COSEWIC
Assessment and Update Status Report

on the

Wood Turtle
Glyptemys insculpta

in Canada

THREATENED
2007

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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COSEWIC
Assessment Summary

Assessment Summary – November 2007

Common name
Wood Turtle

Scientific name
Glyptemys insculpta

Status
Threatened

Reason for designation
This species is declining across much of its range, and occurs in small, increasingly disjunct populations. It is more terrestrial than other freshwater turtles, which makes it extremely vulnerable to collection for the pet trade. It has a long-lived life history typical of turtles, so that almost any chronic increase in adult and juvenile mortality leads to a decrease in abundance. Such increased mortality is occurring from increased exposure to road traffic, agricultural machinery and off-road vehicles, collection for pets, and perhaps exotic food/medicines. Increased level of threat is associated with new or increased access to the species' range by people.

Occurrence
Ontario, Quebec, New Brunswick, Nova Scotia

Status history
Designated Special Concern in April 1996. Status re-examined and designated Threatened in November 2007. Last assessment based on an update status report.

COSEWIC
Executive Summary

Wood Turtle
Glyptemys insculpta

Species information

The Wood Turtle (*Glyptemys insculpta*) is a medium-sized turtle with adults weighing about 1kg and having a carapace (upper shell) length of 16-25cm. The carapace ranges from grayish-brown to yellow and is broad and low. Each scute (scale-like section) has pyramidal concentric ridges (growth lines), giving the carapace a sculptured appearance. In older turtles, the ridges on the scutes may become worn smooth. The plastron (bottom shell) does not have a hinge, and is yellow with black splotches on the outer posterior corner of each scute. The plastron is flat in females and juveniles and becomes concave in males as they reach maturity. Males are slightly larger than females and have a broader head. The skin is generally brown but the legs and neck often have yellow, orange or reddish colouring.

Distribution

The Wood Turtle is native to North America and has a patchy range from Nova Scotia west through New Brunswick, Quebec and Ontario to Minnesota, south to Virginia and Maryland. In Canada, the Wood Turtle occurs in Nova Scotia, New Brunswick, south-central Quebec, and south-central Ontario extending west to the district of Algoma. Approximately 30% of the global distribution is in Canada. The range is discontinuous, and populations are often isolated and small.

Habitat

The Wood Turtle is more terrestrial than most freshwater turtles, but is still semi-aquatic. It is associated with rivers and streams with sand or gravel bottoms and prefers clear, meandering streams with moderate current. Natural nesting habitat of the Wood Turtle consists of sand or gravel-sand beaches or banks of streams. The turtles also nest on anthropogenic sites such as gravel pits and roads.

Riparian areas with diverse, patchy cover are generally the most commonly used or preferred terrestrial habitats across the Wood Turtle's range. Other habitats used less frequently by Wood Turtles include bogs, marshy pastures, beaver ponds, shrubby cover, meadows, coniferous forests, mixed forests, hay and agricultural fields and pastures. Quantitative data on the area of habitat available in the past and at present are not available, but suitable undisturbed habitat is declining over much of the range of the Wood Turtle.

Biology

Wood Turtles overwinter underwater in streams, rivers and ponds. They emerge in spring but remain close to water until summer, when they may range up to 500 m from water and several kilometres along a stream from their hibernation sites. Females nest between late May and early July in sand or gravel areas that receive a moderate to high amount of sunlight. Rate of embryo development varies directly with ambient temperature and hatching occurs in fall. Wood Turtles reach sexual maturity at 11 – 22 years of age and this range largely depends on latitude, with turtles in the northern parts of the species' range maturing later and at a larger body size. Mating occurs throughout the active season. Wood Turtles use the same areas each year, and are capable of returning to these areas from several kilometres away. The main predators of adults and juveniles are raccoons, coyotes, and foxes, and these and other mammals eat eggs as well. Various mammals, fish and birds prey on hatchlings.

Population sizes and trends

A crude estimate of total population size of the Wood Turtle in Canada, based on quantitative estimates from researchers across its Canadian range, is ~6,000-12,000 adults. Wood Turtle populations that are in areas to which people have limited access may be stable, but where there is road access many populations are declining, and the overall trend in Wood Turtle abundance over the past three generations (~100+ years) is also one of decline.

Limiting factors and threats

Threats to Wood Turtles across their range include: increased mortality of adults on roads (general increase in road networks and traffic volume and speed), and off-roads (ATVs and modern agricultural machinery); removal of turtles for the pet trade, construction of forestry roads; destruction/alteration of riparian habitat, destruction of nests by humans in recreational vehicles such as ATVs, collection for the exotic food trade; loss of nesting habitat and hibernacula due to stream and river bank alteration, flooding, and shoreline stabilization; and increased depredation of nests and turtles by raccoons. Lesser threats include pollution, casual collection for pets, and perhaps, increased sedimentation of waterways inhabited by Wood Turtles. Overall, this species is exceptionally vulnerable to increased access to its habitat by people.

Special significance of the species

The Wood Turtle is endemic to North America, and approximately 30% of its range is in Canada. The four species of turtles previously included in the genus *Clemmys* (which included the Wood Turtle) are the most threatened freshwater turtles in North America. The Wood Turtle has become unusually popular for a turtle, largely because of its attractive appearance, terrestrial habits and non-aggressive response to people, all features which have been significant in putting this species at risk. The numerous threats facing Wood Turtles and the ease of capturing and handling them have made this species the focus of much recent research on conservation and given it a high profile as a species at risk. Wood Turtles also are reputed to stomp their forefeet and plastron to attract earthworms for dinner.

Existing protection or other status designations

The Wood Turtle is currently listed under Appendix II of CITES; listed as a "Specially Protected Reptile" by the *Ontario Fish and Wildlife Conservation Act*; designated as "endangered-not regulated" under the Ontario *Endangered Species Act*; designated as "threatened?" in Quebec; protected under the Nova Scotia *Endangered Species Act* (as Vulnerable); listed as "Vulnerable" by the IUCN; listed as "Special Concern" by COSEWIC in 1996; and listed under Schedule 3 of the Canadian *Species at Risk Act* (SARA). Some small subpopulations in Canada are in National or Provincial Parks, but most are on private land.

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 (2007)

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

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

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

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

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

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2007

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SPECIES INFORMATION

Name and classification

Family: Emydidae
Species: *Glyptemys insculpta* (Agassiz 1857) (No subspecies recognized)

The common name for this species is Wood Turtle, or, in French, tortue des bois. The scientific name was recently changed from *Clemmys insculpta* to better reflect the genetic relationships of species previously included in the genus *Clemmys* (Feldman and Parham, 2002; Holman and Fritz, 2001; NatureServe 2004). *Emys orbicularis*, *Emydoidea blandingii* and *Clemmys marmorata* were designated a monophyletic group, and *Clemmys muhlenbergii* and *Clemmys insculpta* were placed in a second monophyletic group (Feldman and Parham, 2001; Holman and Fritz, 2001). The type species for the genus *Clemmys* (*Clemmys guttata*) was retained as the only member of that genus (NatureServe 2004), *Clemmys muhlenbergii and Clemmys insculpta* were placed in the genus *Glyptemys* (Agassiz 1857), as recommended by Feldman and Parham (2002).

Morphological description

The Wood Turtle is a medium-sized turtle with adult carapace length ranging between 16cm and 25cm (Litzgus and Brooks, 1996, Smith, 2002). The grayish-brown to yellow carapace is broad and low, sometimes having dark lines and dots. Each scute has pyramidal concentric ridges (growth lines), giving the carapace a sculptured appearance. The carapace is strongly keeled and is serrated at the posterior margin (Babcock, 1971; Litzgus and Brooks, 1996). In older turtles, the ridges on the scutes may become worn smooth to some degree. The plastron lacks a hinge and is yellow with black splotches on the outer posterior corners of each scute in patterns that vary among individuals. The skin is generally brown, and the legs and neck often have yellow, orange or reddish colouring. The feet are slightly webbed with strong claws. The irises of the eyes are yellow or brown, and the upper jaw forms a beak, arched downwards over the slightly shorter lower jaw. Males are larger than females (Foscarini, 1994), and have a deeply notched plastron that generally contains grooves running cranio-caudally. The plastron is flat in juveniles and adult females, but it becomes strongly concave in males as they reach sexual maturity. In adult males, the cloacal vent is distal to the posterior margin of the carapace, whereas in females it is not. The male also has a longer thicker tail than does the female.

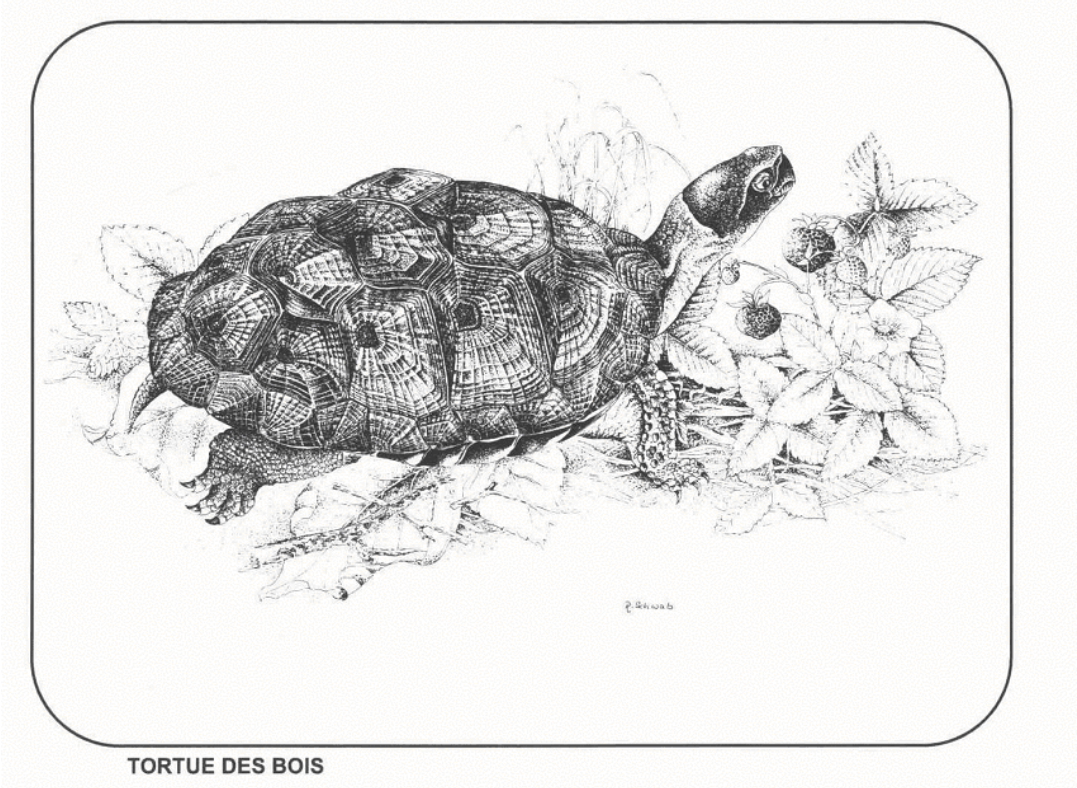

Figure 1. Wood Turtle, *Glyptemys insculpta* (by Rosemarie Schwab) (reproduced with the permission of the Ministère des Ressources naturelles et de la Faune, du Québec).

Genetic description

A recent study of the phylogeography of Wood Turtles using 750 bp of the mitochondrial control region sampled 117 turtles from 29 localities across the species' range (Amato *et al*. in press). Twenty-one haplotypes were identified and there was little genetic variation, which is typical of turtles in general and the genus *Glyptemys* in particular (Avise *et al*. 1992, Rosenbaum *et al*. 2007). Nested clade analysis indicated a main postglacial dispersal up the east coast from a southern refugium to Nova Scotia with subsequent westward dispersal (Amato *et al*. in press). A BEAST analysis using a Bayesian skyline plot, indicated the Wood Turtle population had been growing rapidly over the last 12,000 years. One clade is represented along the eastern USA and Canada and in the west into states south of the Great Lakes. A second clade occurs in Ontario and adjacent Quebec west of the St. Lawrence, although some presence of the first clade was also found in this region. In contrast to work on mitochondrial DNA, genetic studies on six populations of Wood Turtles in Quebec found these populations were highly polymorphic and characterized each of the six using five microsatellite loci (Tessier and Lapointe, 2002; Tessier *et al.*, 2005). There was high variability within all populations indicating that putative past declines have not yet led to significantly reduced variability, although the most genetically distinct populations had the lowest diversity (Tessier *et al.*, 2005). Ultimately, it appears that there were three genetically different units, two on the north shore of the St. Lawrence, and a single homogeneous

group (of four populations) south of the river (Tessier *et al.*, 2005). Despite their small size, these populations showed high levels of heterozygosity and allelic diversity (H_0 ranging from 0.561-0.886, an average of 10 alleles per locus per population, Tessier *et al*. 2005).These data suggest that these Wood Turtles have genetic variation expected of a relatively abundant species and that until "recently" (given the long generation times of the species) these populations existed in "long-term genetic neighbourhoods" comprising several thousand individuals based on equilibrium considerations and the stepwise mutation model (Ohta and Kimura, 1973; P. Bentzen, email communication, Nov. 22, 2007). These conclusions further suggest that these populations have undergone rapid, large declines, recent enough that they still show little genetic evidence of inbreeding despite their small sizes and relative isolation.

In Canada, most Wood Turtle populations tend to be associated with watersheds that are often widely separated, and thus the populations become isolated (Foscarini, 1994; Arvisais *et al.*, 2002, 2004; Smith, 2002; Seburn and Seburn, 2004; Wesley *et al.*, 2004, Tessier *et al*., 2005, Wesley and Brooks, 2005), because turtles tend to move along streams and rarely move between streams even when they are only a few kilometres apart (e.g. Foscarini, 1994, Foscarini and Brooks, 1997). The observed genetic distinctness among nearby populations is likely a reflection of low vagility. For example, in a long-term study (>15 years) located on two Ontario creeks that were less than 5km apart and were tributaries of the same river, no turtle was ever recorded in both streams even though virtually every turtle was individually marked throughout the study (Cameron and Brooks, 2002).

Designatable units

Across its Canadian range, the Wood Turtle is exposed to different degrees of threat. In southern Ontario, and in Quebec around Montréal, the species has been extirpated or has declined (Table 1), probably from increased mortality on roads, private and commercial collection as pets, and loss of key habitat features (Wesley, 2006) caused by alteration and pollution of streams and their associated riparian habitats. The species has likely not declined much over the most northern parts of its range in these provinces, but there its density is low and numbers are small (Walde, 1998, Smith, 2002, Wesley, 2006) particularly in Ontario. On the other hand, in Nova Scotia, limited data suggest that one or two watersheds have populations that are comparatively robust, and it is possible that the species has larger numbers in this province and that some populations are still relatively secure.

The different status of the Wood Turtle across its range in Canada is somewhat reflected by biogeographic and phylogeographic distinctions. The species' Ontario distribution is/was in the Canadian Shield, Great Lakes/St. Lawrence and Carolinian herpetofaunal provinces (COSEWIC O and P Manual F5, p. 5). The species is now effectively extirpated from the Carolinian province, and from almost all of the southern and eastern parts of the Great Lakes/St. Lawrence (Mitchell *et al.*, 1997; Boyd and Brooks, 1998; Galois and Bonin 1999; Cameron and Brooks, 2002; NHIC, 2004ab; Seburn and Seburn, 2004; Equipe de retablisement des tortues du Quebec, 2005).

Populations of the species occupying the Canadian Shield herpetofaunal province may be declining and threatened in the southern part of this distribution and comparatively secure in the north (Table 1). Shield populations tend to be small (<200 adults, Table 1). and isolated by topography (Wesley 2006). Presumably, Shield populations were stable until recently (Tessier *et al*. 2005, see comment by P. Bentzen above in section on Genetic Description), but are increasingly threatened by new road access and associated activities (Arvisais *et al*. 2002, 2004; Saumure 2004; Seburn and Seburn 2004; Smith 2002; Crowley 2006). Finally, many of the Appalachian/Atlantic Coast populations of Wood Turtles appear to be under less immediate threat than those further west, but they have been less studied (see Population trends/ Abundance).

Despite these differences among the Faunal Provinces, there are no clear distinctions in genetic structure (Tessier *et al*., 2005, Amato *et al*. in press) in either microsatellites or mitochondrial genes, certainly none that can be associated with specific faunal provinces. Furthermore, there are no clear disjunctions among populations according to Faunal Province, indeed many populations seems to span the boundaries of these (see map in Figure 3). Finally, the putative conservation status also does not match well with the distribution in the Faunal Provinces. Therefore, potential separate Designatable Units based on the criteria for assigning such units (see COSEWIC Operations and Procedures Manual, Appendix F5, Nov. 2007) do not appear defensible at this time.

DISTRIBUTION

Global range

The Wood Turtle is endemic to North America and has a discontinuous range from Nova Scotia west through New Brunswick, southern Quebec and Ontario to Minnesota, south to Virginia and Maryland (Ernst *et al.,* 1994; Conant and Collins, 1998).

Canadian range

In Canada, the Wood Turtle occurs in Nova Scotia, New Brunswick, southern and eastern Quebec and south-central Ontario (Ernst *et al.,* 1994; Bider and Matte, 1994; Conant and Collins, 1998; Desroches and Rodrique, 2004) with populations in Ontario ranging north and west to west Algoma in rivers draining into the east end of Lake Superior (Peiman and Brooks, 2003; J. Trottier, 2004; R. Knudsen, 2004, Wesley *et al.*, 2004; Fig. 2). The species' distribution is discontinuous throughout most of its Canadian range. Approximately 30% of the Wood Turtle's global distribution is in Canada (Ernst *et al.,* 1994; Conant and Collins, 1998).

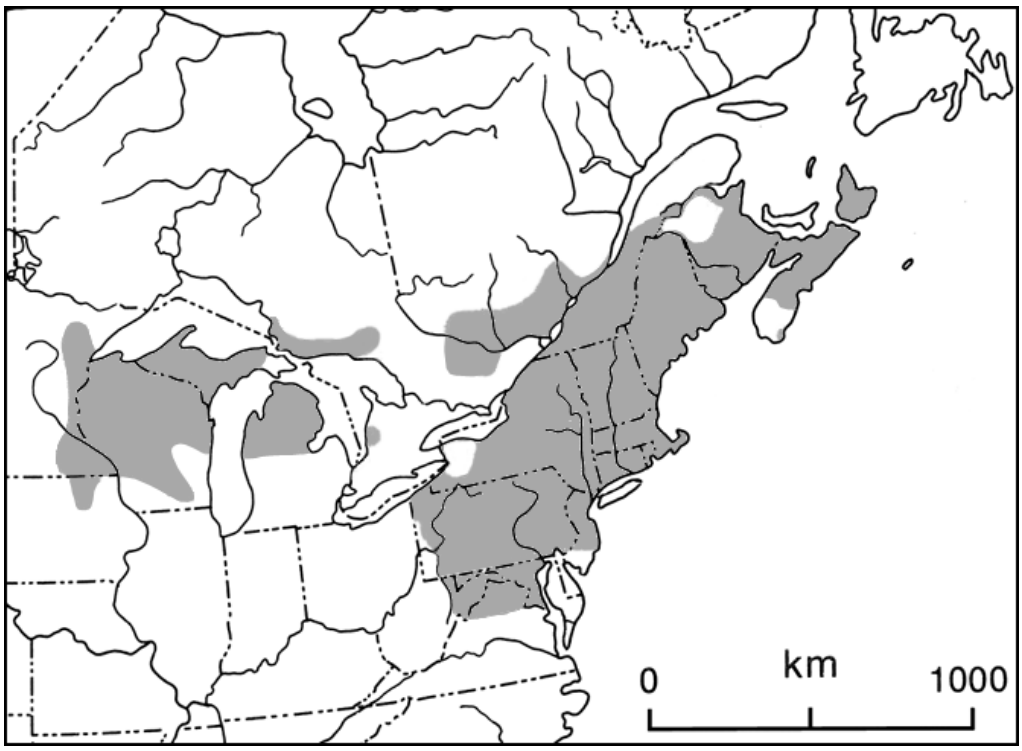

Figure 2. Wood Turtle range in North America (Drawn by M. Amato, 2006).

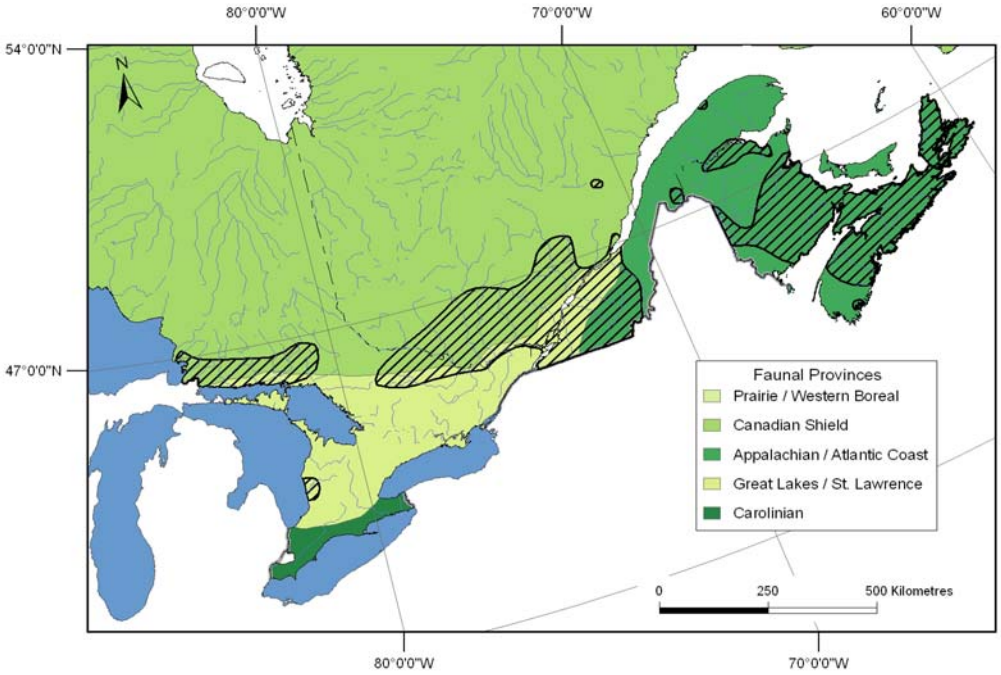

Figure 3. Distribution of the Wood Turtle (see Fig. 2) in relation to the Faunal Provinces of Terrestrial Amphibians, Reptiles, and Molluscs in Canada (O&P Manual Appendix F5).

Although Wood Turtles have declined in many areas (Kaufmann, 1992a; Litzgus and Brooks, 1996; Harding 1997; Oldham, 1998; Seburn and Seburn, 2000; Cameron *et al.* 2002; Compton *et al.*, 2002; Saumure, 2004; Seburn and Seburn, 2004; NatureServe, 2004; Daigle and Jutras, 2005), the Extent of Occurrence in Canada has remained basically the same since the mid-20th century (Fig. 2). There are 60 Element Occurrences (discrete interbreeding populations in a distinct watershed or separated by an effective barrier) in Ontario, but 18 are considered extirpated or historic, 25 are ranked as D (probably not viable) and none have better than a B rating (good predicted viability) (Natural Heritage Information Centre, 2004a and b). There are 122 occurrences of Wood Turtles in Quebec distributed among 37 rivers (Natural Heritage Data Centre, 2005), with 19 rated as historic, species not recorded in last 25 years, 54 rated as extant, with poor locality description, 36 ranked as good, species recorded in fewer than 5 of last 10 years, 12 as poor, species observed once 10-25 years ago, and 1 as excellent, species observed in more than 5 of past 10 years. The Atlantic Canada Conservation Data Centre has 79 Element Occurrence records for New Brunswick and 176 for Nova Scotia (S. Gerreits, pers. comm. 2005). The number of intensively studied areas with known populations is, of course, much lower than the number of occurrence reports.

Extent of Occurrence (EOO) is approximately 500 000 km^2, based on range maps in Ernst *et al.* (1994), Conant and Collins (1998) and Fig. 2. The Area of Occupancy (AO) is very difficult to determine, or even estimate, as not all studies used radio telemetry, maps with specific location information are rarely published, and not all studies list the area of the study site or sites. Based on habitat requirements, and estimates of area used (see, for example, Foscarini and Brooks 1997, Wesley 2006), the AO would include the areas of inhabited rivers and a buffer of shoreline. A recent study of Wood Turtles in Ontario's Algoma District found turtles in 10 of 65 rivers searched and found them only on specific parts of the river that provided critical habitat for nesting, hibernation and foraging/thermoregulation (Wesley, 2006; see also Dubois 2006). Assuming all populations occur (see Abundance) this way, then one can estimate AO as follows. If one takes 438 Element Occurrences as the total in Canada (see previous paragraph), then assumes for each that the occupied stream and riparian areas that contain the critical nesting, foraging and hibernation sites is 100 m wide and 1 km long, then there are 10 ha per Element Occurrence. Therefore, AO = 10 x 438 = 4,380 ha. Alternatively, we could calculate AO by the prescribed grid method (2x2km). In this method, the AO=438x4= 1752km^2. A third method would be to take the area of a stream occupied by a population as 5000m length by 600 m width =3km^2 and total AO = 3 x438=1314km^2. Lastly, if we use the "Quebec" method (D. Banville pers. comm. 2006) and assume each Element Occurrence= 2.4km^2, then AO= 2.4x438=1051km^2.

HABITAT

Habitat requirements

Wood Turtles are exceptionally terrestrial for a freshwater turtle species but are still semi-aquatic (Bishop, 1927; Breckenridge, 1944; Lazell, 1976; Thomas, 1983) and require water for several vital functions, including mating (Harding and Bloomer 1979; Ernst 1986; Farrell and Graham 1991); hibernation (Harding and Bloomer 1979; Green and Pauley, 1987; Farrell and Graham 1991; Hunter *et al.* 1992; Foscarini 1994; Arvisais *et al*. 2004; Trochu, 2004, Wesley, 2006), hydration (Kaufmann 1992) and thermoregulation (Dubois, 2006). They rarely move more than 300m from water (Harding and Bloomer 1979; Quinn and Tate 1991; Kaufmann 1992; Saumure and Bider 1998; Ernst 2001; Arvisais *et al*. 2002; Compton *et al*. 2002; Wesley 2006; Foscarini 1994; Arvisais 2002; Smith 2002, Wesley, 2006). Nesting habitat includes sand or gravel-sand beaches and banks (Hunter *et al.*, 1992; Walde, 1998; Smith, 2002), but as in other turtles, Wood Turtles readily nest on gravel and dirt roads, gravel shoulders of paved roads, gravel pits, and similar anthropogenic structures.

Wood Turtles are associated with rivers and streams with sandy or gravely-sandy bottoms (DeGraaf and Rudis, 1983; Hunter *et al.*, 1992; Daigle, 1997; Wesley 2006), and prefer clear, meandering streams with moderate current and frequent oxbows (DeGraaf and Rudis, 1983; Hunter *et al.*, 1992; Ernst *et al.*, 1994; Adams, 2003; J. Harding pers. comm. 2006; Wesley 2006).

Although Wood Turtles have been described as opportunistic with respect to habitat (Quinn and Tate, 1991), studies over their range have shown that they select particular habitat features (Harding and Bloomer 1979; Kaufmann, 1992a; Foscarini, 1994; Harding 1997; Smith, 2002, Arvisais *et al.*, 2002; Compton *et al.*, 2002; Arvisais *et al.*, 2004; Trochu, 2004, Dubois 2006; Wesley, 2006; Y. Dubois pers. comm. 2005), virtually always associated with clear-water streams and their banks. Alder thickets and alder swale were the preferred or most-used habitats in Ontario (Smith, 2002; Cameron *et al.*, 2002; Peiman and Brooks, 2003; Wesley *et al.*, 2004), Quebec (Arvisais *et al.*, 2004; Trochu, 2004), Nova Scotia (Adams, 2003), and Pennsylvania (Kaufmann, 1992). In late summer, forested habitats are important (Quinn and Tate, 1991; Cameron *et al.*, 2002; Smith, 2002; Wesley *et al.*, 2004, Wesley 2006). Other habitats used less often by Wood Turtles include bogs, marshy pastures, beaver ponds, oxbows, riparian and shrub areas, meadows, coniferous forests, mixed forests, hay and agricultural fields and pastures (Foscarini, 1994; Daigle, 1997; Compton *et al.*, 2002; Smith, 2002; Cameron *et al.*, 2002; Peiman and Brooks, 2003; Adams, 2003; Arvisais *et al.*, 2004; Trochu, 2004; Wesley *et al.*, 2004; Wesley, 2006).

Habitat trends

Even though quantitative historic and contemporary data on changes in the area of available habitat suitable for the Wood Turtle are not available, it is evident that this habitat is declining over much of the species' historic range in both Canada and the United States (Harding and Bloomer, 1979; Kaufmann, 1992a; Garber and Burger, 1995; Mitchell *et al*. 1997; Oldham, 1998; Galois and Bonin, 1999; Ernst, 2001). For example, only a very restricted number of creeks and rivers in the Carolinian region of southern Ontario retain clear water, undisturbed nesting sites, deep pools for overwintering, and undisturbed riparian zones (Mitchell *et al*., 1997; Boyd and Brooks, 1998; Wesley, 2006). This habitat loss and degradation is due to agricultural activities, shoreline development, channelization, dams, contamination, and forestry activities (Harding and Bloomer, 1979; Foscarini 1994; Garber and Burger, 1995; Mitchell *et al*. 1997; Oldham, 1998; Saumure and Bider 1998; Compton, 1999; Galois and Bonin, 1999; Natural Heritage Information Centre, 2004; Saumure 2004; Seburn and Seburn, 2004). The remaining populations in the Great Lakes/St. Lawrence faunal province in southern Quebec and Ontario persist at reduced levels on streams with reduced riparian areas, high disturbance, increased turbidity and exposure to people (Foscarini 1994; Mitchell *et al*. 1997; Boyd and Brooks 1998; Saumure 2004; Daigle and Jutras 2005; Dubois 2006)

For Wood Turtles, given their terrestrial habits, their unique vulnerability to collectors and their attractiveness for the pet trade, any increase in access to their populations constitutes a degradation of habitat even before direct habitat modification occurs. In addition, roads also remove habitat, alter adjacent areas, subdivide populations, and change hydrologic patterns (Kerr and Cihlar 2004; Hawbaker *et al.*, 2006; Crowley 2006; Figure 4). For Wood Turtles though, the key threats come from increased access *per se*, and from roads and agricultural fields attracting turtles to nest thus acting as population sinks (Saumure pers. comm., 2006). To see this effect, one only has to look at the fates of Wood Turtles in southern Ontario and Quebec. Essentially, the species has disappeared from the southern parts of both provinces in conjunction with high road densities (Crowley 2006). Roads provide access (Crowley, 2006), and mortality to wildlife increases with increasing traffic speed (Farmer, 2006). At a more general level, land use is a strong predictor of densities of endangered species in Canada (Kerr and Cihlar, 2004), in particular there is a strong link between habitat conversion to agriculture and level of species endangerment. For the Wood Turtle, a similar link likely exists where forestry practices increase road access or alter riparian habitats.

Habitat protection/ownership

In Ontario, Wood Turtle populations are located mainly on Crown land. However, portions of three populations are in Provincial Parks (Smith, 2002; J. Trottier, 2004; R. Knudsen, 2004; D. Coulson, pers. comm. 2004). The remaining parts of these populations and other Ontario populations are on private land (some small segments are on federal lands and Nature Conservancy of Canada lands). One small population in Nova Scotia is in a National Park (Adams, 2003; Adams, 2004), and the remainder are on private or Crown lands (T. Herman, pers. comm. 2005). Part of one population in New Brunswick is in a National Park (E. Tremblay, pers. comm. 2004) and a second is on a military base (G. Forbes, V. Roy, pers. comm. 2004), but most reported locations are privately owned (McAlpine and Gerriets, 1999). In Quebec, part of one population is in a National Park (Bourgeois *et al.*, 2004), but most studied populations are on private or public lands (Daigle, 1996; Walde *et al.*, 2003; Trochu, 2004; Saumure, 2004). Therefore, no significant proportion of Canadian Wood Turtle habitat is under legal protection.

BIOLOGY

Since the original COSEWIC Report (Litzgus and Brooks 1996), there have been many studies completed on various aspects of the biology, demography, and ecology of Wood Turtles across the range of the species, so most of the information in this section will be referenced from this published work (see Ernst *et al.*1994; for review up to the time of the original COSEWIC report). There are also many unpublished studies since 1996, some of which are ongoing.

Life cycle and reproduction

Wood Turtles emerge from hibernation in late March to early April. They mate throughout the active season (April to September), but most commonly in spring and fall (Kaufmann, 1992b; Foscarini, 1994; Walde *et al*., 2003; Trochu, 2004). Mating usually occurs in shallow water (DeGraaf and Rudis, 1983), although Wood Turtles occasionally have been observed copulating on land (S. Gillingwater, pers. comm. 2006). There has been at least one account of Wood Turtles and Blanding's Turtles (*Emydoidea blandingii*) mating and at least one account of Wood-Blanding's hybrids (Harding and Davis, 1999).

Female Wood Turtles nest in late May to mid-June (Schaffer, 1991; Smith, 2002, R. Brooks, pers. comm. 2004), and hatching, when it occurs successfully, is in late August to September or early October (Schaffer, 1991; Foscarini, 1994; Smith, 2002). There are few accounts of hatchlings overwintering in the nest (DeGraaf and Rudis, 1983; Schaffer, 1991; Parren and Rice, 2004), and it is unlikely this happens often, if at all, in Canadian populations (R. Brooks, pers. comm. 2004). Female Wood Turtles lay only one clutch per year (Powell, 1967; Farrell and Graham, 1991; Brooks *et al*., 1992), although individual females may not nest every year (R. Brooks, pers. comm. 2005). In late May to early June, females migrate to nesting areas and dig nests, usually in the

evening, often after several “test” digs (Bishop, 1927; Thomas, 1983; Schaffer, 1991; Brooks *et al*., 1992; Kaufmann, 1992b; Foscarini, 1994; Walde, 1998; Smith, 2002; Brooks *et al*., 2003; Trochu, 2004). However, nesting can occur throughout the day or night depending primarily on climatic conditions (Walde, 1998; R. Brooks, pers. comm. 2005). Typically, nests are dug in sand or gravel beaches, riverbanks or other open areas near water (Thomas, 1983; Smith, 2002, Wesley *et al*. 2004). Wood Turtles also nest in gravel pits (Foscarini, 1994; Walde, 1998), along roads and railways (Brooks *et al*., 1992; Trochu, 2004), utility rights-of-way, agricultural fields, pastures and old fields (Saumure, 1997, 2004; Saumure and Bider, 1998; Trute *et al*., 2004), areas that are exposed to sunlight and amenable to digging.

Sex determination is independent of incubation temperature in Wood Turtles (Ernst, 2001). Successful embryonic development and hatching requires sufficiently warm thermal conditions and there are several accounts of unsuccessful nesting in years when the summer has been too cool for incubation to be completed, and eggs/hatchlings do not survive over winter in the nest (Brooks *et al*., 1992; Compton, 1999). This constraint likely determines the northern limit of distribution of the species (Compton, 1999). Females lay clutches of 1 to 20 eggs, but the average is from 8-12 (Powell, 1967; Harding and Bloomer, 1979; Brooks *et al*. 1992; Walde, 1998; Peiman and Brooks, 2003). Hatching success can be high, but is often low due to cool summers or to nests being destroyed by predators (Brooks and Brown, 1992; Brooks *et al*., 1992; Walde, 1998; Cameron *et al*., 2002). In addition, larvae of a Sarcophagid fly may attack and kill embryos and newly hatched turtles in the nest (Smith, 2002), but it is possible that the larvae may only feed on dead embryos/hatchlings in most cases (Bolton 2007). Mortality of embryos is generally 20-80%, but often as high as 100% (Brooks and Brown, 1992; Brooks *et al*., 1992; Foscarini, 1994).

Hatchling Wood Turtles are uncommon and, because of their small size, are difficult to find or study (Peiman and Brooks, 2003) and, therefore, there is little information on habitat, survivorship or diet during this stage of life. Wood Turtles do not reach maturity until 11 to 22 years of age (Brooks *et al*., 1992; Walde *et al*., 2003). Sexual maturity seems to be related more to body size rather than to a specific age, and size at maturity is greater in northern populations than in southern ones (Brooks *et al*., 1992; Daigle, 1997; Cameron *et al*., 2002; Smith 2002; Peiman and Brooks, 2003; Walde *et al*., 2003). Maximum ages for Wood Turtles in the wild are difficult to estimate due to the turtles’ longevity and to wear on the carapace, which limits the possibility of counting annuli in older turtles (Harding and Bloomer, 1979). Also, growth slows dramatically after the turtles reach maturity, so that after maturity, the growth lines either are not deposited or become difficult to detect. Nevertheless, some researchers have managed to count as many as 30-50 growth lines on some turtles suggesting that that these turtles reach ages of at least 50 years in the wild (Cameron *et al*., 2002; D. Coulson, pers. comm. 2004). One female captured as an adult on the New Jersey Turnpike has survived over 40 years in captivity (R. Brooks, pers. comm. 2005). Generation time (GT) (average age of adults) has not been calculated in the literature, but an estimation based on published values for age at maturity (AM) and adult rates of mortality (MR) and using the IUCN formula would be: GT=A M +1/MR= 15 + 1/0.05=35 years.

Herbivory/predation

Wood Turtles are opportunistic omnivores at all stages of life (Bishop, 1927; Breckenridge, 1944; Harding and Bloomer, 1979; DeGraaf and Rudis, 1983; Schaffer, 1991; Walde *et al.*, 2003).The main predators of Wood Turtles are raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), and foxes (*Vulpes vulpes*) (Ernst *et al.*, 1994; Peiman and Brooks, 2003; Bourgeois *et al.*, 2004), though large fish such as largemouth bass (*Micropterus salmoides*) (Breckenridge, 1944) and northern pike (*Esox lucius*) (Seburn, 1996) and birds such as great blue herons will include hatchlings in their diet (Seburn, 1996). Raccoon, skunks and foxes dig up and eat eggs (Brooks *et al.*, 1992), resulting in the high levels of nest failure previously mentioned. Some species, particularly raccoons and coyotes (*Canis latrans*) will also attack adult Wood Turtles, resulting in the high numbers of amputated limbs and truncated tails seen in most Wood Turtle populations (Saumure and Bider, 1998; Cameron *et al.*, 2002; Smith, 2002; Peiman and Brooks, 2003). For example, raccoons killed seven of the 37 (19%) female Wood Turtles on a Quebec nesting site in 2004 (D. Masse, pers. comm. 2005). During the spring survey in 2005, eight more dead females were found near the main nesting site. These females had been marked and had nested at the site in previous years. It is estimated that predators have killed 40% of the nesting females at this site in the past few years (J-C. Bourgeois, pers. comm. 2005). In forested areas in Quebec, the mink (*Mustela vison*) is another important predator (D. Masse, pers. comm. 2005).

Physiology

There have been few physiological investigations of Wood Turtles, although there have been some recent studies of thermoregulation in freeliving populations (Y. Dubois, pers. comm. 2005; Dubois, 2006). Wood Turtles hibernate underwater (Schaffer, 1991; Smith, 2002), and they are adapted for anaerobic respiration during this period (Graham and Forsberg, 1991). It is also suspected that aquatic pollutants may cause hatchling deformities or other reproductive problems (Ernst, 2001).

Dispersal/migration

Wood Turtles are philopatric using the same general area (home range) both during a year and over many years, with males being territorial (Thomas, 1983; Ross *et al.* 1991; Quinn and Tate, 1991; Brooks and Brown 1992; Kauffman, 1992b; Foscarini, 1994; Walde 1998; Cameron *et al.*, 2002; Smith, 2002; Arvisais *et al.*, 2002; Peiman and Brooks, 2003; Wesley *et al.,* 2004). Wood Turtles hibernate in underwater "hibernacula" over winter (October to April, depending on location) (Harding and Bloomer, 1979; Ernst *et al.*, 1994; Smith, 2002). This species may hibernate alone, communally with other members of the species or with other species of turtles (Breckenridge, 1944; Harding and Bloomer, 1979; Foscarini, 1994). Hibernacula are usually just the bottom of deep pools in streams. Wood Turtles remain close to water after emerging from hibernation (Arvisais *et al.*, 2002; Arvisais *et al.*, 2004), then become more terrestrial as summer progresses (Bishop, 1927; Breckenridge, 1944; Arvisais *et al.*, 2002; Peiman and Brooks, 2003; Arvisais *et al.*, 2004; Trochu, 2004).

Home range sizes vary in response to many factors, including distance to nesting and hibernation sites and habitat productivity (Daigle, 1997). Home range sizes of 0.25 ha up to 70+ ha have been reported (Quinn and Tate, 1991; Ross *et al.*, 1991; Brooks and Brown, 1992; Arvisais *et al*. 2002; Smith, 2002; Trochu, 2004). There is great variability in size of home ranges not only among study sites but among individual turtles within sites. The reasons for these differences within sites remain obscure. Wood Turtles can home reliably over 2 km, but there are accounts of them homing greater distances as well (8 km: Harding and Bloomer, 1979); straight-line distances travelled have been recorded up to 8.3 km (Daigle, 1997; Cameron *et al.*, 2002; Smith, 2002; Adams, 2003; Wesley *et al.*, 2004), and 23 km over 5 years (Brooks and Brown, 1992).

Interspecific interactions

Wood Turtles actively "stomp" to attract earthworms, which are then eaten (Kaufman, 1989); display "anting behaviour" (use of ants to remove epibionts) (McCurdy and Herman, 1997); and remain still while being cleaned by blacknose dace (*Rhinichthyes* spp.) (Kaufmann, 1991).

There are many accounts of Wood Turtles with leeches, *Placobdella parasitica* and *P. ornata*, on their legs, necks and carapaces (Brewster and Brewster, 1986; Farrell and Graham, 1991; Foscarini, 1994; Saumure and Bider, 1996; Smith, 2002), but it is not clear how this ectoparasite affects the Wood Turtle (Kaufmann, 1991). Other parasites of the Wood Turtle include trematodes, an acanthocephalan, caddisfly larvae (an epibiont), and the flesh fly, *Sarcophagus* spp., which may parasitize eggs and hatchlings (Foscarini, 1994; Walde, 1998; Smith, 2002).

Adaptability

The Wood Turtle's longevity, late age of maturity, low reproductive success and inability to respond to increases in adult mortality with compensatory reproduction makes them slow to recover from population declines (Litzgus and Brooks, 1996; Oldham, 1998; Compton, 1999; Brooks *et al*. 1991; Cameron and Brooks, 2002). Headstarting of hatchlings is being attempted in Ontario, but it will take several years for enough appropriately headstarted turtles to have an impact on the population (Cameron and Brooks, 2002; M. Malhiot, pers. comm. 2004). La Mauricie National Park in Quebec is also considering a headstarting program to sustain its declining population (J-C Bourgeois, pers. comm. 2005).

POPULATION SIZES AND TRENDS

Search effort

Prior to 1990, there were very few studies on any aspect of Wood Turtle biology in Canada, but since the species was listed as Vulnerable (Special Concern) by COSEWIC in 1996, many studies have been initiated, especially in Quebec and Ontario, that have filled gaps in our knowledge of the species' numbers, demography, habitat requirements and distribution. A number of known populations were studied using radio telemetry (e.g., Brooks and Brown, 1991; Quinn and Tate, 1991; Foscarini, 1994; Walde 1998; Compton, 1999; Arvisais *et al*., 2002, 2004; Cameron *et al*., 2002; Compton *et al*. 2002; Dubois, 2006; Smith 2002; Peiman and Brooks, 2003; Saumure, 2004; Wesley *et al*., 2004; Wesley, 2006). Surveys of new areas usually were completed by walking (one to four people) alongside a river thought to provide good habitat, sometimes with one person walking or canoeing the river or stream. In Ontario, systematic surveys of this type were carried out across the province from the extreme southwest to western Algoma (Mitchell *et al.*, 1997; Boyd and Brooks, 1998). Geographic Information Systems were used in some cases to focus search effort (Smith, 2002). One survey (of New Brunswick) used an Internet newsgroup to solicit reports of sightings (McAlpine and Gerreits, 1991), while a second (Nova Scotia) interviewed local residents (Adams, 2002). When population estimates were given, they were usually based on mark-recapture rates. Population estimates are not available for all of the populations, and search effort was quantified only on rare occasions (Daigle, 1996).

Abundance

The total number of Wood Turtles in Canada is not known, but given that there are several recently completed studies on Wood Turtles, and several more ongoing across the species' Canadian range,, it is possible to derive a rough estimate of the number of adults in Canada. To obtain this estimate, the COSEWIC Amphibians and Reptiles SSC co-chair (R. Brooks) used information from provincial Recovery Teams and other resources and contacted by email in June-August 2005, all researchers and government biologists known to have an interest in Wood Turtles and asked them to estimate numbers of adult Wood Turtles in their research areas, jurisdictions or whatever area they felt competent to cover. The following information was requested; location, number of adults marked, estimated number of adults, and method of estimation. A summary of responses from Ontario and Quebec is in Table 1. From some regions, individuals were also asked to report the number of rivers searched and the number with or without Wood Turtles, and the number of rivers that may have Wood Turtles, but have not yet been searched. This endeavour allowed calculation of reasonable estimates of adult abundance in the Carolinian, Great Lakes/St. Lawrence and Canadian Shield faunal provinces in Ontario and Quebec, but estimates for the Appalachian/Atlantic Coast region were considerably more uncertain, because this region had fewer studies and surveys.

In providing estimates, some people who responded to the request for numbers assumed that the density of turtles per km of river in their study area could be extrapolated to the entire length of the river. This assumption likely gives an overestimate in that most study areas only include a limited section of a watercourse and are selected for study because they are already known to have a population of Wood Turtles. However, experience indicates that even in rivers with apparently good habitat throughout their length, the turtles are usually patchily distributed with most of the river unoccupied except by transients (R. Brooks, pers. comm. 2005; Wesley, 2006). For example, on a major river in central Ontario, virtually all sightings of Wood Turtles along a 20-km stretch of the river occurred at 2 sites, one 1.2km and the other 0.4km. in length. Extrapolation from these sites over the 20-km surveyed would have given an estimate over 2000 adults, when the real population of adults is likely fewer than 150 (R. Brooks, pers. comm. 2005). Three other examples that indicate the species' patchy distribution follow, "In my primary study site (oldest) and other sites in Michigan, the turtles are definitely clumped in distribution, and essentially absent (or just transient) on much of the river's length. Attached is an aerial view of my study site, showing the prime habitat. Portions of the river that lack the grassy-edged sandbars are MUCH less frequently used. The sloughs are not used at all" (J. Harding, pers. comm; 2006). "I also think that taking localized "sub-population" estimates and extrapolating them to the entire stream will result in a serious over-estimate of metapopulation size". (P. Wesley pers.comm 2006). "As for the River X, there is a meta-population, so to speak. We have one in the agricultural village of XXX proper and my site upstream from XY Lake. Nothing in between. You can calculate rough distance on a map. So, as far as we know, there are likely 3 small populations along the entire X river that probably don't intermingle that much (my longest move for a male was just over 5km). So, does that constitute three populations or a metapopulation? As to guessing on how many turtles there are along an unsurveyed river, estimates generalized to an entire river or watershed will grossly over-estimate metapopulation size" (R. Saumure pers. comm., 2006)

In addition, it appears that there is a significant positive correlation between Wood Turtle density and number of frost-free days (Walde, 1998; Smith, 2002). Therefore, Canadian populations, especially those near the northern limits of the species' distribution have much lower densities (up to two orders of magnitude) than those in the central part of the species' distribution in the USA.

Populations of the Carolinian Faunal Province

There has never been much information on Wood Turtles in this faunal province although the species evidently did occur there in small scattered "populations" in historic times (NHIC 2004a,b, Seburn and Seburn 2004). Most Element Occurrences are Extinct or Historic and it is unlikely that any viable populations still occur in this region (see Figure 4). Recent surveys that focused on Wood Turtles failed to find any evidence of the species in the Carolinian Region (Mitchell *et al*. 1997, Boyd and Brooks 1998).

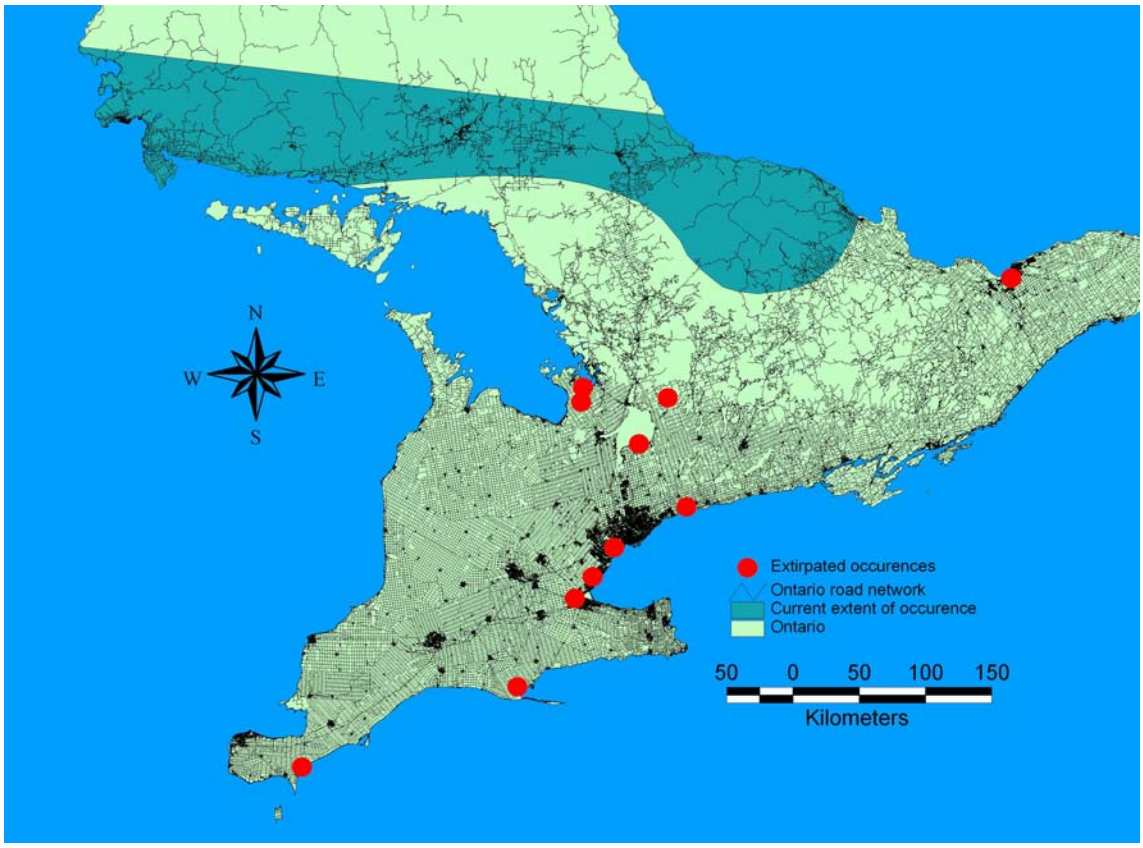

Figure 4. Locations of extirpated "populations" of the Wood Turtle in southern Ontario and current "Extent of Occurrence" in Ontario overlaid with distribution of roads ~1995 (Taylor *et al*. 2001) Note that there have so far been no Wood Turtles found in the central part of the EOO depicted (see Fig. 2).Map was created and provided by J.F. Crowley..

Populations of the Great Lakes/St. Lawrence Faunal Province

All extant populations of Wood Turtles in Ontario and those in the upper St. Lawrence around Montréal are in Great Lakes/St. Lawrence habitat. The only population remaining in "southern" Ontario (i.e. south of Algonquin Park) was estimated at 412-420 individuals in 1993 (Foscarini, 1994), but a 65%-75% decrease occurred in 1994-95 (Mitchell *et al.*, 1997), and a recent Population Viability Analysis indicated that the population is expected to be extirpated within 50 years if there is not active intervention (Cameron and Brooks, 2002). Headstarting of hatchlings is being attempted with this population in an effort to restore it (M. Malhiot, pers. comm. 2004). A more recent estimate suggests that the total population is <50 adults (K. Beriault, pers. comm. August 2007). In 1991 and 1992 respectively, 144 and 157 adults were captured in this area compared to <25 in 2007 using similar effort (Foscarini, 1994, K Beriault, pers. comm.,Sept. 2007). There may be another small and possibly viable population south of Georgian Bay, but neither its size nor viability are known (M. Oldham pers. comm. 2007).

A "population" occurs in low density over a wide area in and near eastern Algonquin Provincial Park (Quinn and Tate 1991; Brooks and Brown, 1992; Brooks *et al.* 1992; Mitchell *et al.* 1997; Boyd and Brooks 1998; Smith 2002) and has been studied over approximately the past 14 years with population estimates of 48 (Quinn and Tate, 1991); 108 over three parts of the area (Brooks *et al.*, 1992); and 121 turtles at 5 different sites within this area (Smith, 2002). Sightings of Wood Turtles have been recorded at this location from 1972 to 2005 (B. Steinberg, pers. comm. 2005). The most intensively studied area within this population's distribution is in Madawaska River Provincial Park, and this population has shown a slow decline over the past 15 years, possibly related to increasing ATV and 4WD truck use (R. Brooks, pers. comm. 2005). Another segment of this population occurs along the Opeongo river in Opeongo Provincial Park and there have been 15 adults captured there (L. Trute, pers. comm. 2005). Overall, there may be over 200 adults in this whole region. In the wild river parks, the numbers are likely declining with increasing human activity.

A "population" occurs in scattered locations across Renfrew County where there have been 19 adults marked over the past few years and a rough estimate of 100 adults is based on capture data from 5 rivers (L. Trute, pers. comm. 2005).

In 2003, a population was discovered on a river near Sudbury (Keable and Kearns, 2004), and to date 34 adults have been marked, but there has been no estimate of population size (J. Litzgus, pers. comm. 2005, 2007).

Further west, there are a number of streams in Algoma district that have populations of Wood Turtles. In Western Algoma District, 6 streams/rivers have been found to harbour Wood Turtles, 22 streams/rivers appear suitable but have no Wood Turtles, and 12 streams/rivers look suitable for Wood Turtles but have not been searched (P. Wesley, pers. comm. 2006). In the 6 rivers in which Wood Turtles have been observed, a total of 158 adults were captured and marked over the past 6 years (Knudsen, 2004; Wesley *et al.* 2004; P. Wesley, pers. comm. 2006).

In Eastern Algoma district, Wood Turtles have been found in 5 rivers with 114 adults marked over the past several years and an estimated population (assuming similar densities along the whole length of the rivers, of ~600 adults (Cameron *et al*. 2002; Peiman and Brooks, 2003; Trottier, 2004; J. Trottier, pers. comm. 2005) (see Table 1).

There have been numerous recent surveys and studies of the Wood Turtle in Quebec. Several biologists collaborated to produce estimates from 16 rivers from across the species' range in the province. (J. Jutras, pers. comm. 2005: see Table 1). Of these rivers, ~10 are in or partly in, the Great Lakes/St. Lawrence FP (Table 1). Of these 10, 6 were thought to contain declining populations and 4 were "unknown" with respect to population trends and one was "stable" (Table 1).

From these data, a total estimate for the Great Lakes/St. Lawrence FP was calculated as ~ 1600 adults (Table1). This value may be slightly inflated because some of the numbers from Ontario were extrapolated from small study sites to entire lengths of rivers (see text above).

Populations of the Canadian Shield Faunal Province

In Quebec, ~6 rivers are in or partially in the Canadian Shield FP. Of these, two are thought to be stable, two are declining and four have population status “unknown” (Table 1). The total numbers of adult Wood Turtles is estimated to be 1320 (Table 1). As noted earlier, the high estimate from simple extrapolation is likely too high.

Populations of the Appalachian/Atlantic Coast Faunal Province

In Quebec, ~ 7 streams are in, or partially in, this Faunal Province (Table 1). Of these, four are thought to be declining and status is “unknown” in the other three. Estimated number of adults is ~500. In New Brunswick, there have been sightings recorded from several areas (hence the 79 Element Occurrences for the province), but there is no abundance information for these sightings (McAlpine and Gerreits, 1999; E. Tremblay, pers. comm. 2004). A private study by a landowner over the past 8 years has found and marked nearly 100 Wood Turtles (66 adults) to date, with observations of nesting and juveniles (P. Brewer, pers. comm. 2005). A study begun on federal land in the province captured 111 turtles in the first field season, including hatchlings, juveniles and 57 adults (V. Roy, pers. comm. 2005). Overall, turtles have been reported from ~13 watersheds (streams/rivers (McAlpine and Gerrits, 1999).Total numbers for the province are difficult to estimate, but based on numbers from similar regions in Quebec and Ontario may be in the order of 1,000 adults.

In Nova Scotia, there have been few studies on Wood Turtles and the estimates of numbers are generally much less certain than in Ontario and Quebec. Estimates from J. Gilhen cover 12 watersheds which are known to have populations of Wood Turtles. These estimates suggest there is a total of about 2200 adults in these rivers (J. Gilhen, pers. comm. 2005). These estimates are based on Gilhen’s long experience and contacts (see Gilhen, 1990). A set of much higher estimates has been documented by M. Elderkin and M. Pulsifer (pers. comm. 2005). On 8 km of one tributary of River A, 55 person hours of searching yielded 21 adults (0.38 turtles per hour) and a “density” of 2.65 adults per km. Given about 500 km of streams and creeks in this river system, they extrapolated to an estimate of 1300 adult Wood Turtles for this single river (J. Gilhen estimated 240 adults for this stream, pers. comm. 2005). For the River B watershed, M. Pulsifer estimated about 1000-1500 Wood Turtle adults (M. Elderkin, pers. comm. 2005). For this same watershed, Gilhen estimated 800 adults (J. Gilhen, pers. comm. 2005). Both sets of estimates are much higher than was reported in the 1996 COSEWIC report, which stated that there were thought to be 9 “populations” in Nova Scotia, most with fewer than 100 turtles (Litzgus and Brooks, 1996). However, it does appear that Rivers A and B are outliers, and that most or all other populations in Nova Scotia have fewer than 100 adults and many of these populations are thought to be declining and in “big trouble” (T. Herman, pers. comm. Minutes of A&R SSC Meeting Akwesasne, Sept. 21, 2007).

Table 1. Summary of "known" populations[+] of Wood Turtles in Ontario and Quebec.

Jurisdiction	Biogeog. Region (Faunal Province)[1]	Population ID	# marked individuals	Estimated Number of adults	Length of Study (years)	Trend
Ontario	7	1	~400	~80	~15	>60% decline[2]
	7	2	15	-	-	Unk
	7	3	~100	~70	15	>30% decline[3]
	7	4	-	-	-	Unk
	7	5	15	70	<5	Unk
	7	6	1	10	<5	Unk
	7	7	1	10	<5	Unk
	7	8	~30	-	<5	Unk
	7	9	-	~50	<5	Unk
	7	10(6+rivers)	126	200	<5	Unk
	7	11	140	340[E]	<5	Unk
	7	12	38	225[E]	<5	Unk
	7	13	10(3 rivers)	30[E]	<5	Unk
Québec	5	1a	225	300	10	Decline
	5	1b	-	150	10	Decline
	5	2	10	50	2	Unk
	5/7	3	20 (12?)[++]	50	1	Unk
	5	4	7	50	-	Unk
	5/7	5	20(34?)[++]	34-43	1	Stable
	6/7	6a	14	50	1	Unk
	6/7	6b	-	50	1	Unk
	6	7	65	78	8	Decline[4]
	5	8	150	620[E]	8	Stable
	7	9	23	50	-	Unk
	7	10	18-27(33?)[++]	50	4	Decline
	7	11	8-11(12?)[++]	50	3	Unk
	7	12	5	50	8	Decline
	7	13	11	50	1	Decline
	6	14a	92(112?)[++]	No est.	-	Decline
	6	14b	150(112?)[++]	No est.	5	Decline
	6	15	35(8?)[++]	No est.	2	Decline
	6	16	13	No est.	2	Unk

Contents of the table are based on interpretation of information forwarded to T. Kraus and R.J. Brooks in 2005 by Ontario: J. Trottier (OMNR and Co-chair of Wood Turtle Recovery Team in Ontario) and L. Trute (OMNR, former co-chair of the Wood Turtle Recovery Team in Ontario; and Quebec: J. Jutras (MRnFQ) and P. Galois (Coordonateur et rédacteur du plan multi-tortues). Trends for Quebec populations were updated in Nov. 2007 based on new information provided by D. Banville.

[1] Designation of a Faunal Province is arbitrary in many cases because the turtles occupy streams that are in more than one Faunal Province.

\+ "Populations" are somewhat arbitrary as some may not be separate breeding units. "Trends" are listed when researchers felt competent to give a trend.

++ Numbers with a question mark are taken from the 2006 version of the Quebec multi-species plan and differ from the values given to R. Brooks in 2005. Presumably, the numbers in the Recovery Plan are more accurate as they reflect new captures and greater discussion.

E = number obtained by extrapolating density of Wood Turtles in a study area to entire length of a river.

1. Faunal provinces of terrestrial amphibians, reptiles and molluscs in Canada (COSEWIC Operations and Procedures Manual, Appendix F5). FP 7 = Great Lakes/St. Lawrence, FP 6 = Appalachian/Atlantic Coast, FP 5 = Canadian Shield.
2. Cameron and Brooks (2002)
3. Samson and Brooks (2005)
4. Daigle and Jutras (2005)

Estimates of total numbers for Nova Scotia will have a high degree of uncertainty given the disparity in estimates and the limitations of extrapolation. It seems a range of 2000-7000 would cover most guesses. Therefore, the totals for the Appalachian/Atlantic Coast FP range from ~3000-9000 adults.

Canada

If we combine the above estimates from the four provinces, the values range from a low of ~6,000 to a high of 12,000 adult Wood Turtles in Canada. However, it should be remembered that some of the estimates are based, especially high values, upon simple linear extrapolations from small study areas. These extrapolations and their high estimates have a greater uncertainty for reasons given earlier. The turtles are not found along entire lengths of watercourses, but occur in discontinuous patches. Second, given the visibility of this turtle at nesting areas and along creeks and rivers in early spring, it is unlikely that such high numbers could have remained undetected for so long. Third, the experience from long-term studies (Foscarini, 1994; Cameron and Brooks, 2002; Saumure, 2004; Wesley *et al*., 2004, Wesley and Brooks, 2005) also indicates a high number of new captures in the first 2-3 years, followed by a rapid decline thereafter and few new turtles over subsequent years. The initial burst of new turtles is, of course, expected but the rapid decline is unusual when compared to other species, even other turtles (R. Brooks, pers. comm. 2005). It appears that compared to other species a larger proportion of Wood Turtle populations are captured fairly quickly, and this situation is presumably a reflection of the ease of capturing them on land. Therefore, population estimates using capture-mark-recapture from only 1- to 2-year studies are likely to be higher and to have higher uncertainty than estimates based on longer studies.

Fluctuations and trends

The general decline of Wood Turtles indicated by anecdotal evidence has spurred the initiation of studies throughout the range of the Wood Turtle. The majority of these studies have been underway for less than 4 years and so only a few studies can provide more “long-term” quantitative data from Canadian populations. So far no population has been judged to be increasing (see Table 1 and above text).

In Quebec, population trends from demographic studies or knowledge of regional biologists are available from ~16 rivers (Table 1). Of these, ~9 are considered declining and two are thought to be stable in Wood Turtle abundance (Equipe de rétablissement des tortues du Quebec, 2005). More specifically, one well-studied population was believed to be stable (Walde *et al.*, 2003), but recent increases in predators have brought about a rapid decline in the population (Bourgeois *et al.*, 2004). Two estimates made seven years apart show a decline of close to 50% (Daigle and Jutras, 2005). Additionally, this population could decline further due to increased mortality from agricultural machinery (Saumure, 2004). The situation is likely to be similar in other rivers located in the agricultural region of Quebec, which contains about half the provincial population of Wood Turtles (C. Daigle, pers. comm. 2005). Wood Turtle

populations in more forested landscapes are likely more secure and declines, if any, are expected to be smaller (Walde *et al.*, 2003; C. Daigle, pers. comm. 2005), as long as road access is not extensive.

In Nova Scotia, there is no published information on population trends, but there is anecdotal evidence that many populations are declining (Litzgus and Brooks, 1996; T. Herman, pers. comm. Sept. 2007).

In New Brunswick, there has been no formal long-term monitoring. However, anecdotal information indicates a population decline and lack of protection of at least one site in the southern part of the province, where illegal ATV activity has occurred in nesting areas (P. Brewer, pers. comm. 2005). This informal study, begun in 1998, has reported that the population has declined in the past few years, and suggested that the decline is from increasing ATV traffic and its effects. i.e., turtles being run over, nests destroyed and turtles picked up or deliberately killed (P. Brewer, pers. comm. 2005). Five of 6 nesting areas are driven on daily by several ATVs and as water levels decline over summer, ATV crossings increase to about 15 crossing points per km of river.

In Ontario, the lone population in southern Ontario was modelled after it underwent a sharp decline in 1994-5, presumably because of collection for the pet trade (Table 1). The model predicted that the population would be extirpated in 50 years without significant intervention (Cameron and Brooks, 2002). Currently, this population is being bolstered by headstarted juveniles, and it remains to be seen if this strategy will help restore its numbers (M. Malhiot, pers. comm. 2004); however, it appears that the population is continuing to decrease (K. Beriault, pers. comm., Sept. 2007). A second population near Algonquin Provincial Park has been monitored since 1987 (Quinn and Tate, 1991; Brooks *et al.*, 1992; Brooks and Boyd, 1998; Smith, 2002), and it appears also to be declining (R. Brooks, pers. comm. 2005) (Table 1). This population is in a Provincial Park, but as with the population in New Brunswick (see above paragraph), the area is open to ATVs and increasing recreational use (R. Brooks, pers. comm. 2005). As reported in a 20-year study in Connecticut, even opening an area to hikers and picnicking can lead to the complete extirpation of a Wood Turtle population through collection (Garber and Burger, 1995). Other populations are reported as “healthy”, although road mortality and high levels of foot and vehicular traffic are seen on nesting sites and along some roads near the sites (J. Trottier, pers. comm. 2004; R. Knudsen, pers. comm. 2004; J. Litzgus, pers. comm., 2007). None of these populations has been investigated long enough that trends in abundance could be detected or inferred at this point. No other Ontario populations have been studied long enough to detect any potential trends, but all are subject to increasing contact with people and their vehicles. Expanding human impacts have placed virtually all Ontario Wood Turtle populations under threat.

The overall trend in both Canada and the USA (J. Harding, pers. comm. 2004) is one of decline, and although some populations are described as stable, the exceptionally high vulnerability of Wood Turtle populations to anthropogenic sources of mortality means that any population to which humans have access (all current known populations, to some degree) are susceptible to decline.

Rescue effect

In the United States, most Wood Turtle populations are declining (NatureServe, 2004), and there is no exchange of individuals known to occur between these populations and those in Canada. It is highly unlikely that any Canadian population would be bolstered or renewed by another population (from Canada or from the United States) were it to become extirpated (see “Distribution” and “Dispersal/Migration”).

LIMITING FACTORS AND THREATS

There are several threats, of varying degrees of imminence and potential severity, to the Wood Turtle throughout its range. Imminent threats with population-scale impacts include: increased mortality rates, particularly of adults, by traffic on roads (Anon., 2002; Seburn and Seburn, 2004; R. Brooks, pers. comm. 2004); modern agricultural machinery (Saumure, 1997; Anon., 2002; Saumure, 2004 and pers. comm. 2006, 2005); collection of all age classes, but especially of adults for personal and commercial use as pets and food (Lazell, 1976; Harding and Bloomer, 1979; Garber and Burger, 1995; Anon., 1996; Litzgus and Brooks, 1996; Seburn, 1997; Galois and Bonin, 1999; Cameron and Brooks, 2002; R. Brooks, pers. comm. 2004; J. Harding, pers. comm. 2004; R. Saumure, pers. comm. 2004); increased predation of nests and females by larger populations of edge predators (increase in edge predators due to increased fragmentation of habitat by forestry, agriculture and urban expansion) (Oldham, 1998; NatureServe, 2004; Bourgeois *et al.*, 2004; R. Saumure, pers. comm. 2004) and destruction of nests by vehicles such as ATVs (J. Trottier, pers. comm. 2004; R. Knudsen, pers. comm. 2004; P. Brewer, pers. comm. 2004, 2005). On land, Wood Turtles are exceptionally vulnerable to collection, especially in spring when they bask and feed along watercourses before vegetation leafs out and makes the turtles much harder to find. Thus, the turtles are easily found and readily captured as they have no capacity to escape when on land. Construction of new forest access roads may increase the potential for collection to occur, as previously inaccessible areas become readily accessible, and often heavily travelled by outdoors people. As well, these new roads and water crossings may provide new nesting locations, which are less than ideal due to the vehicular traffic (trucks and ATVs) associated with them (Trute *et al.*, 2004), and therefore, act as population sinks.

Like most turtles, Wood Turtles are long-lived and vulnerable to chronic increases in rates of mortality of adults or older juveniles. Recent modelling studies suggest that a chronic annual increase in adult mortality rate as low as 1% can lead to extirpation of a population of Wood Turtles (Compton, 1999). In other turtle species with similar age of

maturity and reproductive output, increases of 5% in rates of adult mortality lead to population declines, whereas an annual mortality of 70% of eggs can be tolerated, all else being equal (Congdon *et al.,* 1993: based on models from long-term study of a population of Blandings Turtle (*Emydoidea blandingii*)). Wood Turtle females reproduce only once per year at most and lack the ability for compensatory recruitment if population sizes decrease (Brooks *et al.*, 1991, 1992). Effects on population structure of mortality associated with roads and vehicles are demonstrated in a recent study of sex ratios in turtle populations associated with different densities of roads nearby. In *Chrysemys picta* and *Chelydra serpentina*, in 18 wetlands surrounded by "low" road density (>1.5 km of roads/$km^2$of landscape) and 17 wetlands with "high" road density (> 1.5 km of roads/km^2 of landscape) in New York, significantly male-biased sex ratios were associated with high road densities, but not with low road densities (Steen and Gibbs, 2002). The authors concluded that this difference was a consequence of biased mortality of females on the roads. A recent meta-analysis compared sex ratios of 38,166 turtles from 157 studies and found a consistently larger proportion of females in populations sampled along roads (61%) than those sampled off roads (41%) (Steen *et al*. 2006). The authors concluded that the observation that freshwater turtle populations are becoming more male-biased was because females are more likely to go on roads and be killed than are males (Steen *et al*. 2006). For Wood Turtles, the sex ratios were 0.51 and 0.68 female:male for off and on road samples respectively (Steen *et al*. 2006). Also, telemetry studies of Wood Turtles usually show that males remain closer to water compared to females (Foscarini 1994, Walde 1998, Smith 2002) and that females often nest in agricultural fields (Saumure and Bider, 1998; Saumure, 2004) or on roads. Thus, female turtles are more likely to be killed, and even when they are not, their hatchlings in roadside nests are often killed (Ashley and Robinson, 1996). Nesting success and survival of hatchlings over their first year is extremely low (usually between 0-30%). On average, adult females are likely to nest successfully (i.e. "clutch" survives to maturity) only once in their, often long, reproductive lifetime. One population in Ontario is predicted to become extirpated within 50 years, because over a few days, collectors removed about 60% of the adult population (Cameron and Brooks, 2002). Two populations in Connecticut were extirpated within 10 years after allowing human access to a reserve used for picnics and family outings (Garber and Burger, 1995). These authors speculated that the decline and extirpation of the population occurred because of occasional removal of turtles by hikers and picnickers. A population in Quebec has declined because female adults are killed by agricultural equipment (Saumure, 2004; Daigle and Jutras, 2005), and such losses are occurring in other parts of the Wood Turtle's range in agricultural areas (R. Saumure, pers. comm. 2004).

Therefore, humans contribute to Wood Turtle mortality in several ways, including road kills (Brooks *et al.*, 1992; Seburn, 1996); injury or killing of Wood Turtles with farm machinery (Saumure and Bider, 1998; Saumure, 2004; M. Pulsifer, pers. comm. 2005); destroying nests with ATVs, dirt bikes, or 4WDs (R. Knudsen, pers. comm. 2004); and intentional shooting of turtles (Harding and Bloomer, 1979; Litzgus and Brooks, 1996). Collection for the pet trade does not directly cause mortality, but removes adults from the population, which, given the species' long-lived life history with its consequent low annual reproductive output, greatly reduces recruitment, and collection has most likely

been the cause of some drastic declines in the past (Lazell, 1976; Harding and Bloomer, 1979; Garber and Burger, 1995; Anon., 1996; Litzgus and Brooks, 1996; Galois and Bonin, 1999; Cameron and Brooks, 2002; R. Brooks, pers. comm. 2005; R. Saumure, pers. comm. 2004).

The crux of the problem for the Wood Turtle is that even compared to other late maturing, long-lived turtles, this species is exceptionally vulnerable to increased loss of adults because of its terrestrial habits and extreme "tameness" (i.e. it can't evade capture when on land). Thus, even casual collection for pets (Garber and Burger, 1995), when added to the "usual" commercial collection, road mortality, and mortality from farm machinery, increased predation by racoons and coyotes and mortality from off-road vehicles, leads inevitably to population declines and extirpation if these losses are not mitigated more or less completely.

Perhaps a growing threat is collection for the exotic food trade (a US turtle researcher in Wisconsin tracked a transmittered turtle to a dumpster and found remains of over 60 other Wood Turtles that had been killed for food by one individual) (R. Saumure, pers. comm. 2004). Recently, different anonymous sources have reported directly to the A and R cochair examples of extensive private "harvesting" of turtles (and other taxa) for food (e.g., students on the University of Guelph campus capturing and keeping wildlife in their apartments for food or sale) (Anon. pers. comm. 2006) and the existence of a network to provide native turtles and other wildlife to restaurants in southern Ontario (Anon. pers. comm. 2007). Another threat is from the loss of nesting habitat and hibernacula due to stream and riverbank alteration and stabilization (Galois and Bonin, 1999; D. Coulson, pers. comm. 2004; Wesley 2006). Lesser threats include being buried alive during bank stabilization (Saumure, 2004); and perhaps pollution of waterways inhabited by Wood Turtles (Ernst, 2001; Trute *et al.*, 2004).

Some attempts at mitigating the effects of collecting, agriculture and forestry are being made, including: a website listing captive breeding and a registry thereof to undercut the black market pet trade (R. Saumure, pers. comm. 2004); suggestions for agricultural methods that decrease the likelihood of injuring or killing turtles, though these are entirely unlegislated and voluntary (R. Saumure, pers. comm. 2004); forest management planning guidelines for the protection of Wood Turtle habitat (Anon., 2002; Trute *et al.*, 2004; Wesley 2006); and headstarting of hatchlings (M. Malhiot, pers. comm. 2004). These are all quite recent initiatives, however, and their effectiveness has not been tested.

One of the interesting properties of the Wood Turtle's current distribution is that it occurs discontinuously across its range (Ernst *et al*., 1994). Many researchers have noted that there seem to be many suitable rivers and creeks in areas occupied by Wood Turtles that are not used by the turtles (but see Mitchell *et al*. 1997; Boyd and Brooks, 1998; Wesley 2006). These absences could be explained by poor dispersal capabilities or key habitat requirements that are missing (Wesley 2006), or by random extinctions characteristic of small, isolated populations where isolation is accentuated in some areas by anthropogenic activity. M. Elderkin of Nova Scotia Wildlife has proposed that

these patterns of presence and absence may reflect other historical events that extirpated turtles from some areas (M. Elderkin, pers. comm. 2005). Basically, Elderkin suggests that logging drives extirpated Wood Turtles, and perhaps other species. In Nova Scotia, the drives occurred in May and early June when the turtles would still be in the rivers, and occurred through about 250 years ending around 1950 (M. Elderkin, pers. comm. 2005). Logging drives could kill turtles directly and scarify and destroy nesting beaches, and oxbows in which the turtles spend much of their time (R. Knudsen, pers. comm. 2004; Wesley 2006). Although, logging drives no longer are a significant threat, they may have destroyed much Wood Turtle habitat and populations and may still have an effect on current abundance and distribution of the species. In a similar vein, some populations may have been extirpated by harvesting for food by Aboriginals as Wood Turtle remains do occur in native middens, or for pets by the much larger post-European settlement population.

SPECIAL SIGNIFICANCE OF THE SPECIES

The Wood Turtle is endemic to North America, and approximately 30% of its range is in Canada. The species was previously in the genus *Clemmys* and the four species in this genus are the most threatened turtles in North America (Ernst, 2001). Wood Turtles are unique among Canadian freshwater turtles in their highly terrestrial behaviour. Their attractive appearance and colour and seeming intelligence in captivity all serve to make them popular. Wood Turtles also possess a unique “worm stomping” behaviour (Brooks *et al.*, 2003). They alternately stamp their forefeet and plastron on the substrate and then consume earthworms that come to the surface. Just why, or even whether, earthworms do this is not clear, but certainly stomping and subsequent consumption of earthworms has been documented. Perhaps, a better hypothesis for this behaviour is that the turtles scuffle and bounce to flush small invertebrates from the litter on the forest floor and in doing so may uncover worms (M. Ireland, pers. comm. Sept. 2007).

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The Wood Turtle is currently listed under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (restricts export but not import of the species); designated as “Endangered – not regulated” under the Ontario *Endangered Species Act* and in the process of being regulated; listed as a “Specially Protected Reptile” in the Ontario *Fish and Wildlife Conservation Act* (prohibits hunting, possessing, selling, purchasing, and taking of any listed amphibian or reptile for educational or scientific purposes except under the authority of a licence and subject to the regulations) and protected by the same prohibitions in Quebec under the *Loi sur la conservation et la mise en valeur de la faune*. It was designated as “vulnerable” in Quebec in early 2005 (Arvisais *et al.*, 2004; J. Jutras, pers. comm. 2005); protected under the Nova Scotia *Endangered Species Act* as a species of special concern; listed as “Vulnerable” by the IUCN; listed as “Special Concern” by COSEWIC in 1996; and listed under Schedule 3 of the Canadian *Species at Risk Act* (SARA).

Table 2. Global, National, Provincial and State ranks of the Wood Turtle					
Global	G4	District of Columbia	SH	New Jersey	S3
Canada	N3	Iowa	S1	New York	S3
United States	N4	Maine	S4	Pennsylvania	S4
New Brunswick	S3	Maryland	S4	Rhode Island	S2
Nova Scotia	S3	Massachusetts	S3	Vermont	S3
Ontario	S2	Michigan	S2S3	Virginia	S2
Quebec	S3	Minnesota	S2	West Virginia	S2
Connecticut	S3	New Hampshire	S3	Wisconsin	S3

(NatureServe, 2004).

TECHNICAL SUMMARY

Glyptemys insculpta
Wood Turtle — Tortue des bois
Range of Occurrence in Canada: ON, QC, NB, NS

Extent and Area Information

• *Extent of occurrence (EO)(km²)* Based on range maps from M. Amato (Fig. 2) and Conant and Collins, 1998.	500 000 km²
• *Specify trend in EO*	Apparently stable
• *Are there extreme fluctuations in EO?*	No
• *Area of occupancy (AO) (km²)* Estimated based either on studies with areas occupied by Wood Turtles given, and using only the areas of inhabited rivers that are critical to their survival or based on the 2x2km^2 method. See Canadian range p. 6-7.	4380 ha or 1051-1752 km^2)
• *Specify trend in AO*	Unknown
• *Are there extreme fluctuations in AO?*	No
• *Number of known or inferred current locations*	438 element occurrences (see Canadian Range and Population Sizes and Trends)
• *Specify trend in #*	Decreasing (see Population Sizes and Trends)
• *Are there extreme fluctuations in number of locations?*	No (see Population Sizes and Trends)
• *Specify trend in area, extent or quality of habitat*	Decreasing (see Habitat trends)

Population Information

• *Generation time (average age of parents in the population) See p. 10*	35 yr
• *Number of mature individuals based on estimates submitted by current researchers across Canada. May be significantly overestimated in some cases, but there may also be undiscovered populations*	N/A (*very* rough estimate of ~6,000-12,000) see Population Sizes and Trends
• *Total population trend:*	Decreasing (see Population Sizes and Trends)
• *% decline over the last/next 3 generations (~100+ years)*	Unknown, but likely substantial in parts of Ontario and Quebec
• *Are there extreme fluctuations in number of mature individuals?*	No
• *Is the total population severely fragmented?*	Yes. Fragmentation is likely "natural", to some extent, but has been increasing because of loss of habitat and population
• *Specify trend in number of populations*	Decreasing?
• *Are there extreme fluctuations in number of populations?*	No
• List populations with number of mature individuals in each: Too numerous to list. Ontario: ~13 watersheds Quebec: ~16 watersheds N.B.: unknown but several watersheds N.S.: ~12; numbers uncertain, ~ 12 watersheds	

Threats (actual or imminent threats to populations or habitats)

Commercial collection for the pet trade; increased mortality of adults caused by road traffic, offroad vehicles and modern agricultural machinery; predation of adults, eggs and all other life stages by increased populations of raccoons and perhaps coyotes and other mammals; habitat loss and modification; degradation of stream habitat by dams, channelization, and sedimentation; and destruction of nests by humans, in vehicles such as ATVs; road mortality, especially on logging roads, casual collection for "pets". Flooding of streambank nest sites due to deforestation, increased access to habitat via logging and ATV access roads; long-lived life history=late maturity, low reproductive rate, low recruitment.

Rescue Effect (immigration from an outside source)

• *Status of outside population(s)?* **USA:** Declining; listed as S1, S2 or S3 in 13 of 16 states (and SH in a 17th)	
• *Is immigration known or possible?*	No
• *Would immigrants be adapted to survive in Canada?*	Yes
• *Is there sufficient habitat for immigrants in Canada?*	Yes
• *Is rescue from outside populations likely?*	No

Quantitative Analysis

n/a

Current Status

COSEWIC: Threatened (November 2007) COSEWIC: Special Concern (1996) Vulnerable (IUCN); Endangered – regulated (Ontario); Appendix II (CITES); Yellow (Nova Scotia); Menacé (Québec)

Status and Reasons for Designation

Status: Threatened	**Alpha-numeric code**: B2ab(iii,v), C1+2a(i)
Reasons for Designation: This species is declining across much of its range, and occurs in small, increasingly disjunct populations. It is more terrestrial than other freshwater turtles, which makes it extremely vulnerable to collection for the pet trade. It has a long-lived life history typical of turtles, so that almost any chronic increase in adult and juvenile mortality leads to a decrease in abundance. Such increased mortality is occurring from increased exposure to road traffic, agricultural machinery and off-road vehicles, collection for pets, commercial collection for the pet trade, and, perhaps, for exotic food/medicines. Increased level of threat is associated with new or increased access to the species' range by people.	

Applicability of Criteria

Criterion A: (Declining Total Population): Not applicable.
Criterion B: (Small Distribution, and Decline or Fluctuation): Applies to Threatened. Small AO (<2000km^2), usually occurs in small populations that are increasingly isolated by anthropogenic activity, and there is decline in area and quality of habitat and in number of mature turtles.
Criterion C: (Small Total Population Size and Decline): There are likely fewer than 10,000 adults and there is little doubt that they are declining currently at a rate > 10% in 3 generations (100 years). Only 1 population is likely to have > 1000 individuals.
Criterion D: (Very Small Population or Restricted Distribution): Not applicable.
Criterion E: (Quantitative Analysis): Not applicable.

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Talena Kraus completed her Honour's Bachelor of Science at the University of Guelph in 1999, with a specialization in Wildlife Biology. She spent the summers of 1999 and 2000 working for Kim Smith on Wood Turtles in Algonquin Park. Over the next four and a half years, she worked a variety of contracts in her field, including work for Ducks Unlimited, the Ontario Ministry of Natural Resources, the Natural Heritage Information Centre, and a forestry company in northern Ontario. She spent seven months travelling in Australia and New Zealand, one month of which was spent working on Tasmanian Devils in Tasmania. She is currently working on her Master's at Laurentian University in Sudbury, studying fisher. She intends to complete her Ph.D. and continue to work in the field, and with species at risk.