of the decline at local, regional, and national scales. Other metrics of changing population structure, such as changes in population sex ratios, body size, and/or age classes, are unavailable outside of Browne and Hecnar (2007).

Painted Turtles are expected to demonstrate long-term population stability given their bet-hedging life history strategy; however, the necessity of long-term study in order to detect population fluctuations and trends makes the availability of such data limited. Southern subpopulations of the Midland Painted Turtles in Canada (*i.e.*, Carolinian and Great Lakes/St. Lawrence faunal provinces) are likely declining based on multiple and continuing pervasive threats (see **THREATS**) and observed declines (Browne and Hecnar 2007). The loss of greater than 70% of wetlands in southern Ontario over the past 200 years has very likely resulted in significant declines in both abundance and distribution throughout this region (see **HABITAT, Habitat Trends**, and **THREATS**)**.** For Midland Painted Turtles in the Canadian Shield region, any declines are more likely to be localized because of a reduced number and severity of threats (e.g., lower road density, lower traffic volumes, and far less habitat loss) when compared to the Carolinian and Great Lakes/St. Lawrence region. Although the few existing long-term datasets for Shield subpopulations show neither increase nor decline, subpopulations in the Canadian Shield region demonstrate a greater vulnerability to decline than subpopulations further south owing to their environment and life history traits (e.g., shorter active season, slower growth, later age at maturity, longer generation times, risk of reproductive failure because of cold temperatures). This is consistent with the pattern of historical vs. recent records on the Canadian Shield from the Ontario Herpetofaunal Summary and Ontario Reptile and Amphibian Atlas (ORAA) (Figure 4). In large areas of eastern Québec, New Brunswick, and Nova Scotia where human impact is relatively low (see **HABITAT, Habitat Trends**, and **THREATS**), Painted Turtle subpopulations are likely at lesser risk of widespread decline. An absence of population data for Eastern Painted Turtles across their Canadian range limits our understanding of population fluctuation and trends.

Rescue Effect

Natural dispersal of Midland and Eastern Painted Turtles from U.S. states to neighbouring Canadian provinces may be possible over long time scales. Extensive urbanization, agriculture, natural (particularly Lake Erie and Lake Ontario), and human-made barriers along the Canada-United States border throughout the range of Midland Painted Turtles would limit dispersal likelihood and success. Although these apply to a lesser extent to Eastern Painted Turtles, turtles south of the border face similar threats to those north of the border. Potential immigrants from neighbouring states of Michigan, New York, Vermont, and Maine would be adapted for climatic conditions, and subpopulations in these states are generally considered secure (Table 5). Natural dispersal to Nova Scotia from mainland sites of Canada and the United States would be very low and infrequent. Painted Turtles from the northeastern United States are likely genetically similar to those in eastern Canada considering the relatively recent post-glacial dispersal of the former from the latter and the general genetic similarity of the subspecies (Starkey *et al.* 2003; Jensen *et al.* 2015). Given that the greatest threats to Painted Turtles in Canada relate to habitat loss, road mortality, and subsidized predators (see **THREATS AND LIMITING FACTORS**), supplemental individuals would provide little benefit to Canadian subpopulations unless the underlying causes of mortality were mitigated.

Table 5. Conservation status ranks of the Midland Painted Turtle (*Chrysemys picta marginata*) and Eastern Painted Turtle (*C. p. picta*) across North American range. Note that not all provinces and states explicitly recognize Painted Turtles at the subspecific level and therefore assign conservation status ranks simply to *C. picta*. Statuses from NatureServe (2016).

Rank	Jurisdiction
Chrysemys picta marginata	
Provincial and State Status S5 (Secure) S4 (Apparently Secure) SNR (Not Assessed)	 Ontario; Illinois, Kentucky, Pennsylvania, West Virginia Indiana New Jersey
National Status N5 (secure)	 Canada (2011); United States (1996)
Global Status G5 (secure)	 Globally
Infraspecific taxon status T5 (secure)	 Globally
Chrysemys picta picta	
Provincial and State Status S5 (Secure) SNR (Not Assessed)	 New Brunswick, Nova Scotia; Pennsylvania, Rhode Island, West Virginia New Jersey
National Status N5 (secure)	 Canada (2011); United States (1996)
Global Status G5 (secure)	 Globally
Infraspecific Taxon status T5 (secure)	 Globally
Chrysemys picta (evaluations within the range of *C. p. marginata, C. p. picta*, and intergrades thereof)	
Provincial and State Status S5 (Secure) S4 (Apparently Secure) SNR (Not Assessed)	 Ontario, New Brunswick, Nova Scotia; Alabama, Connecticut, Delaware, Georgia, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New York, North Carolina, Rhode Island, Tennessee, Vermont, Virginia, West Virginia Québec Illinois, Indiana, Ohio, Pennsylvania, South Carolina
National Status N5 (secure)	 Canada (2011); United States (1996)
Global Status G5 (secure)	 Globally

THREATS AND LIMITING FACTORS

Anthropogenic sources of mortality include vehicular mortality (road, rail, off-road, boat), habitat loss, entanglement and drowning in fishing nets, ingestion of fishing hooks, entrapment in mesh erosion control fencing, trapping in shoreline riprap, collection for consumption or trade, and displacement by or competition with invasive species (Ernst and Lovich 2009; Gillingwater and Piraino pers. comm. 2015).

Like other turtles (Congdon *et al*. 1993, 1994), Painted Turtles are sensitive to even low levels of additional adult mortality. The long generation times and relatively slow population declines of turtles, including Painted Turtles, make detection of these declines difficult on human-life timescales, and recovery is very slow (Brooks *et al.* 1988, 1991; Congdon *et al.* 1993, 1994; Pitt and Nickerson 2013; Midwood *et al.* 2015). Proxy data may be used to elucidate the severity of a threat (e.g., wetland loss or road density as a predictor of Painted Turtle abundance or decline), but targeted monitoring and direct threat assessments are still needed.

Threats to Painted Turtle reviewed below are categorized following the IUCN-CMP (International Union for the Conservation of Nature – Conservation Measures Partnership) unified threats classification system, based on the standard lexicon for biodiversity conservation of Salafsky *et al*. (2008). They are presented in decreasing order of severity of impact, ending with those for which scope or severity is uncertain. The assigned overall threat impact is High-Medium for Midland Painted Turtle (Appendix II) and Medium for Eastern Painted Turtle (Appendix III).

Threats Calculator results for both Midland Painted Turtle and Eastern Painted Turtle clearly identify the direct and indirect effects of roads, invasive species, and habitat loss as the major threats for both DUs. Additional threats from commercial and recreational fishing, other recreational activity, and human-subsidized predators were also identified.

<u>Roads and Railroads (4.1)</u>

Predicted impact for Midland Painted Turtle: **Medium-Low** (Scope Large-Restricted, Severity Moderate)

Predicted impact for Eastern Painted Turtle: **Low** (Scope Large, Severity Slight)

Roads pose multiple threats to Painted Turtles, causing direct and indirect mortality. Roads contribute to habitat destruction and fragmentation, intentional persecution, and mortality (Ashley *et al.* 2007), act as barriers to movement, are a source of environmental degradation and pollution, increase access for human use, and may result in sublethal impacts from persistent disturbance. Turtles come into contact with roads for two reasons: i) nesting areas owing to favourable substrate, heat conductance, exposure, and drainage on roads and roadsides; ii) incidental use during overland movement associated with dispersal and/or migration. The slow movement and tendency for turtles to retreat into their protective shell when disturbed results in loitering on the road surface, and thereby increases exposure to vehicular collision. Roads may serve as ecological traps to females who are drawn to gravel shoulders for nesting, resulting in the death of the female and/or her offspring. All sex and age classes are vulnerable to road mortality during migratory movements, and elevated presence of predators along disturbed edge habitat. The threat of roads to Midland Painted Turtles has received appreciable and growing attention in Ontario and Québec. Impacts of roads on Eastern Painted Turtles in the Maritime provinces are generally poorly known and unquantified. Although they are likely localized given the relatively low road density in this region (McAlpine 2010), they can be locally significant (Herman pers. comm. 2018).

<u>Spatial and temporal road impacts:</u>

There are three active season periods of particular concern with respect to road mortality of Painted Turtle in Canada: May, post-overwintering movements (Ashley and Robinson 1996); June, nesting period (MacKinnon *et al.* 2005; Desroches and Picard 2007; Baxter-Gilbert and Riley pers. comm. 2015; Boyle, pers. comm. 2015; Garrah *et al.* 2015; Sheppard 2015; Stinnissen 2015); September, pre-overwintering movements and hatching (MacKinnon *et al.* 2005; OREG 2010; Baxter-Gilbert and Riley pers. comm. 2015; Boyle, pers. comm. 2015; Garrah *et al.* 2015; Sheppard 2015; Stinnissen 2015). Herpetofaunal road mortality rates are typically highest where roads are within 100 m of a wetland, the road is flanked on both sides by wetlands, and there is high nearby forest cover (Findlay and Houlahan 1997; Marchand and Litvaitis 2004; Langen *et al*. 2009, 2012). Among multiple spatial, temporal, and climatic variables, wetland proximity to road was the strongest predictor of Midland Painted Turtle and Snapping Turtle road mortality on the Bruce Peninsula, Ontario (Stinnissen 2015). Similarly, turtle mortality at Honey Harbour, Georgian Bay, was associated with water area, distance to water, and number of water crossings (MacKinnon *et al.* 2005). In Outaouais, Quebec, over half (56%) of all roadkilled Painted Turtles were within 100 m of aquatic habitat, while most (82%) were less than 200 m, and the vast majority (92%) of individuals were within 300 m of wetlands (Desroches and Picard 2007). On average, roadkilled Painted Turtles were found within 115 m of aquatic habitat (Desroches and Picard 2007). The proportion of males and adult Painted Turtles in 29 New Hampshire ponds was strongly related to road densities within 100 m of aquatic habitat (Marchand and Litvaitis 2004). Turtle road mortality is often spatially clustered (Garrah *et al.* 2015); however, road mortality hotspots may not be identifiable where roads have already impacted subpopulations (Eberhardt *et al.* 2013).

<u>Scale of threat</u>

Southern Ontario has experienced a nearly 6-fold increase in paved roadway length (1935: 7,133 km; 1965: 23,806 km; 1995: 35,637 km; 2005: 40,800 km) and substantial increase in multi-lane roads between 1935-2005 (Fenech *et al*. 2000; OBC 2010, 2015). In southern Ontario, few areas on the terrestrial landscape are more than 1.5 km from a road (Figure 7; OMNR 2009). An estimated 25% of provincial parks and conservation reserves of south-central Ontario have higher road densities than that of the surrounding landscape (Crowley and Brooks 2005; Crowley pers. comm. 2017). Road densities in the Canadian Shield ecozone of central-northern Ontario have experienced small increases in recent years (0.02% growth from 2001-2005), but road densities in this region remain low (OBC 2010). Although the rate of increase of total road length has slowed in Ontario at least (>2% increase between 1985-2005), the impacts of roads with respect to habitat fragmentation and increasing traffic volume are predicted to be lasting (Fenech *et al*. 2000). In addition to increased land area occupied by roads, there has been a substantial increase in traffic volume in Ontario (1988-2010; OMTO 2010a,b) and Nova Scotia (NSDTIR 2009, 2014) in recent decades. The same is likely true for Québec and New Brunswick; however, data are apparently lacking.

<u>Severity of threat</u>

Road mortality and indirect road impacts are pervasive threats impacting all life stages of Painted Turtles. Of 151 Painted Turtle and Snapping Turtle roadside nests monitored in Outaouais, Québec, 3.4% of total nests (representing 24% of successful nests) experienced soil compaction such that eggs or young were crushed in the nest or that natural emergence was impeded (Desroches and Picard 2007). Carapacial deformities were observed in young from compacted nests suggesting sub-lethal effects may be possible (Desroches and Picard 2007). Soil compaction represents a substantial and little known source of additional sublethal and lethal impacts for roadside nests. In addition to mortality from vehicular collision, roads, being ecological edge habitat, can act as linear search corridors for predators, placing nesting females, eggs, and hatchlings at an elevated risk of mortality (Temple 1987; Steen and Smith 2006).

Hatchlings and juveniles can form a large proportion (~22-45%) of individuals killed on roads (Farmer *et al.* 2012; Seburn 2014; Baxter-Gilbert and Riley pers. comm. 2015; P. Heaven pers. comm. 2015). There was no sex bias in roadkilled juvenile Midland Painted Turtles from Algonquin Provincial Park and Presqu'ile Provincial Park (Noble 2015; Keevil pers. comm. 2015). Hatchling and juvenile mortality is likely underreported given the inconspicuous size of young turtles, loss to scavengers (Steen and Smith 2006) and two nest emergence periods for Painted Turtles (autumn and spring). Given that approximately 40% of Midland Painted Turtle hatchlings seek refuge in grass, woody debris, and leaf litter before travelling to water (Riley *et al.* 2014b), hatchlings emerging from roadside nests lacking nearby cover are susceptible to elevated rates of predation. In contrast, Dorland *et al.* (2014) suggest that roads may ease predation pressure through the displacement of local predators. Roadsides can provide additional nesting habitat (DeCatazaro and Chow-Frazer 2010; Dorland *et al.* 2014; but see Marchand and Litvaitis 2004), but this would only be expected to serve a net benefit where traffic volume is low enough that recruitment exceeds adult mortality.

Road mortality demographics have been compiled from studies in Ontario, Québec, and select U.S. locales (Table 6). The loss of reproductive adults has serious negative consequences for population demography and long-term genetic integrity. Chronic nest failure and disruptive genetic effects can exacerbate the impact of roads (Angers and Silva-Beaudry 2006; Laporte *et al.* 2013). Road mortality is purported to disproportionately affect reproductive females due to their overland forays for nesting (Steen and Gibbs 2004; Aresco 2005; Gibbs and Steen 2005). However, males also undergo long-distance overland dispersal (see **Movement**) and may be subject to road mortality impacts equal to or greater than females (Carstairs *et al.* 2016). Research by Findlay and Bourdages (2000) in southeastern Ontario suggests that the impact of roads on herpetofaunal populations is detectable within <8 years, on average. Given the life history of (Painted) turtles and likelihood of slow declines, this detectability time lag is probably much greater, perhaps by many decades (Findlay and Bourdages 2000; Marchand and Litvaitis 2004; Eskew *et al.* 2010). In eastern Ontario, Dorland *et al*. (2014) found no difference in relative abundance, sex ratio, or mean body size between ponds adjacent to roads and those more distant from roads. Painted Turtles living in road-impacted sites did not demonstrate elevated levels of the stress hormone corticosterone compared to those at a control site (Baxter-Gilbert *et al.* 2014).

Table 6. Road mortality data for Painted Turtle (*Chrysemys picta* ssp.) in Ontario, Québec, and select areas of the United States. Note that values of density for road sightings and mortalities not weighed to search effort. *Number of individuals represented in sex ratio data not equal to number of total turtle road sightings due to differential data recording between haphazard and transect sampling. AOR = alive on road, DOR = dead on road, IOR = injured on road, M = male, F = female, UnknAd = adults of unknown sex, J = juvenile (sexually immature).

Year	No. turtle obs.	Turtle status, AOR: DOR: IOR	Sex ratio, M:F:UnknAd: J	Distance sampled (km) during each survey	Density of road sightings (turtles/km) per sampling period	Density of road mortalities (turtles/km) per sampling period (year or year range)	Description of survey effort	Location	Source
2013 2014 2015	26 30 21	14:12:0 11:19:0 4:17:0	10:9:1:6 6:12:1:11 3:11:0:7	2.4 2.4 2.4	10.8 12.5 8.8	5.0 7.9 7.1	3 surveys by bicycle and 1 walking survey daily from May until end of August, haphazard sighting reports	Presqu'ile Provincial Park (Presqu'ile Parkway), Ontario	Boyle, unpublished
2015	16	13:3:0	1:12:2:1	3.0	5.3	1.0	3 surveys by bicycle daily from May until end of August	Murphy's Point Provincial Park (County Road 21), Ontario	Noble and Kiesewalter, unpublished
2003-2004	54	Unknown	Unknown	12.2	4.4	Unknown	Daily survey by car from April to October	Honey Harbour (Muskoka Road 5), Ontario	MacKinnon *et al.* 2005
2014-2015	34	34:0:0	3:30:1:0	Unknown	Unknown	N/A	Incidental sampling by park staff	Grundy Lake Provincial Park, Ontario	Sheppard 2015
2014a 2014b 2015	102 76 51	63:39:0 37:39:0 33:17:1	18:33:51 12:17:47 4:29:18	4.0 1.5 1.5	25.5 50.7 34.0	1.5 26.0 19.3	2014a = 8 sights, 2349 survey hours. 2014b = 1 mitigation test and 2 control sites (1185 survey hours). 2015 = 1 mitigation test and 2 control sites (1211 survey hours).	Haliburton, Ontario	Heaven 2015
2002-2013	36	19:15:2	4:27:2:3	15.0	2.4	1.0	Incidental sampling by car from May until end of August	Algonquin Provincial Park, Ontario	Litzgus 2014
2012 2013	91 108	10:81:0 12:96:0	23:8:29:31* 37:8:8:24*	6.0 6.0	15.2 18	13.5 16	2 surveys by car daily from May until end of August	Magnetawan First Nation (Hwy 69), Ontario	Baxter-Gilbert and Riley, unpublished
2012 2013	34 13	24:10:0 10:3:0	Unknown Unknown	2.8 2.8	12.1 4.6	3.6 1.1	2 surveys by car daily from May until end of August, haphazard sighting reports	Magnetawan First Nation (Hwy 529), Ontario	Baxter-Gilbert and Riley, unpublished

Year	No. turtle obs.	Turtle status, AOR: DOR: IOR	Sex ratio, M:F:UnknAd: J	Distance sampled (km) during each survey	Density of road sightings (turtles/km) per sampling period	Density of road mortalities (turtles/km) per sampling period (year or year range)	Description of survey effort	Location	Source
2012 2013	43 40	15:28:0 4:36:0	11:4:11:17 17:7:10:6	13.0+2.0 13.0+2.0	2.9 2.7	1.9 2.4	Three 13 km daily surveys by car (09:00, 18:00, 22:00) from 01 May until 31 August; 1 daily 2 km roadside walking survey (10:00). Total of 960 surveys 2012 and 974 surveys 2013 (1934 total surveys).	Burwash (Hwy 69), Ontario	Baxter-Gilbert *et al.* 2015, Baxter-Gilbert and Riley, unpublished
1979 1980 1992 1993	95 74 93 79	0:95:0 0:74:0 0:93:0 0:79:0	Unknown Unknown Unknown Unknown	4.3 4.3	22.1 17.2 21.6 18.4	22.1 17.2 21.6 18.4	3 surveys by bicycle weekly, June to end of October (1979), April to end of October (1980, 1992, 1993)	Long Point (Hwy 59), Ontario	Ashley and Robinson 1996
2012	167	0:167:0	Unknown	100 (80 km of Hwy 7, 20 km of Hwy 41)	1.67	1.67	28 driving surveys, from end of May to mid-September	Peterborough and Hastings Counties (Hwy 7 and 41), Ontario	Lesbarrères *et al.* 2013
2012 2013	49 92	29:20:0 35:56:1	3:17:29:0 5:14:15:58	100 100	0.49 0.92	0.20 0.56	2012: daily surveys 25 May to 31 August, 40 km by bicycle and 60 km by car (78 surveys). 2013: 16 April to 21 September, 80 km by bicycle and 20 km by car (96 surveys). 17,400 kilometres surveyed 2012-2013.	Bruce Peninsula (Hwy 6), Ontario	Stinnissen 2015; Stinnissen pers. comm. 2015
	52	3:49:0	18:16:18 (Unknown sex adults and juveniles combined)	100			8 surveys by car from 30 May to 02 July, average 4.25 days between surveys but not more than 6 days	Arnprior to Petawawa (Hwy 17), Ontario	Seburn 2014
2008 2010 2011	69 46 45	0:69:0 0:46:0 0:45:0 (estimated mean annual mortality 95 individuals)	Unknown	37	1.87 1.24 1.22 (2.57)	1.87 1.24 1.22 (2.57)	3-4 weekly bicycle surveys, 14 April to 16 October 2008 (84 surveys), 02 June to 30 September 2010 (56 surveys), 03 May to 30 June 2011 (23 surveys).	1000 Islands Parkway, Ontario	Garrah *et al.* 2015
2003	45	0:45:0	10:28:7:0	625	0.072	0.072	Weekly car surveys, 01 June to 05 July	Outaouais, Québec	Desroches and Picard 2005
2003-2004	119	0:119:0	20:80:17:2	700	0.17	0.17	Weekly car surveys, 03 June to 04 July (2003), 07 June to 01 July (2004) with incidental observation outside sampling period	Outaouais, Québec	Desroches and Picard 2007
2013 2014 2015	4 6 6	0:4:0 0:6:0 0:6:0	Unknown	40 40 40	0.1 0.15 0.15	0.1 0.15 0.15	Park wardens report incidents of road mortality	Parc National de Plaisence, Québec	Houle, pers. comm. 2015
2012 2013	12 8	3:9:0 2:6:0	Unknown Unknown	32.1 32.1	0.37 0.25	0.28 0.19	Daily surveys by car, bicycle or foot from 20 May to 14 July (2012), 27 May to 03 July (2013)	North Missisquoi River (Hwy 243 and 245), Québec	Lafrenière and Sicotte 2013; Robidoux pers. comm. 2015
2006-2007	126	0:126:0	Unknown	160	0.79	0.79	Weekly surveys by car from May to October, total of 41 surveys for survey distance of 6564 km	St. Lawrence County, New York	Langen *et al.* 2012

Year	No. turtle obs.	Turtle status, AOR: DOR: IOR	Sex ratio, M:F:UnknAd: J	Distance sampled (km) during each survey	Density of road sightings (turtles/km) per sampling period	Density of road mortalities (turtles/km) per sampling period (year or year range)	Description of survey effort	Location	Source
2000-2001	32	0:32:0	11:21:0:0	Unknown	Unknown	Unknown	Incidental encounters	Strafford and Rockingham Counties, New Hampshire	Marchand and Litvaitis 2004
1995	206	1:205:0	88:54:63 (Unknown sex adults and juveniles combined)	7.2	28.6	28.5	3 surveys weekly from 17 May to 24 August	Mission Valley (Hwy 93), Montana	Fowle 1996
2002 2003 2004	357 414 269		0:3:101:87:(166) 50:49:92:86:(137) 49:29:78:48:(65)	10.4			33 surveys over 3 years	Mission Valley (Hwy 93), Montana	Griffin and Pletscher 2006

Painted Turtles are regularly reported as the most frequently encountered turtle and reptile species encountered (alive and dead) during road surveys in Ontario and Québec, though these values are rarely available as population mortality rates. In Point Pelee National Park, Ontario, Midland Painted Turtle road mortality averaged only 5.3 adults/year (Browne 2003). Population modelling did not show a park-level population decline due to road mortality, likely because of a large local subpopulation, low road density, speed limits and traffic volume, and the active removal of live turtles from the road by park visitors and staff (Browne 2003; Browne pers. comm. 2016). Bradford (2003) conservatively estimated that 5% of the Painted Turtle subpopulation in St. Lawrence Islands National Park is subject to road mortality every year, a level unlikely to be sustainable. By studying roadside populations and road mortality in Québec, Desroches and Picard (2007) found annual population losses from road mortality ranged from 0.29% to 9.9% (Table 8). Gibbs and Shriver (2002) predicted that very high road densities ($\gg$2 km of roads/km^2) and high traffic volumes ($\gg$200 vehicles/lane/day) would be necessary to reduce the viability of regional subpopulations of small-bodied pond turtles, such as Painted Turtles. Currently, the best available data for southern Ontario (1995), an area with the highest road densities in the province, suggests that road densities range from 0.503-0.518 km of road/km^2 (Fenech *et al.* 2000). Gibbs and Shriver (2002) recognize that their prediction underestimates population-level impacts of road mortality by not considering concurrent threats, limiting mortality to the nesting period, and variation in life history across the Painted Turtle range.

<u>Invasive Non-Native/Alien Species (8.1)</u>

Predicted impact for Midland Painted Turtle: **Low** (Scope Restricted, Severity Slight)

Predicted impact for Eastern Painted Turtle: **Unknown** (Scope Small, Severity Unknown)

Numerous species of non-native freshwater turtles from the pet trade (e.g., Sliders, Cooters, and Map Turtle species; ORAA, unpublished) have been introduced within the

Canadian range of Painted Turtles. Many such introductions have been recorded in protected areas, such as Point Pelee National Park (ON, Browne, 2003; Browne and Hecnar 2007), Pinery Provincial Park (ON, Davy pers. comm. 2015; Steinberg pers. comm. 2015), St. Johns Conservation Area (ON, P. Moldowan pers. obs.), and Rockwood Park (NB, Browne and Sullivan 2015). These non-native turtle species are capable of successfully overwintering in south and central Ontario as well as the Maritimes (McAlpine 2010; Browne and Sullivan 2015; Seburn 2015; ORAA, unpublished), and at least Red-eared Slider (*T. s. elegans*) has been observed to successfully reproduce in southern Ontario (Gillingwater 2013; Seburn 2015). Introduced turtles, often larger in body size, can compete with native turtle species for access to basking sites (Cadi and Joly 2003), food and spatial resources (Cadi and Joly 2004), and serve as a source of parasite and pathogen introduction (Varneau *et al.* 2011). Given the close taxonomic relatedness of Painted Turtles and other emydid turtles commonly found in the pet trade, there is a possibility of ecological niche overlap, mating interference competition, and risk of parasite and pathogen transfer. The most commonly introduced exotic turtle, the Pond Slider, largely overlaps with Painted Turtles in their southern range (Ernst and Lovich 2009), so co-existence is likely.

The introduction of predatory sport fishes (e.g., bass (*Micropterus* spp., Northern Pike (*Esox lucius*), Muskellunge (*Esox masquinongy*), bullhead catfish (*Ameiurus* spp.) can be a source of juvenile turtle mortality (Ernst and Lovich 2009). Many of these predatory species occupy shallow, warm water, and well vegetated areas that would be frequented by young Painted Turtles.

The invasion of non-native aquatic vegetation, particularly *Phragmites a. australis*, is negatively impacting Painted Turtle subpopulations in southern Ontario and likely elsewhere. This species occupies a large and growing area across the range of Painted Turtles in eastern Canada (Catling and Mitrow 2011), and displaces Painted Turtles from areas of optimal (riparian) habitat and reduces access to shoreline for nesting. Monitored subpopulations of Midland Painted Turtles have been “heavily impacted” by *P. a. australis* at sites in southern Ontario including Long Point National Wildlife Area, Big Creek National Wildlife Area, St. Clair National Wildlife Area, Rondeau Provincial Park, Crown Marsh, Long Point Provincial Park, and Kettle and Stony Point First Nation (Gillingwater and Piraino pers. comm. 2015).

Residential and commercial development (1.1,1.2)

Predicted impact for Midland Painted Turtle: **Low** (Scope Small, Severity Serious)

Predicted impact for Eastern Painted Turtle: **Low** (Scope Small, Severity Moderate)

Widespread habitat loss and modification have occurred in southern Ontario and western Québec where the (sub)species has been historically recorded in greatest abundance (see **DISTRIBUTION**). However, large regions of central Ontario and Quebec, as well as New Brunswick and Nova Scotia remain relatively undisturbed, and Painted Turtle habitat loss and degradation have been minimal in these regions. Between 1982-

2002, Ontario's human population has increased by almost 3.3 million to more than 12.5 million, with expanding urban centres concentrated in the south (Greater Toronto Area, Kitchener-Waterloo-Cambridge, Hamilton and Niagara region, and Ottawa; Chiotti and Lavender 2008). The human population of Ontario is estimated to grow by an additional 31% by 2031, with anticipated continued growth in the south and gradual depopulation of rural areas of central and north subregions (Chiotti and Lavender 2008). Although a large proportion of human population growth is confined to city centres (Chiotti and Lavender 2008), urban sprawl and settlement in rural areas will place continued pressure on the habitat of Painted Turtles.

In Québec, 82% of the human population (7.5 million as of 2005) is concentrated in the south and along the St. Lawrence River (Bourque and Simonet 2008). Aside from direct habitat loss, wetland suitability for Painted Turtle can be altered by human activities such as hydroelectric (damming) development, channelization, and invasive species presence (e.g., European Common Reed, *Phragmites australis*). Wetland loss in the Canadian Shield ecoregion of Ontario and Québec is lower than in southern Ontario. Fragmentation of habitat patches threatens Painted Turtle subpopulations. Wetland isolation is negatively associated with Painted Turtle abundance and females in isolated ponds were disproportionately afflicted with sub-lethal injuries from automobiles, machinery (e.g., lawn mowers), and predators (Marchand and Litvaitis 2004). The number of injured turtles per pond was significantly related to the amount of urban development within 100 m of ponds (Marchand and Litvaitis 2004). Loss of forest cover within 2 km of a wetland and road density within 2 km of a wetland have a strong negative impact on herpetofaunal richness, turtles included (Findlay and Houlahan 1997). Wetland water quality and macrophyte community index scores have been strongly negatively correlated with road densities within 1-2 km zones around Lake Ontario, Lake Erie, and Lake Huron marshlands occupied by Midland Painted Turtles (DeCatanzaro and Chow-Fraser 2010), which may indicate a decline in overall habitat quality.

Cottage and seasonal (second) home development along shoreline habitats in both New Brunswick and Nova Scotia is growing, eliminating and degrading habitat, particularly in southwest Nova Scotia, where Eastern Painted Turtle densities are probably highest.

The threat of habitat loss and degradation is often concurrent with other threats including, but not limited to, road mortality, human-subsidized predators, and pollution. See **Climate Change** with respect to temperature and precipitation regime shifts and implications for wetland loss.

Fishing and Harvesting Aquatic Resources (5.4)

Predicted impact for Midland Painted Turtle: **Low** (Scope Small, Severity Moderate-Slight).

Predicted impact for Eastern Painted Turtle: **Unknown** (Scope Small, Severity Unknown)

Commercial Fisheries By-Catch

By-catch in commercial fyke/hoop net fisheries poses a threat to Painted Turtle subpopulations in Canada, particularly in southern Ontario and western Québec. Midwood *et al.* (2015) assessed population viability for a Midland Painted Turtle subpopulation subject to small-scale commercial fisheries by-catch in Lake Opinicon, Ontario. In this robust subpopulation with an estimated carrying capacity of over 1000 individuals, the mortality of greater than two adult females per year would lead to extirpation within 350 years and mortality of 10 adult females would cause extirpation within 75 years (Midwood *et al.* 2015). This study did not consider other sources of mortality (e.g., road mortality, pollution, collection), leading to optimistic estimates of population viability.

Painted Turtles are captured in 1-2% of commercial fisheries net checks from Long Point Bay (Gislason *et al.* 2010) and Lake Ontario and Upper St. Lawrence (Mathers 2015). Midland Painted Turtles represented 26-32% (Larocque *et al*. 2012b) and 15-44% (Larocque *et al.* 2012c) of all non-fish by-catch in experimental by-catch studies of two eastern Ontario lakes. Up to 33% of Midland Painted Turtles died in trap nets despite floats having been placed in the traps to provide airspace (Larocque *et al.* 2012a). Still, trap floats have been suggested as an effective means of curbing by-catch mortality (Larocque *et al.* 2012a,b). In addition, the installation of exclusion devices and/or effort reduction (*i.e.*, shortening or temporal shift of the commercial fisheries season) has significantly reduced capture and mortality for Midland Painted Turtles, among three other turtle species, in Lake Opinicon (Larocque *et al.* 2012a,b,c; Cairns *et al*. 2013; Midwood *et al.* 2015). Keeping oxygen-deprived turtles out of the water following extended submergence in nets may reduce the chance of post-release mortality (LeDain *et al*. 2013). Despite high anoxia tolerance of Painted Turtles when submerged at cold temperatures (Ultsch 2006), forced submergence in fishing nets at warm temperatures is likely to result in sublethal and lethal conditions (Larocque *et al.* 2012a,b; LeDain *et al.* 2013; Stoot *et al.* 2015).

Commercial fisheries are subject to Section 5[1] of the *Fish and Wildlife Conservation Act, 1997, S.O. 1997, c.41*, prohibiting the hunting (including capturing, harassing, injuring, killing) and trapping of specially protected wildlife (Midland Painted Turtles included; see **PROTECTION, STATUS, AND RANKS**). In response to concerns about turtle by-catch mortality in commercial fishing operations in Ontario, the Ontario Commercial Fisheries' Association drafted a non-legally binding *Commercial Fisher's Biodiversity Resolution and Protocol for Lake Ontario and the Ottawa and St. Lawrence Rivers* (Appendix IV). The industry relies on due diligence by its members to take measures to minimize turtle by-catch (Critchlow pers. comm. 2015). However, resistance from commercial fishers to report turtle by-catch (Nguyen *et al*. 2013) results in unreliable data for informing the severity of by-catch.

Low levels of additional adult mortality imposed by commercial fisheries by-catch (among other, often concurrent, threats) in long-lived iteroparous species such as Painted Turtles have profound negative population-level impacts (Raby *et al.* 2011; Larocque *et al.* 2012b; Midwood *et al.* 2015).

Recreational angling

Painted Turtles, being dietary generalists (Ernst and Lovich 2009), may be attracted to baited hooks used in recreational angling. Among 78 Eastern Painted Turtles admitted to the Wildlife Centre of Virginia between 1991-2000, 9% of individuals demonstrated morbidity or mortality from fishing equipment trauma (Brown and Sleeman 2002). Comparable in size and dietary ecology to Painted Turtles (Ernst and Lovich 2009), 3.5% of male Pond Sliders in Tennessee contained hooks (Steen *et al*. 2014). Ingestion of fishing hooks can be a threat inside and outside protected areas, and would be especially prevalent in areas where sport fishing is popular and overlaps with turtle habitat (e.g., bass angling in warm water, shallow, and well vegetated areas). Approximately 0.5-1.0% of annual Midland Painted Turtles admissions to the Ontario Turtle Conservation Centre are brought in on account of recreational fishing injuries, though this value is an underestimate of the prevalence of hook injuries (Carstairs pers. comm. 2015).

Recreational Activities (6.1)

Predicted impact for Midland Painted Turtle: **Low** (Scope Small, Severity Slight)

Predicted impact for Eastern Painted Turtle: **Negligible** (Scope Small, Severity Negligible)

Boating and aquatic recreational activities have a number of direct and indirect consequences for turtles. Disturbance from boat traffic curtails basking, which can in turn negatively impact thermoregulation, feeding, body condition, and reproduction, among other aspects of species' biology (Moore and Seigel 2006; Bulté *et al.* 2010). Traumatic sub-lethal and lethal boat strike injuries have been reported for Canadian turtles species including Northern Map Turtles (*Graptemys geographica*) (Bulté *et al.* 2010; Bennett and Litzgus 2014), Eastern Musk Turtles (*Sternotherus odoratus*) (Bennett and Litzgus 2014), and Eastern Spiny Softshell Turtles (*Apalone spinifera*) (Galois and Ouellet 2007), but data are lacking for Painted Turtles. Two percent (1 of 58) of captured Midland Painted Turtles in the Trent-Severn Waterway, Ontario, demonstrated injury from a boat propeller strike (Bennett pers. comm. 2015) compared to 3.6% of Eastern Musk Turtles, 2.7% of juvenile Northern Map Turtles, and 17.4-19.5% of adult Northern Map Turtles (Bennett and Litzgus 2014). Painted Turtles with boat strike injuries are rarely admitted to the Ontario Turtle Conservation Centre (Table 7), which may result from a low incidence of boat strike or high incidence of mortality upon boat strike. The similar life history traits of Painted Turtles (this report; Midwood *et al.* 2015) compared to Northern Map Turtles (Bulté *et al.* 2010; COSEWIC 2012; Midwood *et al*. 2015) in Ontario suggests that if Painted Turtle subpopulations were subject to elevated rates of mortality from boat strikes, Painted Turtles would demonstrate reduced long-term population viability.

Table 7. Admittance circumstances for Midland Painted Turtles (*Chrysemys picta marginata*) at the Ontario Turtle Conservation Centre (Peterborough, Ontario). Note that admissions do not necessarily reflect the severity of the threat in the environment at large. All percentage values rounded to the nearest tenth and may not sum to 100%. Data courtesy Sue Carstairs and the KTTC (unpublished). Fish hook ingestion and injury is underreported in admittance values because of its cryptic nature and secondary diagnosis post-admittance. *1 case may be a boat strike and/or vehicular collision. **A turtle admitted from a vehicular collision also had a fish hook injury and has therefore been included in 2 categories.

Admittance circumstances	2011 (%)	2012 (%)	2013 (%)	2014 (%)	2015 (%)
Motor vehicle collision (or trauma consistent with such)	75.2	78.8-79.7*	79.9	87.4-87.9*	86.1
Other terrestrial vehicular collision (e.g., all-terrain vehicle)	0.9	0.0	0.5	0.0	0.5
Uninjured turtle collected during road crossings	1.4	0.8	2.5	0.0	0.5
Mower strike	0.7	0.0	0.0	0.0	0.0
Boat strike	0.0	0.0-0.8*	0.5	0.0-0.9*	0.5
Attack by animal (e.g., dog mauling)	2.1	4.2	2.9	2.8	4.2
Fisheries by-catch (near drowning)	0.0	0.0	0.0	0.5	0.0
Fish hook injury/ingestion	0.7	0.0	0.0	0.9**	0.0
Confiscation, surrender from illegal possession	0.0	3.4	3.4	0.9	2.8
Nest disturbance	7.8	2.5	0.0	0.9	0.0
Natural injury (aural abscess)	0.7	0.0	0.0	0.0	0.5
Old injury, injury of unknown origin, or moribund	1.4	5.1	6.9	1.4	0.5
Post-mortem examination	2.1	0.0	0.5	0.0	0.0
Transfers from other care facilities (without case history)	3.5	2.5	0.0	0.0	0.0
Unknown, unrecorded	3.5	1.7	2.9	5.1	4.7
Total no. admitted	**141**	**118**	**204**	**215**	**215**

Table 8. Road mortality pressure in a subpopulation of *Chrysemys picta* ssp. from Outaouais, Québec. Population estimates from mark-recapture study and road mortality sampling between 2003-2004. Data from Desroches and Picard (2007).

Site	Adult population estimate	Annual population mortality (individuals/year)	% of population subject to road mortality annually
1	117.4 - 173.8	0.5	0.29-0.43
2	13.3-22.5	0.5	2.2-3.8
3	58.8-102.2	1.0	0.97-1.7
4	Unknown	1.5	Unknown
5	25.3-34.3	2.5	7.3-9.9

Painted Turtles are exposed to threats from railways and human use trails. Of 16 observations of Midland Painted Turtles associated with railways in the Ontario Reptile and Amphibian Atlas (unpublished), nine records are mortalities, four are of living turtles, and three are turtles of unknown status. One railway death is reported in Québec from Le Centre de données sur le patrimoine naturel du Québec (unpublished). Painted Turtle mortality from all-terrain vehicles has been reported in Ontario (ORAA, unpublished). In all cases there are insufficient data to assess the distribution and severity of these threats.

<u>Problematic Native Species (8.2)</u>

Predicted impact for Midland Painted Turtle: **Low** (Scope Small, Severity Slight)

Predicted impact for Eastern Painted Turtle: **Unknown** (Scope Unknown, Severity Unknown)

Human-subsidized predators are animals, native or introduced, whose populations proliferate through association with humans or human-altered landscapes owing to increased access to food, water, shelter, and/or release from predation pressure (Garrott *et al.* 1993; Boarman 1997). Subsidized predators threaten populations of Midland and Eastern Painted Turtles primarily though the predation of nests and secondarily through the maiming or mortality of juvenile and adults. Raccoon (*Procyon lotor*), Striped Skunk (*Mephitis mephitis*), Red Fox (*Vulpes vulpes*), Coyote (*Canis latrans*), American Crow (*Corvus brachyrhynchos*), and Common Raven (*Corvus corax*; Rollinson and Brooks 2007a; Baxter-Gilbert *et al.* 2013a; Riley and Litzgus 2014)) are known predators of Painted Turtles and their eggs (Ernst and Lovich 2009) and are relevant for consideration in eastern Canada. Free ranging Domestic Dogs (*Canis domesticus*) and Cats (*Felis catus*) are responsible for the mauling and death of juvenile and adult Painted Turtles in Canada (Table 7).

Raccoon population densities in semi-urban (Rosatte *et al.* 2010) and natural areas, including parks (Phillips and Murray 2005), of Ontario can be very high. For example, Raccoon densities in Point Pelee National Park (24.6-28.2 individuals/km^2, Phillips and Murray 2005) were 2-5 times greater than average densities observed throughout agricultural, forested, and semi-urban landscapes of southern Ontario (5-12 individuals/km^2, Rosatte 2000; 3-14 individuals/km^2, Rosatte *et al.* 2010), eastern Ontario (5 individuals/km^2, Rosatte *et al.* 1992), and northern Ontario (<2 individuals/km^2, Rosatte *et al.* 2010). Raccoon densities in Point Pelee National Park (24-28 individuals/km^2) exceed those of urban sites within the Greater Toronto Area (7-20 individuals/km^2) (Rosatte *et al.* 1992).

Baseline data on nest survival has been discussed under **BIOLOGY, Survivorship and Longevity**. Turtle nesting sites in proximity to subsidized predator populations experience high levels of nest predation: 87% (of 15 nests) and 98% (of 60 nests) of nests predated at Rondeau Provincial Park, Ontario, in 2000 and 2001 (Gillingwater and Piraino, pers. comm. 2015); 75% predated in Mont-Orford National Park, Québec (Lascelles 2004); 94% predation rate at an active gravel pit along the North Missisquoi River, Québec (Sirois and Vallières 2015). Poor recruitment from high predation rates is difficult to detect and very long lag times are expected between the onset of excessive nest losses and population decline. As such, our knowledge of the impacts of elevated nest predation rates is incomplete.

<u>Agriculture and Aquaculture (2.1, 2.3)</u>

Predicted impact for Midland Painted Turtle: **Negligible** (Scope Negligible, Severity Extreme)

Predicted impact for Eastern Painted Turtle: **Low** (Scope Restricted, Severity Slight)

Although agriculture has dramatically modified the landscape historically across the species' range, contributing to decline of wetland habitat quality and extent, conversion of additional land for agricultural use will likely be low over the next 10 years. Agricultural land can act as an ecological trap for nesting. Open, well-drained soil attracts females, but growing crops shade and reduce growing degree-days for eggs. Additionally nests are vulnerable to destruction or compaction from tilling/heavy equipment. Adult turtles are also vulnerable to mortality from heavy machinery.

Painted Turtles often inhabit natural and anthropogenic ponds on agricultural lands, which may have high levels of nutrient enrichment and environmental contaminants. These ponds may provide connectivity for populations, but lack of long-term data limits our understanding of whether they serve as population sources or sinks.

Livestock operations expose turtles to the risk of trampling, erosion in and around ponds, and nest destruction. Inadequate management of riparian areas adjacent to both non-timber croplands and livestock operations in some locations presents a risk to turtles, but the extent is uncertain.

Logging and Wood Harvesting (5.3)

Predicted impact for Midland Painted Turtle: **Low** (Scope Small, Severity Slight)

Predicted impact for Eastern Painted Turtle: **Low** (Scope Restricted-Small, Severity Slight)

Degradation of aquatic habitat may result from wood harvesting activities in adjacent terrestrial environments. This is more likely to arise on small private land holdings, where application of comprehensive harvesting guidelines is more constrained. This is a particular concern for Eastern Painted Turtle in southwest Nova Scotia, which likely supports the densest populations in the species' range and has recently experienced an increase in harvesting. However, extent and intensity of impact on life stages (egg, juvenile, adult), activity (e.g., incubation, nesting, dispersal), and critical habitat (e.g., run-off, nutrient leeching/cycling) are uncertain.

Climate Change and Severe Weather (11)

Predicted impact for Midland/Eastern Painted Turtle: **Unknown**

Although the Threats Calculator was unable to adequately score these threats, a discussion of them is included here, since significant climate change will occur within three Painted Turtle generations. Long-lived turtles have few options to adapt to rapid environmental change; they must do so behaviourally, since evolution is simply too slow in species with such long generation time.

Across terrestrial and aquatic systems, species have demonstrated a host of responses, including shifts in geographic range, seasonal activities, abundances, and interspecific interactions as a result of climate change (IPCC 2014). Climate change is expected to act in synergy with and exacerbate a number of other threats (in the Great Lakes region), including disease outbreak, algal blooms, susceptibility to invasive species, shifts in ecological community composition, and especially wetland loss (Chiotti and Lavender 2008). Across the range of Midland and Eastern Painted Turtles in Canada, mean annual temperatures are predicted to increase in excess of 2°C in the next 40 years and upwards of 4°C within the next 80-100 years, with high temperature extremes forecasted for summer months (Colombo *et al.* 2007; Bourque and Simonet 2008; Vasseur and Catto 2008; Bourdages and Huard 2010).

Janzen (1994) reported that a modest (incubation) temperature increase of <2°C can skew sex ratio in Painted Turtles. Thus, a temperature increase of 2-4°C may be capable of shifting the temperature-dependent sex determination of Painted Turtles to a female bias (Janzen 1994; Schwanz and Janzen 2008; see **Reproduction**). Any such temperature increase may be buffered by nest site selection and thermal variation in the nesting environment. Increased temperatures and declining rainfall during summer periods may contribute to loss of habitat area and/or quality. Over the medium- to long-term, wetland habitats may be subject to succession from surrounding grassland or forest, or development.

Ontario and Québec

Between 1948-2006, annual average temperature across Ontario and southwestern/ south-central Québec has increased between 0-1.4°C, with more pronounced changes occurring in the spring (Bourque and Simonet 2008; Chiotti and Lavender 2008). Maximum warming will occur in winter in northern regions, and an increase in warm temperature extremes is expected during summer (Bourque and Simonet 2008; Chiotti and Lavender 2008). The number of freezing degree days is anticipated to decrease by 30-45% over short-term and 43-61% over longer-term projections (Bourdages and Huard 2010). For regions of Ontario and Québec within the range of the Painted Turtle, climate projections suggest a 2-4°C increase in annual mean daily temperature by 2050 and a 4-6°C increase between 2070-2099 relative to a 1971-2000 baseline (Colombo *et al.* 2007; Bourdages and Huard 2010; Bourque and Simonet 2008). In general, total annual precipitation is expected to increase, but changes are expected to be highly variable and seasonally dependent (Bourque and Simonet 2008; Chiotti and Lavender 2008). A significant increase in evaporation and decline in water levels and duration of ice-in are predicted for the Great Lakes (Chiotti and Lavender 2008). Wetland habitats will be sensitive to increased temperatures and flooding events (Hudon *et al.* 2005; Bourque and Simonet 2008; Chiotti and Lavender 2008).

New Brunswick and Nova Scotia

Between 1948-2005, Atlantic Canada has experienced a mean temperature increase of 0.3°C, with the greatest increase occurring in summer (+0.8°C), whilst winters have become colder (-1.0°C, Vasseur and Catto 2008). By 2050, summer and winter temperatures are predicted to increase 2-4°C and 1.5-6°C, respectively (Vasseur and Catto 2008). Interior regions of Nova Scotia and western New Brunswick are expected to experience greater temperature changes and drier summer conditions relative to coastal regions (Vasseur and Catto 2008). Increasing but highly variable rainfall is expected but, as in Ontario and Québec, may not be offset by increasing rates of evaporation due to extended growing season, overall warmer temperatures, and summer drought (Vasseur and Catto 2008). Storms in the North Atlantic are expected to increase in frequency and magnitude (Vasseur and Catto 2008).

Increasing rainfall and severity of rain events have potential habitat and population implications. Flooding has been responsible for Painted Turtle nest destruction, recruitment failure, and population structure shift (Ernst 1974; Christens and Bider 1987; Janzen 1994; see **Survival and Longevity**). A reduction in snow depth and increase in mean winter temperature are expected across the range of Midland and Eastern Painted Turtles in Canada (Bourque and Simonet 2008; Vasseur and Catto 2008; Bourdages and Huard 2010), though extreme cold weather events are inevitable. Snow cover serves as a thermal insulator protecting terrestrially overwintering Painted Turtle hatchlings from temperature extremes, and the survival of terrestrial overwintering Midland Painted Turtles is correlated with snow cover (Breithenbach *et al.* 1984). Thus winters with low snowfall result in hatchling exposure to extreme sub-zero nest temperatures and high mortality (Breitenbach *et al.* 1984).

Predictions of shorter ice-in periods, extended growing season duration, and warmer temperatures, could benefit the Painted Turtle. Across the Canadian range, northern range expansion is possible given that temperature and growing season are currently range-limiting factors, and that suitable habitat is generally available in areas abutting the northern range of the species. Phenological changes in activity (such as nesting; Schwanz and Janzen 2008; Edge *et al*. 2017) in response to climate change are likely. The impact of milder winters, if any, is unknown for the cold-adapted winter physiology of northern Painted Turtle subpopulations.

Limiting Factors

Across the species' range, natural sources of mortality for Midland and Eastern Painted Turtles include predation and exposure to extreme environmental conditions. While early life stages (egg, hatchling, juvenile) are resilient at the population level to high and variable mortality, adult stages are less so. Most at-risk turtle populations are at risk because of unsustainably high adult mortality. This may result from prolonged mortality forces, or acute mortality events; the latter may involve large numbers of individuals.

Mass mortality events are stochastic but can have profoundly negative and lasting population-level impacts on long-lived species such as turtles (Brooks *et al.* 1989, 1991; Congdon *et al.* 1993, 1994; Pitt and Nickerson 2013). A mortality event of 54 Midland Painted Turtles was reported in the spring of 1954 from a pond in eastern Ontario (Bleakney 1966). In 1977, more than 150 Midland Painted Turtles were reported dead at the tip of Long Point, Ontario, apparently from winterkill (ORAA, unpublished). Annually between 1996 and 2005, at least 10 adult Midland Painted Turtles were found dead around pond and sand dunes used for nesting in the Long Point Wildlife Area, suspected of having succumbed to winterkill or predators (Gillingwater and Piraino pers. comm. 2015). In spring 2014, 84 dead and six moribund Painted Turtles were found at Miller Pond, Rosemère, Québec (Boutin pers. comm. 2015); it is believed that the mortality was caused by a sewage discharge directly into the pond from a local water treatment facility in April 2014. An unknown portion of the subpopulation was lost in the mortality event, though more than 100 Painted Turtles were observed during visits prior to 2014 but no more than 25 individuals were seen in the pond in 2015 (Boutin pers. comm. 2015). Mortality events associated with water drawdown and harsh conditions leading to freezing or prolonged anoxia can be severe (Ultsch 2006).

Number of Locations

The number of locations for the Midland and Eastern Painted Turtle across their respective ranges in Canada is unknown, but for each DU the number plausibly greatly exceeds 10. Road mortality is probably the single greatest threat across the species' range, but its impacts vary both within and among the wetland complexes that encompass the active season, nesting, and overwintering habitat of individual subpopulations. This multi-scaled variation makes it difficult to ascribe any particular number, but intuitively the number is presumed to be large.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Midland and Eastern Painted Turtles are not protected under the Canadian *Species at Risk Act* (2002). Midland Painted Turtle is listed as a specially protected reptile under Schedule 9 of the *Ontario Fish and Wildlife Conservation Act* (1997) and therefore cannot be legally hunted or trapped (including, but not limited to: killing, capturing, injuring, and harassing; Section 5[1] of the Ontario *Fish and Wildlife Conservation Act*). Painted Turtle is afforded protection from capture, collection, captive holding, and import/export within the general regulations of Québec*'s Loi sur la conservation et la mise en valeur de la faune* (LCMVF, 2002), Nova Scotia's *Wildlife Act* (1989), and New Brunswick's *Fish & Wildlife Act* (2004). Under Ontario's FWCA and Quebec's LCMVF, it is also illegal to disturb, destroy, or damage the eggs and nest of this species. The aquatic habitat of turtles in Québec is also indirectly protected by Article 128.6 of the LCMVF, under the *Loi sur la qualité de l'environnement* (RLRQ, c. Q-2) (*Environment Quality Act*) (CQLR, C. Q-2), and under the *Politique de protection des rives, du littoral et des plaines inondables* (RLRQ, c. Q-2, a. 2.1) (*Protections Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains*) (CQLR, c. Q-2, a. 2.1). At the federal level, Midland and Eastern Painted Turtle may receive protection, either directly or indirectly, through the *Health of Animals Act* (1990), *Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act* (1992), and *Canadian Environmental Assessment Act* (2012). The unlicensed collection, possession, transportation, and sale of Painted Turtles, including those moved across the border from Canada, is punishable under the *Lacey Act* (1900) of the United States.

Non-Legal Status and Ranks

Painted Turtle is recognized as a species of Least Concern by the IUCN Red List (Van Dijk 2013) and is not listed on the Convention on the International Trade in Endangered Species of Wild Fauna and Flora Appendices I, II, or III (CITES 2015). Midland Painted Turtle has not yet been evaluated by the Committee on the Status of Species at Risk in Ontario (COSSARO). Provincial, national and global status ranks for Midland and Eastern Painted Turtles have been summarized (Table 5).

Habitat Protection and Ownership

In Ontario and Québec, the broad range of Midland Painted Turtle overlaps with a large number of protected lands (Appendix V). The subspecies is estimated in at least 86 Ontario and 19 Québec regionally, provincially, or federally protected lands, including provincial parks, national parks, and conservation reserves. In total, the area of these protected areas is appreciably large (see **Extent of Occurrence and Area of Occupancy**; note, again, that EOO, IAO, and protected habitat estimates assume all specimens in Québec are Midland Painted Turtles, but include intergrades with Eastern Painted Turtle in a poorly defined zone in southern Quebec). Protected areas in Ontario are widespread across the province, although those in the south exist as small and increasingly isolated patches. With the exception of La réserve faunique de Papineau-Labelle, designated wildlife reserves of Québec are located in central-north regions of the province (SÉPAQ 2015) providing little protected area for Painted Turtles. The main protected areas for Eastern Painted Turtles in Nova Scotia are Kejimkujik National Park and Lake Rossignol Wilderness Area (Appendix V). In New Brunswick the subspecies is largely confined to (or at least has been confirmed in) protected areas, including Grand Lake Meadows (Legere 2001) and adjacent Portobello Creek National Wildlife Area, Rockwood City Park (Saint John), and a disjunct subpopulation in Kouchibouguac National Park. In total, the area of protected habitat in Canada for Eastern Painted Turtles is also sizable (Appendix V; compare with **Extent of Occurrence and Area of Occupancy**).

Even in areas of protected habitat, Midland Painted Turtle subpopulations are still subject to a wide range of other threats that can result in population decline or other negative effects. For example, the Midland Painted Turtle subpopulation in Point Pelee National Park has experienced demographic change, including shifts in sex ratio, body size distribution (partly driven by shift to male bias), and catch per unit effort (relative abundance), over the past three decades or approximately 1 generation (Browne and Hecar 2007). It is not known if sufficient protected land currently exists to ensure the long-term integrity of Midland and Eastern Painted Turtles in Canada.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Patrick Moldowan graduated from his B.Sc. in Wildlife Biology (Honours with Distinction, 2012) from the University of Guelph. During the summers of his undergraduate years, Patrick was a field assistant on long-term salamander and turtle research projects at the Algonquin Wildlife Research Station, Algonquin Provincial Park. Under the supervision of Dr. Jacqueline Litzgus and Dr. Ronald Brooks, he returned to Algonquin Park to complete his M.Sc. Biology (Laurentian University, 2014) on the morphology and reproductive biology of Midland Painted Turtles. Patrick was the 2015 recipient of the Canada's New Noah Scholarship from Wildlife Preservation Canada that sent him to study abroad in Mauritius with the Durrell Wildlife Conservation Trust, Mauritian Wildlife Foundation, and University of Kent (U.K.) to earn a Post-graduate Diploma in Endangered Species Recovery. Patrick is enrolled in PhD studies at the University of Toronto to continue his research with Spotted Salamander in Algonquin Provincial Park.

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Appendix I. Table A1. Body size of Painted Turtles (*Chrysemys picta* ssp.) across their range in eastern Canada and select subpopulations of the United States. Subpopulations with an unspecified or uncertain subspecific classification are recognized as *C. picta*.

(Sub)species	Male MidCL (mm) ± SD	Male mass (g) ± SD	Female MidCL (mm) ± SD	Female mass (g) ± SD	Location	Source
C. p. marginata	126.8 ± 11.3	247.8 ± 57.9	149.6 ± 11.3	442.5 ± 96.8	Pinery Provincial Park, Ontario	Davy, unpublished (2008-2011)
C. p. marginata	115.9 ± 14.5		139.4 ± 10.9		Rondeau Provincial Park, Ontario	Davy, unpublished (2008-2015)
C. p. marginata	125 (107-139)		141 (127-169)		Big Creek National Wildlife Area, Ontario	Gillingwater, unpublished (2003)
C. p. marginata	136.3 ± 14.4		151.0 ± 14.7		Algonquin Provincial Park, Ontario	Moldowan 2014; Algonquin Park Turtle Project, unpublished
C. p. marginata	137.6 ± 15.3	351.2 ± 112	151.0 ± 16.0	471.1 ± 128.5	Grundy Lake Provincial Park, Ontario	Sheppard, unpublished
C. p. marginata	121.0 ± 12.9		138.8 ± 21.0		Estrie, Québec	Picard and Desroches 2013
C. p. marginata	127.5 ± 12.4		138.8 ± 23.3		Magog, Québec	Picard 2014
C. picta			169.8		Eastman, Québec	Sirois and Vallières 2015
C. picta	142 ± 21	339 ± 173	165 ± 22	561 ± 173	Montérégie, Québec	Bernier *et al.* 2008
C. picta	137 ± 40	425 ± 170	154 ± 39	553 ± 283	Montérégie, Québec	Bernier *et al.* 2009
C. picta	115.5 ± 12.9		137.8 ± 21.1		Estrie, Québec	Weller and Desroches, unpublished
C. p. picta	131-165		143-171		Kejimkujik National Park, Nova Scotia	Gilhen 1984
C. p. picta	137 ± 2.8 SE (123-153)		175 ± 5.0 SE (143-207)		Rockwood Park, New Brunswick	Browne and Sullivan 2017
C. picta	135.8 ± 1.17	286.4 ± 16.33	152.5 ± 8.55	422.3 ± 72.28	Beaver Island, Michigan	Rowe 2003
C. p. marginata	109.7 ± 0.54	176.9 ± 1.92	134.2 ± 0.81	326.7 ± 4.95	E.S. George Reserve, Michigan	Congdon *et al*. 1986
C. picta	120.8 ± 10.4	198 ± 46	135.1 ± 13.8	320 ± 91	Central Massachusetts	Rhodin and Butler 1997

Appendix II. Threats Assessment Worksheets (Threats Caculator) - Midland Painted Turtle.

THREATS ASSESSMENT WORKSHEET

Species or Ecosystem Scientific Name	*Chrysemys picta marginata* (Midland Painted Turtle)		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	5/Apr/16		
Assessor(s):	Patrick Moldowan (report writer), Jim Bogart (Facilitator and COSEWIC Reptile and Amphibian Committee Chair), B. McBride (COSEWIC Secretariat), Ron Brooks, Jackie Litzgus, Matt Keevil, Joe Crowley, Isabelle Picard, Yohann Dubois, Connie Browne, Jeffie McNeil, Mary Sabine, Wayne Weller		
References:	Draft COSEWIC status report (2015)		

Overall Threat Impact Calculation Help:

		Level 1 Threat Impact Counts	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	1	0
D	Low	4	5
Calculated Overall Threat Impact:		High	Medium

Assigned Overall Threat Impact:	**High-Medium**
Impact Adjustment Reasons:	
Overall Threat Comments	**Generation time estimated at 29-44 years, so use maximum 100 year horizon for severity of impact; Canadian distribution throughout south-central Ontario and western Quebec (uncertain zone of intergradation with *C. p. picta* in Quebec); regional subpopulation size and total population size are unknown**

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development	D	Low	Small (1-10%)	Serious (31-70%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.1	Housing & urban areas	D	Low	Small (1-10%)	Serious (31-70%)	High (Continuing)	Large urban centres of Ontario and Quebec likely to grow substantially in next 10 years but with small impact to turtle habitat (given scale of development that has already occurred in southern Ontario and SW Quebec). Turtle subpopulations on Canadian Shield likely to experience little intrusion directly from housing (but impacts from subsidized predators, shoreline development, etc., considered elsewhere). Where housing development occurs, it is likely be be a high impact activity. Historically, housing and urban sprawl in large part responsible for habitat loss in southern Ontario and southwestern Quebec.
1.2	Commercial & industrial areas	D	Low	Small (1-10%)	Serious (31-70%)	High (Continuing)	Most commercial and industrial expansion likely to take place over small portion of subspecies range in Ontario and western Quebec. Where commercial and industrial development occurs, it is likely to be a high impact activity. Historically, commercial and industrial activity in large part responsible for habitat loss in southern Ontario.
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Includes campgrounds, lake side resorts, golf courses, etc. Impacts from subsidized predators, shoreline development, etc., considered elsewhere.
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
2.1	Annual & perennial non-timber crops		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Conversion of land for agricultural use likely low over next 10 years, especially for boreal/Canadian shield subpopulations. Agricultural land can be ecological traps for nesting (open, well drained soil attracts females; growing crops shade and reduce growing degree days for eggs; nest destruction/compaction via tilling/heavy equipment). Risk of turtle death from heavy machinery. Agricultural areas represent "double jeopardy" for turtle: attractive and often fatal.
2.2	Wood & pulp plantations		Negligible	Negligible (<1%)	Negligible (<1%)	Insignificant/Negligible (Past or no direct effect)	Christmas tree farms and other tree plantations considered here.
2.3	Livestock farming & ranching		Negligible	Negligible (<1%)	Moderate (11-30%)	High (Continuing)	Risk to turtles of livestock trampling, erosion in and around ponds, and nest destruction. Painted Turtles known to inhabit natural and manmade ponds on agricultural lands (including those ponds with high levels of nutrient enrichment), which may provide source of population connectivity

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.4	Marine & freshwater aquaculture		Negligible	Negligible (<1%)	Unknown	Unknown	Freshwater aquaculture (of salmonids) currently limited to Georgian Bay and the north channel of Lake Huron. Possible risk of enclosure net entanglement, eutrophication (nutrient enrichment; addressed under Threat Section 9, Pollution), introduced parasite/disease; however, aquaculture takes place offshore and often in deep areas unlikely to be inhabited by turtles.
3	Energy production & mining		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
3.1	Oil & gas drilling						Not applicable; concern expressed over whether fracking is grouped here.
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Mining only of concern for northern subpopulations on the Canadian Shield. Any quarry sites represent a small proportion of subspecies' range.
3.3	Renewable energy		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Impact of renewable energy an area rich for future research. Interest expressed in wind turbine vibration and turtle egg development (W.F. Weller)
4	Transportation & service corridors	CD	Medium - Low	Large - Restricted (11-70%)	Moderate (11-30%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.1	Roads & railroads	CD	Medium - Low	Large - Restricted (11-70%)	Moderate (11-30%)	High (Continuing)	Identified as a severe threat and subject to a great deal of discussion during threats call. Turtles subject to mortality from crossing roads (dispersal/migration), nesting on roads/shoulders, and nest compaction from nesting roadside. Extensive road networks and high traffic volumes in southern Ontario and SW Quebec can lead to concern over turtle road mortality, whereas road densities and traffic volumes low in boreal/Shield region. Natural nest sites especially limited in boreal/Shield subpopulations so turtles are attracted to roads to nest. Caveat that in northern subpopulations, life history constrains the ability of subpopulations to recover from perturbation. Suggestion that survivor bias exists in roadside subpopulations (RJ Brooks and MG Keevil) whereby those individuals that move a lot are often subject to road mortality and those that do not can persist long-term in roadside subpopulations. Also, new roads are likely to disproportionately impact turtles compared to established roads. Recognized that Painted Turtles do not move as far as other turtle species (e.g., Blanding's Turtles and Snapping Turtles) so a 300-500 m buffer zone around roads likely represents range of impact of roads on turtle subpopulations. Historically, housing and urban sprawl in large part responsible for habitat loss in southern Ontario and southwestern Quebec. There will likely be relatively few roads built within the next 10 years, but growing traffic volume is concerning. Large turtle subpopulations in relatively remote areas away from roads across the large range of the Midland Painted Turtle.
4.2	Utility & service lines		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Includes oil and gas pipelines, hydro towers.
4.3	Shipping lanes		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Includes dredging. Major shipping lanes limited to the Welland Canal, Trent-Severn, St. Lawrence. Mortality from boat strikes unknown for (Midland) Painted Turtles.
4.4	Flight paths						Not applicable
5	Biological resource use	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.1	Hunting & collecting terrestrial animals		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Occasional personal collecting of Painted Turtles and their eggs known, but no apparent commercial market/trade at this time (food/pet) as it concerns Ontario, Quebec, and Canada at large.
5.2	Gathering terrestrial plants						Not applicable
5.3	Logging & wood harvesting	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Private and industrial logging risks deterioration of aquatic habitats; established buffer zones around aquatic environments protect many habitats
5.4	Fishing & harvesting aquatic resources	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)	By-catch of Painted Turtles likely grossly under-reported given that non-species at risk do not require reporting during aquatic resource harvesting. See Midwood *et al.* (2015) on fisheries by-catch of Ontario turtles.
6	Human intrusions & disturbance	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
6.1	Recreational activities	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Recreational boating and fishing represent source of mortality, injury (hook ingestion), and regular disturbance from basking; human use of beach habitat subject turtles to nesting disturbance and loss due to erosion/soil compaction; off-road vehicle use a source of mortality and nest destruction
6.2	War, civil unrest & military exercises						Not applicable
6.3	Work & other activities		Unknown	Unknown	Unknown	Unknown	"Plinking" (target shooting turtles) and tampering with marked nests (vandalism) considered here
7	Natural system modifications		Unknown	Small (1-10%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Fire suppression in the boreal/Shield region may decrease available nesting habitat (loss of open canopy habitat); use of water bombers possible source of habitat/turtle disturbance
7.2	Dams & water management/ use		Unknown	Small (1-10%)	Unknown	High (Continuing)	Greatest concern expressed over hydroelectric operations. Scope on low end of small. High level of damming and water management of flowing water and lake habitats throughout Ontario and western Quebec; water drawdown during sensitive periods (i.e., overwintering) of particular concern.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.3	Other ecosystem modifications		Unknown	Small (1-10%)	Unknown	High (Continuing)	Scope on low end of small. Examples of activities that would impact turtles: aquatic & emergent vegetation removal; beach modification (access to nesting sites); removal of basking logs; grass mowing; shoreline riprap and breakwalls
8	Invasive & other problematic species & genes	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
8.1	Invasive non-native/alien species	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	e.g., Common Reed (*Phragmites australis australis*) and Canary Reed Grass (*Phalaris arundinacea*), among other invasive plants displacing turtles from wetland habitat and encroaching on nesting habitat. Red-eared Sliders (*Trachemys scripta elegans*) and other non-native turtles as competitors and disease/parasite vectors. Asian carp (*Hypophthalmichthys* spp.; *Ctenopharyngodon idella*; *Mylopharyngodon piceus*) and sport fish introductions (bass, muskellunge, pike, etc.) as source of mortality for young turtles; unknown disease risk. Belief that *Phragmites* is less competitive in northern environments and unlikely to invade remote wetlands in areas of central/northern Ontario and Quebec.
8.2	Problematic native species	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Topic of much discussion. Subsidized (nest) predators in urban and semi-urban areas a major threat. Recent isolated cases of Common Raven depredation of nesting female Painted Turtles. Data from Bird Studies Canada indicates Common Raven range (re)expansion throughout central/northern Ontario. Large, albeit isolated, threat often acting in synergy with other threats (urban sprawl and road mortality). Requiring more data to examine in full.
8.3	Introduced genetic material		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Possible introduction of Western Painted Turtle (*Chrysemys picta bellii*) or Eastern Painted Turtle (*C. p. picta*) into range, although naturally occurring intergrades between subspecies occurs in areas of range overlap. Constance Brown on introduced genetic material: "I did catch one western painted turtle in Point Pelee in 2002. It was at the marsh boardwalk area, so I suspect that someone released it. It was a male and healthy, so the potential for introduced genetic material is real, but I agree with the 'Negligible' conclusion".

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9	Pollution		Unknown	Small (1-10%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Small (1-10%)	Unknown	High (Continuing)	Household sewage and urban waste water discharge events can lead to fouling and adverse conditions in aquatic habitats (e.g., anoxia); see Miller Pond (Rosemère, Quèbec) case study presented under "Mass Mortality" threats section of COSEWIC draft report. Eutrophication and mid-range levels of nutrient input can have positive results for Painted Turtles by boosting local productivity.
9.2	Industrial & military effluents		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Research with Snapping Turtles in the Great Lakes has demonstrated feminizing effects of industrial chemical exposure. Exposure to lethal, sub-lethal, and/or detrimental levels of industrial effluent localized.
9.3	Agricultural & forestry effluents		Unknown	Unknown	Unknown	High (Continuing)	Eutrophication and mid-range levels of nutrient input can have positive results for Painted Turtles by boosting local productivity, but erosion from adjacent forestry activities may also degrade habitats.
9.4	Garbage & solid waste		Unknown	Unknown	Unknown	High (Continuing)	
9.5	Air-borne pollutants						Not applicable
9.6	Excess energy						Not applicable
10	Geological events						
10.1	Volcanoes						Not applicable
10.2	Earthquakes/tsunamis						Not applicable
10.3	Avalanches/landslides						Not applicable
11	Climate change & severe weather		Unknown	Unknown	Unknown	Unknown	
11.1	Habitat shifting & alteration		Unknown	Unknown	Unknown	High (Continuing)	High degree of uncertainty surrounding scope and severity of habitat shifting and alternation due to climate change. See discussion in text.
11.2	Droughts		Unknown	Unknown	Unknown	High (Continuing)	High degree of uncertainty surrounding scope and severity of drought due to climate change. See discussion in text.
11.3	Temperature extremes		Unknown	Unknown	Unknown	High (Continuing)	High degree of uncertainty surrounding temperature extremes due to climate change. See discussion in text.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.4	Storms & flooding		Unknown	Unknown	Unknown	High (Continuing)	High degree of uncertainty surrounding scope and severity of storms and flooding due to climate change. See discussion in text.
Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).							

Appendix III. Threats Assessment Worksheets (Threats Caculator) - Eastern Painted Turtle.

THREATS ASSESSMENT WORKSHEET

Species or Ecosystem Scientific Name	*Chrysemys picta picta* (Eastern Painted Turtle)		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	06/04/2017		
Assessor(s):	Patrick Moldowan (report writer), Jim Bogart (Facilitator and COSEWIC Reptile and Amphibian Committee Chair), Bev McBride (COSEWIC Secretariat), Connie Browne, Jeffie McNeil, Mary Sabine, Tom Herman		
References:	Draft COSEWIC status report (2015)		

Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	4	4
Calculated Overall Threat Impact:		Medium	Medium

Assigned Overall Threat Impact:	**C = Medium**
Impact Adjustment Reasons:	
Overall Threat Comments	**Generation time estimated at 29-44 years, so use maximum 100 year horizon for severity of impact; large Canadian distribution from south/eastern Quebec (uncertain intergradation zone with *C. p. marginata*), southern New Brunswick, and southwestern Nova Scotia; regional subpopulations and total population size are unknown and basic biology of eastern subspecies understudied.**

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.1	Housing & urban areas	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)	Eastern Painted Turtle does not appear to have experienced a human-induced range contraction caused by habitat loss in Atlantic Canada, though historical baseline data are limited. Human population growth rates in New Brunswick have demonstrated a small decline in recent years, while Nova Scotia's population has shown a slight increase with both provinces projected to follow their respective human population trend through to 2030. Cottage/seasonal (second) home development continuing along shoreline habitats in both New Brunswick and Nova Scotia.
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Moderate (11-30%)	High (Continuing)	
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Moderate (11-30%)	High (Continuing)	
2	Agriculture & aquaculture	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
2.1	Annual & perennial non-timber crops	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	New Brunswick: Scope Restricted. Severity: estimated to be Slight. Generally no new agricultural area, just ongoing effects of existing operations. The lower Saint John River valley is an important agricultural area that overlaps with the Eastern Painted Turtle's range in the province. Overall, however, the trend seems to be less area in agriculture in the Saint John River floodplain with old agriculture fields growing in, and change from row crops to topsoil and sod farming. Effects are continuing as this is an important agricultural area.
2.2	Wood & pulp plantations		Negligible	Negligible (<1%)	Negligible (<1%)	Insignificant/Negligible (Past or no direct effect)	New Brunswick: Not applicable.
2.3	Livestock farming & ranching		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	There is some livestock farming along the Saint John River (core Eastern Painted Turtle population), New Brunswick. Poor management of riparian areas in agriculture and livestock areas a small concern in New Brunswick and Nova Scotia. Turtles may make use of farm ponds for summer foraging; however, it is unclear whether there ponds are beneficial or act as habitat sinks.
2.4	Marine & freshwater aquaculture		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	New Brunswick: Not applicable.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3	Energy production & mining		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
3.1	Oil & gas drilling		Unknown	Unknown	Unknown	Unknown	Unknown Scope, Severity, and Timing at present. Heightened interest in fracking activity in Atlantic Canada could quickly elevate Scope, Severity, and Timing of threat.
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Unknown	High (Continuing)	New Brunswick: There used to be coal strip mining on the western side of Grand Lake (Eastern Painted Turtle site), but this has ceased and the area is being reclaimed.
3.3	Renewable energy		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	New Brunswick and Nova Scotia: Wind farm projects within the Eastern Painted extent of occurrence in New Brunswick are currently in early planning phase. Any windfarms would be in high elevation areas outside of habitat use of the Eastern Painted Turtle.
4	Transportation & service corridors	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.1	Roads & railroads	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	New Brunswick: Lots of roads throughout New Brunswick range, on both sides of and all along the length of lower Saint John River, and along most of shoreline of Grand Lake. Many of the roads that bisect habitat are secondary highways and the TransCanada Highway (4-lane), which have relatively high traffic volumes. The TransCanada has been moved away from the Saint John River and Grand Lake Meadows (TransCanada crosses these locations, but does not run alongside of the river anymore). Some areas are road-free (e.g., Oromocto River, much of the Grand Lake Meadows complex). Scope suggested as large, but probably closer to lower end of the range (30%). Nova Scotia: Scope suggested to be large and vehicle mortality is recognized as a threat but it is unclear how severe road mortality is at the population level. In southwestern Nova Scotia increasing forestry roads and secondary roads with low traffic volumes (e.g., cottage development roads) are increasing in frequency. Road regularly run parallel to water leading to habitat degradation and road mortality (dispersing individuals, nesting females), among secondary impacts (e.g., exposure to invasive species and problematic subsidized predators; considered elsewhere). Secondary roads can be used by off-road trails used for off-road vehicles.
4.2	Utility & service lines		Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs)	New Brunswick: There could be a new pipeline (Energy East) in the next 10 years. Proposed route may cross north of Grand Lake, on outskirts of core Eastern Painted Turtle habitat in New Brunswick.
4.3	Shipping lanes						Not applicable
4.4	Flight paths						Not applicable
5	Biological resource use	D	Low	Restricted - Small (1-30%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	New Brunswick and Nova Scotia: Poaching is not recognized as an issue (although very small levels of collection likely). No legal collection permitted.
5.2	Gathering terrestrial plants						Not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.3	Logging & wood harvesting	D	Low	Restricted - Small (1-30%)	Slight (1-10%)	High (Continuing)	New Brunswick: Scope negligible. Small amount of logging may occur, but core habitat along the floodplain has protection measures (20-30m buffer zones). Nova Scotia: logging increasing in southwest of province, where the Eastern Painted Turtle is found. Forestry typically takes place in winter when the turtles are dormant (i.e., mortality/impact unlikely to be direct, but indirect consequences may apply). Overall, high uncertainty about the possible scope of forestry impacts on life stages (egg, juvenile, adult), activity (e.g., incubation, nesting, dispersal), and critical habitat of the Eastern Painted Turtle (e.g., run-off, nutrient leeching/cycling).
5.4	Fishing & harvesting aquatic resources		Unknown	Small (1-10%)	Unknown	High (Continuing)	New Brunswick: Anecdotal information indicates Eastern Painted Turtles are caught as by-catch in eel and Gaspereau commercial fisheries along the Saint John River. Gaspereau fishing is in the spring (May/June) as turtles demonstrate high activity levels. Eel fishing occurs in spring, summer, into early fall (i.e., throughout the turtle active season). There are anecdotal reports of Eastern Painted Turtle drowning in eel traps (which do not provide an air pocket/floats) but no quantitative data are available to inform Scope and Severity of threat. Scope suggested as Small, but probably lower end of small. Most fishing takes place in deeper water, not too near the shore, of Saint John River proper and Grand Lake, and not in wetlands and smaller channels. Severity: no available information on how many individual or what proportion of the turtle population may be caught in the nets and traps. Nova Scotia: Very small freshwater commercial fisheries in province. Any impact related to fisheries and aquatic resource harvesting would be restricted to recreational fishing.
6	Human intrusions & disturbance		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	New Brunswick and Nova Scotia: Possible recreational activities that may interfere with the Eastern Painted Turtle include all terrain vehicles on trails/secondary roads during nesting season (June) and dispersal periods between critical habitats (e.g., between overwintering and active season ponds). Boaters may disturb basking turtles during summer. Eastern Painted Turtles are observed in golf course ponds, but their persistence in these habitats is unknown.
6.2	War, civil unrest & military exercises	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	New Brunswick: 5 CDSG (CFB Gagetown) is Canada's largest training base and is located in middle of Eastern Painted Turtle New Brunswick range. Their operations would mainly be in the upland and there are biologists working on the base who provide guidance to help mitigate effects to wildlife as much as possible.
6.3	Work & other activities	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	E.g., scientific research (handling)
7	Natural system modifications	Negligible	Negligible (<1%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression	Negligible	Negligible (<1%)	Unknown	High (Continuing)	
7.2	Dams & water management/ use	Unknown	Unknown	Unknown	High (Continuing)	Nova Scotia: (Hydroelectric) dams can lead to increased upstream or downstream flooding events and water management practices can lead to rapid, aseasonal changes in water table. Eastern Painted Turtles are found in restored ponds (e.g., Ducks Unlimited Canada initiatives)/impoundments, although the (presumably positive) significance of these wetlands has not been quantified.
7.3	Other ecosystem modifications	Negligible	Negligible (<1%)	Unknown	High (Continuing)	E.g. of activities that would impact turtles: aquatic & emergent vegetation removal; beach modification (access to nesting sites); removal of basking logs. New Brunswick: Indirect impact(s) from non-native species - Phragmites is not presently a concern in New Brunswick] with only small patches observed in lower Saint John River. Japanese Knotweed may be a concern into the future as this invasive plant grows tall, dense, and can shade out nesting sites.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8	Invasive & other problematic species & genes		Unknown	Small (1-10%)	Unknown	High (Continuing)	
8.1	Invasive non-native/alien species		Unknown	Small (1-10%)	Unknown	High (Continuing)	New Brunswick: Muskellunge still spreading throughout the lower Saint John River, but the impact of these predatory fish is uncertain. Red-eared Sliders documented in Saint John at Rockwood Park and have been observed to successfully overwinter in this location. Non-native turtle introductions could leads to disease introduction, although their role as competitors with the Eastern Painted Turtle is likely negligible. Nova Scotia: rapidly spreading predatory chain pickerel and smallmouth bass are of concern for young turtles. Anecdotally, these fishes have been observed to consume young Snapping Turtles.
8.2	Problematic native species		Unknown	Unknown	Unknown	High (Continuing)	E.g., subsidized (nest) predators in urban and semi-urban areas. New Brunswick and Nova Scotia: Ravens have been observed predating Wood Turtles at 5 CDSG (CFB Gagetown) and would likely target Painted Turtles across multiple life stages (eggs, juveniles, and adults). Artificially inflated raccoon populations in rural, urban, and cottage areas. Raccoons a major nest predator and will maim or kill adults.
8.3	Introduced genetic material		Negligible	Negligible (<1%)	Negligible (<1%)	Insignificant/Negligible (Past or no direct effect)	Introductions of other Painted Turtle subspecies not known in Atlantic Canada. Very little reason to think this would be of concern for the integrity of populations.
9	Pollution		Unknown	Small (1-10%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Small (1-10%)	Unknown	High (Continuing)	New Brunwick: water quality improving in Saint John River.
9.2	Industrial & military effluents		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
9.3	Agricultural & forestry effluents		Unknown	Small (1-10%)	Unknown	High (Continuing)	
9.4	Garbage & solid waste		Unknown	Unknown	Unknown	High (Continuing)	
9.5	Air-borne pollutants						Not applicable
9.6	Excess energy						Not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10	Geological events						
10.1	Volcanoes						Not applicable
10.2	Earthquakes/tsunamis						Not applicable
10.3	Avalanches/landslides						Not applicable
11	Climate change & severe weather		Unknown	Unknown	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration		Unknown	Unknown	Unknown	High (Continuing)	
11.2	Droughts		Unknown	Unknown	Unknown	High (Continuing)	
11.3	Temperature extremes		Unknown	Unknown	Unknown	High (Continuing)	
11.4	Storms & flooding		Unknown	Unknown	Unknown	High (Continuing)	

Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).

Appendix IV. Excerpt from the *Commercial Fisher's Biodiversity Resolution and Protocol for Lake Ontario and the Ottawa and St. Lawrence Rivers* (OCFA 2013), a voluntary system of best fishing practices to reduce turtle mortality.

1. **Reporting:** all commercial hoop-net and trap-net fishers will record all incidental catch and mortality of turtles on the daily catch report.

2. **Data Collection:** commercial hoop-net and trap-net fishers will complete by-catch log books that will be used to record the location of nets, details on turtle by-catch and mortalities, install temperature loggers on nets as directed by Ontario Ministry of Natural Resources (MNR), and provide the completed by-catch diaries to MNR

3. **Mitigation:** except where directed by MNR for research purposes, from May 20 through to June 20 (when turtles are most active), all commercial hoop-net and trap-net fishers will take direct action to reduce incidental turtle capture and/or mortality by one or more of the following actions:

    A. Wherever feasible, provide access to air by installing floatation devices.

    B. Wherever feasible, install turtle exclusion devices to reduce incidental capture of large turtles.

    C. If providing access to air is not possible because of depth or some other factor(s), consider installing a turtle escape mechanism.

    D. Avoid areas of known high turtle density if providing access to air, or an escape mechanism, is not possible.

    E. Change location of nets if none of the actions above are possible and turtle mortality occurs.

4. **Cooperation**: Cooperate with MNR or third parties during on-board monitoring, research studies and audits to refine and evaluate the effectiveness of these practices.

5. **Continuous Improvement:** Actively participate in the ongoing evaluation and improvement of the best fishing practices

Appendix V. Sites of Midland Painted Turtle (*Chrysemys picta marginata*) and Eastern Painted Turtle (*C. p. picta*) occurrence in areas of protected habitat (see Habitat Protection and Ownership). Area of total protected area given does not necessarily represent the area available or occupied by Painted Turtles. PP = Provincial Park, NP/PN = National Park/Parc National *Value represents known area of habitat use within Rockwood Park.

Chrysemys picta marginata			
Ontario Protected Areas	**Size (ha)**	**Record history**	**Source**
Wheatley PP	241	Older (≤1994)	ORAA 2014
Rondeau PP	3,254	Recent (≥1995)	ORAA 2014
Port Burwell PP	231	Older (≤1994)	ORAA 2014
Long Point PP	150	Recent (≥1995)	ORAA 2014
Turkey Point PP	316	Recent (≥1995)	ORAA 2014
Selkirk PP	73	Recent (≥1995)	ORAA 2014
Rock Point PP	187	Older (≤1994)	ORAA 2014
Bronte Creek PP	640	Recent (≥1995)	ORAA 2014
Forks of the Credit PP	282	Recent (≥1995)	ORAA 2014
Darlington PP	208	Recent (≥1995)	ORAA 2014
Mono Cliffs PP	732	Older (≤1994)	ORAA 2014
Earl Rowe PP	312	Older (≤1994)	ORAA 2014
Sibbald Point PP	225	Older (≤1994)	ORAA 2014
Springwater PP	193	Older (≤1994)	ORAA 2014
Bass Lake PP	65	Older (≤1994)	ORAA 2014
Sauble Falls PP	20	Older (≤1994)	ORAA 2014
MacGregor Point PP	1,204	Recent (≥1995)	ORAA 2014
Pinery PP	2,532	Recent (≥1995)	ORAA 2014
Balsam Lake PP	448	Recent (≥1995)	ORAA 2014
Silent Lake PP	1,450	Recent (≥1995)	ORAA 2014
Kawartha Highlands PP	37,587	Recent (≥1995)	ORAA 2014
Petroglyphs PP	1,643	Recent (≥1995)	ORAA 2014
Emily PP	83	Recent (≥1995)	ORAA 2014
Mark S. Burnham PP	43	Older (≤1994)	ORAA 2014
Ferris PP	198	Older (≤1994)	ORAA 2014
Presqu'ile PP	937	Recent (≥1995)	ORAA 2014
Sandbanks PP	1,509	Recent (≥1995)	ORAA 2014
Bon Echo PP	8,295	Recent (≥1995)	ORAA 2014
Sharbot Lake PP	69	Recent (≥1995)	ORAA 2014
Silver Lake PP	43	Recent (≥1995)	ORAA 2014
Murphys Point PP	1,239	Recent (≥1995)	ORAA 2014
Frontenac PP	5,214	Recent (≥1995)	ORAA 2014
Charleston Lake PP	2,353	Recent (≥1995)	ORAA 2014
Rideau River PP	187	Recent (≥1995)	ORAA 2014
Fitzroy PP	185	Recent (≥1995)	ORAA 2014

Chrysemys picta marginata			
Ontario Protected Areas	**Size (ha)**	**Record history**	**Source**
Bonnechere PP	162	Recent (≥1995)	ORAA 2014
Algonquin PP	765,345	Recent (≥1995)	ORAA 2014
Arrowhead PP	1,237	Recent (≥1995)	ORAA 2014
The Massasauga PP	13,105	Recent (≥1995)	ORAA 2014
Oastler Lake PP	32	Older (≤1994)	ORAA 2014
Killbear PP	1,756	Recent (≥1995)	ORAA 2014
Samuel de Champlain PP	2,550	Recent (≥1995)	ORAA 2014
Restoule PP	2,800	Recent (≥1995)	ORAA 2014
Grundy Lake PP	2,554	Recent (≥1995)	ORAA 2014
French River PP	51,749	Recent (≥1995)	ORAA 2014
Killarney PP	48,500	Recent (≥1995)	ORAA 2014
Misery Bay PP	760	Recent (≥1995)	ORAA 2014
Mississagi PP	8,328	Older (≤1994)	ORAA 2014
Spanish River PP	35,386	Recent (≥1995)	ORAA 2014
Komoka PP	198	Older (≤1994)	ORAA 2014
Short Hills PP	661	Older (≤1994)	ORAA 2014
Hope Bay Forest PP	353	Older (≤1994)	ORAA 2014
Black Creek PP	286	Recent (≥1995)	ORAA 2014
Ira Lake PP	30	Recent (≥1995)	ORAA 2014
Cabot Head PP	4,514	Older (≤1994)	ORAA 2014
Little Cove PP	16	Older (≤1994)	ORAA 2014
Indian Point PP	946	Older (≤1994)	ORAA 2014
Queen Elizabeth II Wildlands PP	33,500	Recent (≥1995)	ORAA 2014
Gibson River PP	338	Older (≤1994)	ORAA 2014
Hardy Lake PP	808	Recent (≥1995)	ORAA 2014
O’Donnell Point PP	875	Recent (≥1995)	ORAA 2014
Big East River PP	1,050	Recent (≥1995)	ORAA 2014
Magnetawan River PP	3,424	Recent (≥1995)	ORAA 2014
Noganosh Lake PP	3,082	Recent (≥1995)	ORAA 2014
Mattawa River PP	3,260	Recent (≥1995)	ORAA 2014
Manitou Islands	100	Older (≤1994)	ORAA 2014
Little White River PP	12,782	Recent (≥1995)	ORAA 2014
Bonnechere River PP	1,198	Recent (≥1995)	ORAA 2014
Ottawa River PP	125	Recent (≥1995)	ORAA 2014
Burnt Lands PP	522	Older (≤1994)	ORAA 2014
Puzzle Lake PP	?	Recent (≥1995)	ORAA 2014
Cedar Creek PP	50	Recent (≥1995)	ORAA 2014
Lighthouse Point PP	96	Recent (≥1995)	ORAA 2014
St. Clair National Wildlife Area	355	Recent (≥1995)	ORAA 2014
Big Creek National Wildlife Area	802	Recent (≥1995)	ORAA 2014
Rideau Canal National Heritage Site	?	Recent (≥1995)	NHIC 2014

Chrysemys picta marginata			
Ontario Protected Areas	**Size (ha)**	**Record history**	**Source**
Hilman Marsh Conservation Area	344	Recent (≥1995)	ORAA 2014
Wye Marsh National Wildlife Area	47	Recent (≥1995)	ORAA 2014
Holiday Beach Conservation Area	202	Recent (≥1995)	ORAA 2014
Ojibway Prairie Complex	350	Recent (≥1995)	ORAA 2014
Wainfleet Bog Conservation Area	801	Recent (≥1995)	ORAA 2014
Conroys Marsh	2,400	Recent (≥1995)	ORAA 2014
Point Pelee NP	1,500	Recent (≥1995)	ORAA 2014
Bruce Peninsula NP	15,400	Recent (≥1995)	ORAA 2014
Georgian Bay Islands NP	1,350	Recent (≥1995)	ORAA 2014
1000 (St. Lawrence) Islands NP	2,440	Recent (≥1995)	ORAA 2014
Total	1,100,817		

Chrysemys picta ssp.			
Québec Protected Areas	**Size (ha)**	**Record history**	**Source**
PN de Plaisance	2,830	Recent (≥1995)	CDPNQ 2012; Houle pers. comm. 2015
PN de Mont-Tremblant	151,000	Recent (≥1995)	CDPNQ 2012
PN d'Oka	2,370	Recent (≥1995)	CDPNQ 2012
PN Îles-de-Boucherville	814	Recent (≥1995)	CDPNQ 2012
PN du Mont-Saint-Bruno	890	Recent (≥1995)	CDPNQ 2012
PN de la Yamaska	1,290	Recent (≥1995)	CDPNQ 2012
PN du Mont-Orford	5,950	Recent (≥1995)	CDPNQ 2012
Parc de la Rivière des Mille-Îles	26	Recent (≥1995)	CDPNQ 2012
PN de la Mauricie	53,600	Older (≤1994)	CDPNQ 2012
Parc de la Gatineau	36.130	Recent (≥1995)	CDPNQ 2012
Parc-nature du Bois-de-Liesse	158	Recent (≥1995)	CDPNQ 2012
Parc de la Baie-McLaurin	?	Recent (≥1995)	CDPNQ 2012
Parc Le Rocher	125	Recent (≥1995)	CDPNQ 2012
Parc-nature Cap-St-Jacques	302	Recent (≥1995)	CDPNQ 2012
Parc Lucien-Blanchard	?	Recent (≥1995)	CDPNQ 2012
Parc-nature de la Ponte-aux-Prairies	261	Recent (≥1995)	CDPNQ 2012
Parc régional Obalski	?	Recent (≥1995)	CDPNQ 2012
Parc-nature du Bois-de-l'Île-Bizard	216	Recent (≥1995)	CDPNQ 2012
Réserve faunique de Papineau-Labelle	162,800	Recent (≥1995)	CDPNQ 2012
Total	236,668		

Chrysemys picta picta			
Nova Scotia Protected Areas	**Size (ha)**	**Record history**	**Source**
Lake Rossignol Wilderness Area	4,120	Recent (≥1995)	Frances *et al*. 2012
Tobeatic Wilderness Area	103,780	Recent (≥1995)	ACCDC 2014
Kejimkujik National Park	40,400	Recent (≥1995)	ACCDC 2014

Chrysemys picta picta			
Nova Scotia Protected Areas	**Size (ha)**	**Record history**	**Source**
Total	148,300		

Chrysemys picta picta			
New Brunswick Protected Areas	**Size (ha)**	**Record history**	**Source**
Rockwood Park	695 (7.7*)	Recent (≥1995)	Browne and Sullivan 2015; Browne pers. comm. 2015
Portobello Creek National Wildlife Area	2,084	Recent (≥1995)	ACCDC 2014
Grand Lake Meadow	3,000	Recent (≥1995)	ACCDC 2014; NBM 2014; McAlpine pers. comm. 2015
Kouchibouguac National Park	23,800	Recent (≥1995)	ACCDC 2014
Total	28,892		