



COMMITTEE ON THE  
STATUS OF ENDANGERED  
WILDLIFE IN CANADA

OTTAWA, ONT. K1A 0H3  
(819) 997-4991

COMITÉ SUR LE STATUT  
DES ESPÈCES MENACÉES  
DE DISPARITION AU  
CANADA

OTTAWA (ONT.) K1A 0H3  
(819) 997-4991

STATUS REPORT ON THE WOOD TURTLE  
*CLEMMYS INSCULPTA*

IN CANADA

BY

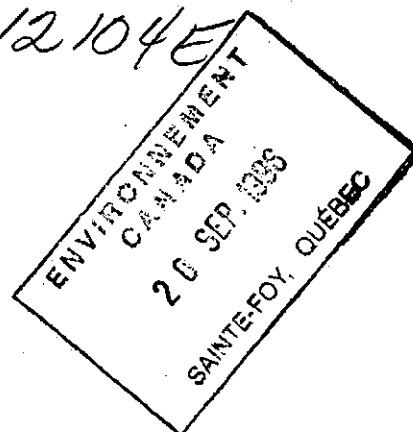
JACQUELINE D. LITZGUS

AND

RONALD J. BROOKS

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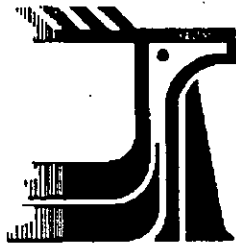
STATUS ASSIGNED IN 1996  
VULNERABLE

**REASON:** WIDE-SPREAD THOUGH PATCHY DISTRIBUTION ACROSS SOUTH-EASTERN CANADA. POPULATIONS APPARENTLY STABLE BUT VULNERABLE TO COMMERCIAL EXPLOITATION FOR THE PET TRADE, AS HAS BEEN THE EXPERIENCE IN THE UNITED STATES.

**OCCURRENCE:** ONTARIO, QUEBEC, NOVA SCOTIA, NEW BRUNSWICK

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CSEMDC - Un comité de représentants d'organismes fédéraux, provinciaux et privés qui attribue un statut national aux espèces canadiennes en péril.



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JUNE 1994

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**IN CANADA**

QL  
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573  
1996

**BY**

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**STATUS ASSIGNED IN 1996  
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**Table 1:** Comparison of size (carapace length) and age at sexual maturity among locations of wood turtles.

**Table 2:** Comparison of clutch variables among locations of wood turtle populations.

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**Figure 1:** Distribution of the wood turtle in North America (from Ernst *et al.*, 1994).

### ABSTRACT

The wood turtle, *Clemmys insculpta*, is restricted to eastern North America. It ranges discontinuously from Nova Scotia and New Brunswick south to Virginia, and west through southern Quebec, southern Ontario, and New York, to northern Michigan, Wisconsin, eastern Minnesota, and northeastern Iowa. The wood turtle is typically associated with streams, creeks, and rivers with sand and gravel bottoms, but is still one of the most terrestrial species in the family Emydidae as it spends much of the summer wandering in terrestrial habitats contiguous with streams. The wood turtle has been assigned varying degrees of protection in the United States. The species is fully protected in Ontario under the Game and Fish Act. The species' status is under review in New Brunswick and Quebec, and the status is currently unknown in Nova Scotia. Two wood turtle populations in Ontario have been studied over five years and these populations appear to be stable. Other Canadian populations have not been studied, therefore, the size and status of these populations is unknown. Many wood turtle populations in the United States have undergone precipitous declines in the past few years, apparently from commercial collection for the pet trade and habitat loss and fragmentation. Direct destruction and exploitation by humans are probably the greatest causes of loss of adult wood turtles. The wood turtle is listed on Appendix II of the CITES (Convention on the International Trade of Endangered Species of Flora and Fauna) treaty. We recommend that the wood turtle be given the status "vulnerable" in Canada, because this species has (a) a discontinuous distribution of small numbers confined to a specific habitat (clear, sand and gravel-bottomed streams), (b) a long-lived life history making the species susceptible to serious decline if adult mortality increases and (c) is threatened by the pet trade and other human activities..

## INTRODUCTION

### **DESCRIPTION/IDENTIFICATION**

**Family:** Emydidae

**Species:** *Clemmys insculpta*

**Subspecies:** none recognized (Ernst and Barbour, 1972; Ernst *et al.*, 1994)

The wood turtle is a medium-sized turtle with an average adult size of 12.5 to 20 cm carapace length, and can attain sizes up to 23.4 cm carapace length. The carapace is broad and low and each pleural (costal) and vertebral scute retains a conspicuous irregular pyramid of growth rings. The carapace is keeled and the posterior marginals are strongly flared in juveniles and adult females and serrated in all individuals. In some older individuals, the carapace is slightly wider posteriorly with an indentation at the bridge. The carapace is brown or dull grey, often with black and yellow lines radiating from the upper posterior corners of the vertebral and pleural scutes. The ventral surfaces of the marginals and the bridge may have irregular dark blotches of colour along the seams. The plastron is hingeless and yellow with an oblong black blotch at the distal margin of each scute. The skin is generally dark brown to black and the neck and legs often have some yellow, salmon-orange, or brick-red colouration. In some localities, the black head may be speckled with faint yellow dots. It has a nonprojecting snout and a notched upper jaw (Ernst, 1972; Froom, 1975; Conant and Collins, 1991; Ernst *et al.*, 1994).

Adult wood turtles are sexually dimorphic and males are generally larger than females (Lovich *et al.*, 1990; Foscarini and Brooks, 1993). Males have a concave plastron with a deeply notched posterior margin, a long thick tail with cloaca distal to carapace margin, long

heavy claws, a broader head than females (Oldham, 1991a), and prominent scales on the anterior surface of the forelimbs. Females have a flat to slightly convex plastron and a relatively short thin tail with cloaca proximal to the carapacial margin (Ernst, 1972; Froom, 1975; Conant and Collins, 1991; Ernst *et al.*, 1994).

Hatchling wood turtles are brown, tan, or grey with an almost circular carapace, and tails that are nearly as long as the carapace (Harding *et al.*, 1991). In a Michigan study, hatchling carapace length ranged from 28.0 to 37.8 mm for 96 turtles, with a mean of 34.0 mm (Harding and Bloomer, 1979). Mean hatchling carapace length in southern Ontario was 35.1 mm (N=15) (Foscarini and Brooks, 1993). Hatchling wood turtles acquire the typical species' colouration and pattern gradually during their first year of growth (Harding *et al.*, 1991).

## STUDIES IN CANADA

In Ontario, wood turtles are apparently confined to three fairly discrete regions and have been studied in two of these. Records since 1933 (LeRay, 1935; Heming, 1935; T. Lobb, pers. comm. to D. Foscarini, 1994) suggest that one area has supported a wood turtle population for at least the past 50 years, and that the species occurs over an extensive area. Preliminary field surveys were conducted on a small creek in 1988 and 1989, and a more extensive mark-recapture and radiotelemetry study which included several creeks took place from 1991-1993 (Foscarini and Brooks, 1993).

Wood turtle populations in north-central Ontario have been studied using mark-recapture and radiotelemetry from 1987-1995 by various researchers (Quinn and Tate, 1987,



1991; Brooks, 1990; Brooks and Brown, 1991; Brooks *et al.*, 1992; Brooks, unpubl. data). A long list of records from Algonquin Park (over 200 entries in the Ontario Herpetofaunal Atlas database from 1962 to 1989) suggests that there are a number of well established populations or perhaps only one or a few extensive populations around the Park.

A third area that has produced several sightings over many years is the region north and east of Sault Ste. Marie. No surveys or studies have been conducted in this area. Other records of wood turtles in Ontario have been sporadic, single observations and there is no evidence that these areas (e.g. Lake Erie shoreline, Lake Simcoe, Peterborough region, Fig. 2) currently sustain populations of wood turtles.

Throughout the rest of the species' Canadian range studies have been less extensive and less intensive than in Ontario. There have been visual surveys of three known Quebec populations, and in 1994, a survey of 18 rivers in that province took place (C. Daigle, pers. comm., 1995). As well, an M.Sc. study is currently being carried out by R. Saumire and R. Bider in Quebec (R. Saumire, pers. comm.).

In Nova Scotia, a recent survey of wood turtle distribution using questionnaires and follow up interviews (Adams, 1995). However, most reports of the species are anecdotal. In 1994, an intensive study of movement using radiotelemetry and thread-trailing was carried out on two populations from Central and Northern Nova Scotia (McCurdy, 1995). In New Brunswick, there have been no formal surveys or studies of wood turtles.

### DISTRIBUTION

The wood turtle is restricted to northeastern North America. It ranges discontinuously from Nova Scotia and New Brunswick south to Virginia, and west through southern Quebec, and central and southern Ontario, to northern Michigan, Wisconsin, eastern Minnesota, and northeastern Iowa (Figure 1) (Ernst *et al.*, 1994). The fossil record indicates that the species occupied a much larger range than it does at present. During the late Pleistocene-early Holocene, the former range extended an additional 650-700 km southwest of the present range (Parmalee and Klippel, 1981). Migration and restriction to a more northern range apparently took place during the late Pleistocene. Pleistocene remains of the wood turtle have been found in Irvingtonian deposits in Pennsylvania (Hay, 1923) and Rancholabrean deposits in northwestern Georgia (Holman, 1967), Pennsylvania (Richmond, 1964), and Tennessee (Parmalee and Klippel, 1981). The remains of the wood turtles in the Tennessee deposits were associated with many other species characteristic of short-grass prairie habitat (Parmalee and Klippel, 1981). Holman (1967) suggested that the herpetofauna of late Pleistocene deposits from the southeastern United States were representative of a relatively brief period in which the climate was characterized by milder winters and cooler summers than are the present norm. Currently, the southern limit of the wood turtle's distribution coincides closely with the 29°C isotherm for normal daily maximum temperatures in July (Parmalee and Klippel, 1981), whereas central Tennessee lies between 32°C and 35°C isotherms. Therefore, the onset of warming conditions (which allowed for the short-grass prairie habitat) in the late Pleistocene may be related to the extirpation of the wood turtle from the southern and central portions of the species'

Wisconsinian range (Parmalee and Klippel, 1981). This conjecture is supported by the fact that these southern areas still have habitats that in other respects seem suitable for wood turtles (Parmalee and Klippel, 1981).

In Canada, the wood turtle has been reported from most of New Brunswick, north-central Nova Scotia, including Cape Breton Island, southern Quebec, and south-central and north-central Ontario (Figure 2) (Bleakney, 1958; Logier and Toner, 1961; Gilhen and Grantmyre, 1973; Cook, 1984; Gilhen, 1984). Bleakney (1958) described the wood turtle as rare in the Annapolis Valley of Nova Scotia, but common in the Musquodoboit and Gay River Valleys and around Oxford. The wood turtle was considered common in south-central New Brunswick, but rare in the northern areas of the province (Bleakney, 1958). The wood turtle was described as common in eastern Ontario (Bleakney, 1958) (see Appendix I for wood turtle records in Ontario). In Quebec, the wood turtle was listed as rare in the southern Laurentian Mountains and southeastern Quebec, but common in the St. Lawrence lowlands and Gatineau Valley (Bleakney, 1958) (see Appendix II for wood turtle records in Quebec).

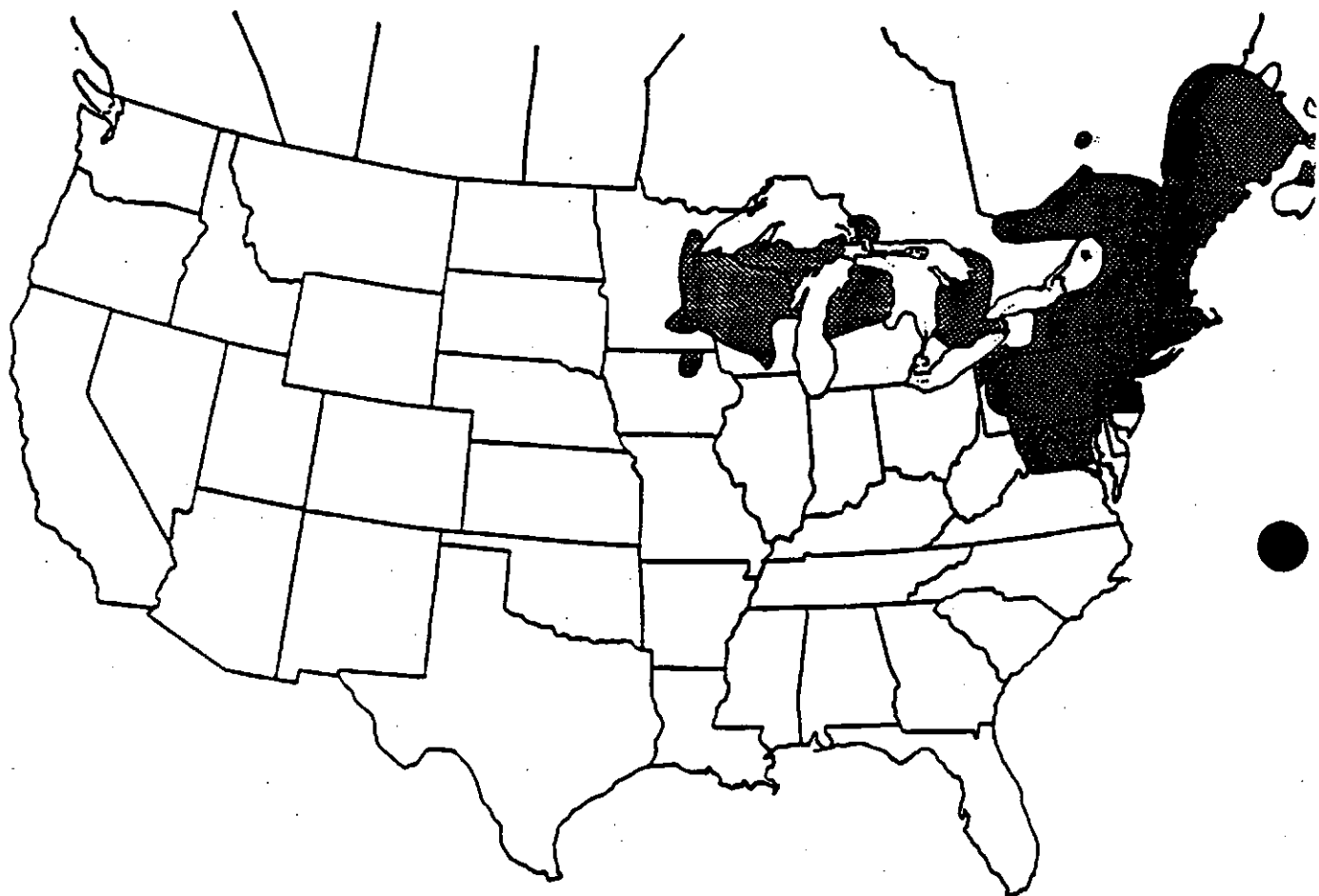


Figure 1: Distribution of the wood turtle, *Clemmys insculpta*, in North America (from Ernst *et al.*, 1994).

## PROTECTION

### Canada

In June, 1984, the wood turtle was given full protection under Ontario's Game and Fish Act (Ontario Reg. 397/84). Under this regulation, all turtle species found naturally in the wild, except the box turtle (*Terrapene carolina*) (an introduced species in Ontario), and the common snapping turtle (*Chelydra serpentina*) (which is a privately, but not commercially, harvestable species), were declared to be reptiles under the Game and Fish Act (Ont. Gazette, Vol. 117-27, 7 July 1984). Sections 76, 77, and 78 of the Act prohibit hunting or possessing any amphibian or reptile (as declared by the act), selling or purchasing any amphibian or reptile, or taking any amphibian or reptile for educational or scientific purposes except under the authority of a licence and subject to the regulations. Thus, the wood turtle is fully protected (in theory) against harvesting or collection for the commercial pet trade (commercial export prohibited) in Ontario.

There is currently no protection for the wood turtle in New Brunswick and Quebec, but the species' status is under review in both provinces. The New Brunswick Endangered Species Act has been under review for several years, and the proposed changes were to be implemented by the end of 1995. Under the new proposed legislation, the province would list the wood turtle as a "Species of Special Concern". Reptiles are now considered "wildlife" in New Brunswick, which gives the wood turtle nominal protection as all "wildlife" in the province is protected unless there is a specific season on it. In New Brunswick, the wood turtle can only be "taken" with scientific collecting permits issued by government agencies (D. McAlpine, pers. comm., 1995).

In Quebec, collecting permits are required for wood turtles (Harding *et al.*, 1991). The wood turtle is one of the species likely to be designated as "threatened" or "vulnerable" in Quebec. Steps to achieve this designation are still in the initial stages as the province is currently conducting field surveys, which will be followed by a legal species designation if a decline is evident, and finally, implementation of conservation measures if necessary (Bider and Matte, 1994; C. Daigle, pers. comm., 1995).

The wood turtle is not explicitly protected under any federal or provincial legislation in Nova Scotia, although it has minimal protection under the Nova Scotia Wildlife Act, and commercial export is prohibited (Harding *et al.*, 1991; Herman, 1993).

#### United States

The wood turtle is now specifically protected in Maine, Maryland, Vermont, Pennsylvania, Connecticut, Iowa, Massachusetts, Michigan, New York, Rhode Island, and West Virginia. The species is specifically protected as "threatened" in Minnesota, New Jersey, and Wisconsin (Harding *et al.*, 1991; Buech, 1995).

New Hampshire is the only state in which the wood turtle occurs and it is not protected (Buech, 1995). However, the status of the wood turtle is under review in this state (Buech, 1995) and it was expected to receive specific protection in New Hampshire by the end of 1995 (J. Harding, pers. comm., 1995).

There have been only two records of the wood turtle in Ohio and the species currently has no official status. It is likely that the wood turtle does not currently exist in Ohio (J. Harding, D.L. Rice, pers. comm., 1995) nor in Delaware (K. Heckscher, pers. comm. 1990).

### POPULATION SIZE AND TRENDS

Wood turtle populations are generally smaller than populations of certain other freshwater turtle species in Eastern North America (Ernst and Barbour, 1972; Garber, 1988).

#### Canada

In Ontario, it appears that southern Ontario holds the largest known wood turtle population, but the species maintains a very discrete and limited range. The population size at this site was estimated at 420 turtles (235.3-521.2) in 1992, and at 412 turtles (379.8-458.8) in 1993. Wood turtle densities were calculated for three tributaries based on surface area of stream where turtles were known to occur, thereby excluding terrestrial areas of the home range. This method gave higher density estimates than for any other areas reported because other estimates include terrestrial areas of the home range. The calculated densities were 90 turtles/ha, 66.9 turtles/ha, and 5.6 turtles/ha respectively for each of the three tributaries (Foscarini and Brooks, 1993).

In north-central, Ontario, an apparently smaller and more scattered wood turtle population has remained relatively stable for about the past five years. The population size estimates around a major nesting site were as follows: 1990, 65 adults; 1991, 69 adults; 1992, 71 adults (95% confidence limits: 57-103) (Brooks, 1990; Brooks and Brown, 1991; Brooks *et al.*, 1992). Population size wasn't estimated in 1993, 1994 or 1995 at this site, but records of captures were kept during the nesting season (June). In 1993, 1994, and 1995 respectively, 38, 34, and 41 wood turtles were observed (Brooks, unpubl. data). Wood turtle density at this site was estimated at 35 turtles/ha of stream (calculated using data from Brooks and

Brown, 1991).

Throughout the rest of the species' Canadian range, no statistical estimates of population size have been calculated. Visual surveys at three known Quebec populations yielded estimates of 200 wood turtles at one river, 100 turtles at another, and a maximum of 50 turtles in a third watershed (J. Bonin, pers. comm. to D. Foscari, 1993). The wood turtle was reported from 28 Quebec sites between 1874 and 1974, and from 56 sites between 1988 and 1991. These observations usually only consisted of single specimens, and the majority of the Quebec populations seem to consist of small numbers occurring in restricted habitats. The principal factors limiting wood turtle numbers in Quebec appear to be predation, encroaching human activity, degradation and destruction of habitat, and collection for the domestic pet trade and biological supply companies (Beaulieu, 1992; Bider and Matte, 1994). It was reported that the wood turtle population at one River was stable at about 200 turtles (Beaulieu, 1992), but R. Saumure, who has surveyed this population, disagrees with this report and believes that the population is unstable and possibly declining (pers. comm., 1995). Eighteen rivers were surveyed for wood turtles in the southeastern part of Quebec in the spring of 1994. Six of the 18 rivers surveyed (33%) had wood turtles, and a total of 45 turtles were found. The results of this survey indicated that wood turtles may be more widely distributed than expected in this part of Quebec, however, the numbers of wood turtles found on each river were small (range: 1-18 turtles) (C. Daigle, pers. comm., 1995).

Nova Scotia and New Brunswick have not published any quantitative data on sizes of their wood turtle populations. In Nova Scotia, a recent survey suggested that wood turtles



were more widespread than previously thought, however, current evidence suggests that numbers in these scattered populations are low and that these numbers are declining (T. Herman, pers. comm., 1995). At least nine discrete populations of wood turtles are presently known from Nova Scotia, but none of these are in protected areas, and at least seven may be declining (Herman, 1993). Most of the populations have less than 100 individuals, and only two relatively undisturbed populations appear to have more than 100 reproductively mature individuals (Herman, 1993; T. Herman, pers. comm., 1995). People interviewed about wood turtle sightings in Nova Scotia reported that they never saw more than six turtles and that almost all of the turtles observed were injured (T. Herman, pers. comm., 1995). Nearly all recent data on wood turtles from Nova Scotia are anecdotal, but these reports indicate a widespread concern that populations are declining (Herman, 1993). Wood turtles are often collected as curiosities or for pets, and then released far away from their preferred habitat (Herman, 1993; Barry, 1994).

In New Brunswick, there have been no formal surveys of wood turtles, although in the last couple of years Fish and Wildlife personnel in northern New Brunswick have collected some anecdotal information from specific sites (D. McAlpine, pers. comm., 1995). Wood turtle populations in New Brunswick appear to be locally common and stable where they are found (D. McAlpine, pers. comm. to J. Harding, 1990). Historically, the wood turtle was noted to be the most common turtle found in New Brunswick as it occurred in suitable habitat in most of the province (Gorham, 1970).

### United States

In the 1950's, the wood turtle was common in many parts of New Jersey. By 1979, the species was almost totally eradicated from eastern and north-central New Jersey due to human development and was declining rapidly in much of northwestern New Jersey, southeastern New York, and eastern Pennsylvania (Harding and Bloomer, 1979). For example, in northwestern New Jersey, wood turtle population size was estimated across a 4-year period from 1978 to 1981 for a 61.3-ha study site. The estimates (and 95% confidence limits) were as follows: 1978, 689 (513-865); 1979, 609 (517-701); 1980, 620 (554-686); and 1981, 699 (635-763) (Farrell and Graham, 1991). However, this New Jersey population is believed currently to have declined by at least 50%, probably as a result of collections for the pet trade (Garber and Burger, 1993; Zappalorti, pers. comm. to D. Foscari, 1993). Population densities of "healthy" populations of wood turtles in New Jersey were estimated at 12.4 turtles/ha (Harding and Bloomer, 1979) and 10.7 turtles/ha (Farrell and Graham, 1991).

Densities of wood turtle populations in Michigan were lower than in New Jersey, and they were "almost certainly less" than 2.5 turtles/ha of habitat (Harding and Bloomer, 1979). In Michigan, Harding and Bloomer (1979) also noted that "...the number of turtles found in the study area is declining steadily, and some parts of the area where specimens were once common are now nearly devoid of resident turtles. Similar patterns are seen in New Jersey due to human development..." More recently, wood turtles in Michigan appear to be declining much more rapidly than was originally thought (J. Harding, pers. comm., 1995). At an historically known wood turtle site in northern Michigan, the decline of the species

has been so great that the population is no longer viable (J. Harding, pers. comm., 1995). It is likely that commercial collectors for the pet trade visited the site in 1988 and took approximately half of the turtles. Prior to 1988, there were 15-20 nesting females observed, whereas presently there are only 2 nesting females remaining in this Michigan population (J. Harding, pers. comm., 1995).

In New York, wood turtles are thought to be widespread and the species occurs in small populations in about 30 of the 50 counties in the state (J. Behler, pers. comm., 1995). In Putnam and Westchester counties, wood turtles were common in the early 1970's, but since then there has been a precipitous decline. These declines are due to increased urbanization and road traffic, invasion by introduced plant species that have resulted in unsuitable monoculture habitats, and increased mammal and avian predation (J. Behler, pers. comm., 1995).

In Connecticut, quantitative studies indicate that even apparently benign human recreation can have catastrophic effects on wood turtle populations. Two populations were studied for 20 years (1974-1993) and 133 different turtles were captured. There was no human recreation allowed at the site in the first half of the study, and hiking and fishing were allowed in the second half of the study. When the area was opened to these activities, both turtle populations declined steadily to zero in 10 years. There was no discernable change in the habitat quality over the course of the 20 years, and small-scale collection for pets by hikers and anglers was proposed as the cause of the extirpation of these populations (Garber and Burger, 1993).

In West Virginia, the wood turtle is confined to the "eastern panhandle", but rapid

urbanization of this region will likely extirpate the species there in the near future (B. Sargent, pers. comm. 1995).

### HABITAT

The wood turtle is associated with moving water, such as streams, creeks, and rivers, throughout its range (Harding *et al.*, 1991) but is, nevertheless, one of the most terrestrial species in the family Emydidae (Foscarini and Brooks, 1993). The species is always found in close association with water, but the degree of association varies geographically (Ernst *et al.*, 1994). There is some evidence that wood turtles from the western part of their range (ie. Wisconsin and Michigan) may be more aquatic than populations in the east (ie. New Jersey) (Pentecost and Vogt, 1976; Harding and Bloomer, 1979; Vogt, 1981; Strang, 1983; Harding, 1991a; Harding, 1991b; Ernst *et al.*, 1994). Drainages with hard sand or gravel bottoms are preferred over those with soft clay or muck bottoms. Moderate current and clear streams are also preferred (Ernst *et al.*, 1994). Wood turtles can be found in forests, but prefer riparian areas with open canopy (Ernst *et al.*, 1994).

Various studies across the species' North American range have indicated that the wood turtle shows great variability in the habitats it uses and selects (Harding and Bloomer, 1979; Farrell and Graham, 1991; Quinn and Tate, 1991; Ross *et al.*, 1991; Kaufmann, 1992; Foscarini and Brooks, 1993). In addition to streams, wood turtles use other habitats including swamps, bogs, wet meadows, upland fields and pastures, agricultural croplands such as bean and corn fields, and the matrix of habitats in between (Harding and Bloomer, 1979; Ross *et al.*, 1991; Foscarini and Brooks, 1993). Generally, wood turtles overwinter in water, are in or near water in spring and fall, and take up a largely terrestrial existence during summer (Harding *et al.*, 1991).

Studies have shown that wood turtles select habitats rather than use them randomly

(ie. habitat use is not in proportion to availability) (Kaufmann, 1992; Foscari and Brooks, 1993; Ernst *et al.*, 1994). In central Pennsylvania, wood turtles spent more time in water than in any single terrestrial habitat during the active season (Kaufmann, 1992). In May, turtles spent the most time in alder (*Alnus sp.*) thickets, whereas hemlock (*Tsuga canadensis*) forests were used very little, except in July and August, when mushrooms (a favourite food) were sprouting. Deciduous forests were hardly used at all in central Pennsylvania (Kaufmann, 1992), but in southeastern Pennsylvania and northern Virginia, deciduous woods were used heavily, however, conifer stands and alder thickets were absent from the latter two areas (Ernst *et al.*, 1994).

In Michigan, forested habitat was generally preferred, but wood turtles were typically found where openings in the streamside canopy lead to grass and herbaceous growth. These habitats were used for feeding and basking (Harding, 1991a). The wood turtles of Michigan were rarely found more than 150 m from water and were essentially aquatic throughout the year (Harding *et al.*, 1991).

In Algonquin Park in Ontario, wood turtles generally occupied mixed forest or alder bordering streams or rivers, but an array of forest habitat types were used. In summer, 40% of the observations on land were within 10 m of water, and 73% were within 30 m. Only 14% of the total observations were actually in water (Quinn and Tate, 1991). Wood turtles in the Algonquin area had specific habitat requirements that involve access to fast flowing, sandy or rocky streams, and sandy soil terrestrial habitat, especially riparian habitat with alder and deciduous forest (Brooks, 1990).

In southern Ontario, wood turtles utilized a variety of habitats and ranged up to 300

m from waterways. Aquatic areas were preferred overall by all turtles. At one creek, open meadows were the second choice, whereas, at the other creek, conifer stands were preferred. Two female turtles spent 90-94% of their July and August observations in an agricultural field (Foscarini and Brooks, 1993).

Male wood turtles generally spend more time in creeks and streams than females (Kaufmann, 1992; Foscarini and Brooks, 1993; Ernst *et al.*, 1994), possibly because they are searching for mates. Females spend more time in habitats dominated by grasses, sedges, and forbs (Kaufmann, 1992). Some females in southern Ontario showed a preference for gravel pits and open meadows over forest and cropland (Foscarini and Brooks, 1993).

## GENERAL BIOLOGY

### **FOOD AND FEEDING**

Wood turtle adults are omnivorous, and hatchlings and juveniles may be more carnivorous (Harding, 1991a). Terrestrial food items include berries (*Fragaria*, *Rubus*, *Vaccinium*), tender leaves of shrubs (*Salix*, *Alnus*), flowers (*Viola*), fiddleheads, mushrooms, and invertebrates such as earthworms (*Lumbricus*), slugs, and insects (Brooks, 1990; C. Shilton, pers. comm., 1990). Aquatic food items include (dead) fish, snails, tadpoles, insect larvae, and algae. Other possible food items include newborn mice, eggs and young of ground-nesting birds, and other turtle eggs (Froom, 1975; Ernst *et al.*, 1994).

In some populations in central Pennsylvania, Michigan, and Ontario, wood turtles have been observed "worm stomping" (Harding and Bloomer, 1979; Kaufmann, 1986, 1989; Rosenberg, 1987; Kaufmann *et al.*, 1989; C. Shilton, pers. comm., 1989; Brooks, 1990). The behaviour involves stomping on the ground with the forelimbs, and occasionally banging the plastron on the ground. Presumably the stomping and banging mimics the vibrations caused by rain, and thereby induces the worms to surface. Any worm brought to the surface is eaten.

### **GROWTH, LONGEVITY, SEXUAL MATURITY, AND REPRODUCTION**

#### Growth

The growth rate of the wood turtle generally follows the "normal" chelonian trend of rapid juvenile growth, slowing at maturity, and practically halting with advanced age (Harding and Bloomer, 1979). Male and female wood turtles appear to grow at



approximately the same rate until reaching a plastron length of about 160 mm, after which size the males grow faster (Lovich *et al.*, 1990). The development of plastral concavity at sexual maturity in male wood turtles truncates the linear growth of the plastron such that linear carapace length increases more rapidly than plastral length. As a result, sexual dimorphism is only significant when carapace length is used as the measure of body size (Lovich *et al.*, 1990). Wood turtles may demonstrate indeterminate growth since some specimens from Pennsylvania and Virginia continued to grow after maturity (Lovich *et al.*, 1990). In Michigan, however, growth in old adults essentially ceased as some marked individuals showed virtually no growth over intervals of 6 or more years (Harding, 1991a). In New Jersey, Farrell and Graham (1991) observed a steady decrease in plastral growth from 84% in the first year to 2.3% in the sixth year, but in the eighth and ninth years the rate of plastral growth increased (9.2% and 10.3% respectively).

### Longevity

Little is known about longevity of wood turtles as there is no reliable way to determine age, especially after the animals reach sexual maturity. However, wild animals are known to live over 30 years (Ross *et al.*, 1991) and captives live to 58 years (Oliver, 1955). Given the evidence of great longevity in similar sized species (e.g. *Emydoidea blandingii*, circa 70-90 years, Congdon *et al.*, 1993), and related species (*Clemmys guttata*, estimated maximum age 70 years, Litzgus, unpubl. data), it seems likely that wood turtles have the potential to live over 50 years in the wild.

### Sexual Maturity

In turtles, age and size at maturity probably vary both among individuals in a population and among populations (Harding and Bloomer, 1979; Galbraith *et al.*, 1989; Lovich *et al.*, 1990; Brooks *et al.*, 1992). Table 1 summarizes available data on the size and age at maturity of wood turtle populations across their range in North America. In general, wood turtles become sexually mature between 14 to 18 years of age, females mature between 158 mm and 185 mm carapace length, and males mature between 192 mm and 200 mm carapace length as determined by courtship behaviour (Ernst *et al.*, 1994). Northern wood turtle populations tend to be larger and older at maturity than southern populations (Brooks *et al.*, 1992). This significant delay in maturity is likely related to a shorter growing season in the north, and possibly also to a selective advantage for greater size resulting in a potential reduction in the risk of predation and/or overwintering mortality, or in greater fecundity, or the ability to produce larger eggs (Brooks *et al.*, 1992).

**Table 1: Comparison of size (carapace length) and age at sexual maturity among locations of wood turtle populations. (NA = data not available)**

POP <sup>N</sup>	CL ♀	AGE♀	CL ♂	AGE♂	SOURCE
North-central Ontario	187 mm	18	205 mm	17	Brooks <i>et al.</i> , 1992
Michigan	158 mm	12	192 mm	>10	Harding and Bloomer, 1979
Michigan	174 mm	15	169 mm	12	Harding, 1991a
Minnesota	152 mm	NA	152 mm	NA	Breckenridge, 1944
Southern Ontario	158 mm	10	173 mm	12	Foscarini and Brooks, 1993
Wisconsin	171 mm	14	150 mm	20	Ross <i>et al.</i> , 1991
Connecticut	170 mm	14	170 mm	14	Garber, 1988
New Jersey	158 mm	14	161 mm	14	Farrell and Graham, 1991
New Jersey	160 mm	7-8	160 mm	7-8	Harding and Bloomer, 1979

### **Reproduction**

Mating can occur at any time during the active season (April through September), but peaks are evident in the spring (April to June) and fall (September to November), at which time wood turtles are most aquatic (Harding and Bloomer, 1979; Farrell and Graham, 1991; Harding, 1991a; Harding *et al.*, 1991). The earliest reported mating was 26 March in Connecticut (Fisher, 1945). Oldham (1991a) reported the majority of matings in southern Ontario to be in April, whereas Foscarini and Brooks (1993) later reported a peak in mating in May at the same site. However, both studies observed mating throughout the whole active

season. In Michigan, mating peaked in June and September (Harding, 1991a), whereas, in New Jersey, mating peaked in late March and April, and again in October and November (Farrell and Graham, 1991). In Virginia, the greatest numbers of copulating pairs were found in the fall (Ernst and McBreen, 1991). Most courtship occurs in late afternoon (Harding and Bloomer, 1979; Ernst and McBreen, 1991). Mating usually takes place in water (Harding and Bloomer, 1979; Farrell and Graham, 1991; Harding, 1991a; Harding *et al.*, 1991; Oldham, 1991a), however, rare occurrences of mating on land have been observed (Ernst, 1986; Oldham, 1991a). During courtship the male may bite the female's legs and head (Harding and Bloomer, 1979; Harding, 1991a; Harding *et al.*, 1991; Ernst *et al.*, 1994).

Nesting season lasts from May to early July depending on geographic location (Ernst and McBreen, 1991; Foscarini and Brooks, 1993). In Nova Scotia, nesting occurs in July and may last only one week (Powell, 1967). Nesting usually takes place in the afternoon (Ernst *et al.*, 1994), however, early morning nesting has also been observed (Pallas, 1960; Brooks and Brown, 1991; Farrell and Graham, 1991; Brooks *et al.*, 1992; Foscarini and Brooks, 1993). The nesting process has been described in detail by Pallas (1960) and Harding and Bloomer (1979). Nest site requirements in Michigan include ample exposure to direct sunlight, well-drained but moist soil or sand substrate not subject to flooding, and a substrate free of rocks and thick vegetation (Harding and Bloomer, 1979). In north-central Ontario, most wood turtle nests were laid on a sandy river embankment (Brooks, 1990). Wood turtles were observed nesting in sandy areas of man-made gravel pits and in agricultural fields in southern Ontario (Foscarini and Brooks, 1993).

Female wood turtles do not lay more than one clutch of eggs per year (Powell, 1967;

Farrell and Graham, 1991; Harding, 1991a; Brooks *et al.*, 1992), but individual females may not nest every year (Ross *et al.*, 1991; Foscarini and Brooks, 1993). Wood turtle clutch size ranges from 4 to 18 eggs (Ernst *et al.*, 1994). These eggs are elliptical, white, thin-shelled, and have the following average dimensions: length, 27.0-49.0 mm; width, 19.5-26.3 mm; mass, 6.3-14.9 g (Combs, 1971; Harding and Bloomer, 1979; Ernst and McBreen, 1991; Farrell and Graham, 1991; Brooks *et al.*, 1992; Foscarini and Brooks, 1993). Table 2 gives the variation in clutch sizes and measured clutch variables found across the wood turtle's range.

Incubation period varies as a function of temperature. In the laboratory, hatching time ranges from 67 days at 25-25.5°C to about 40 days at temperatures above 30°C (Ewert, 1979). Incubation periods for eggs collected in Michigan and hatched in the laboratory at room temperature averaged 58.9 days (Harding and Bloomer, 1979). In New Jersey, two clutches of wood turtle eggs incubated naturally in an outdoor pen hatched in 70-71 days, and incubation lasted from 58 to 69 days in the laboratory (Farrell and Graham, 1991). Wood turtles do not have temperature-dependent sex determination (Bull *et al.*, 1985; Ewert and Nelson, 1991). To date, there is no evidence that hatchling wood turtles over-winter in the nest (Harding and Bloomer, 1979; Harding, 1991a; Ernst *et al.*, 1994).

**Table 2:** Comparison of clutch variables among locations of wood turtle populations. (NA = data not available) CS=clutch size, MEM=mean egg mass, MEL=mean egg length, MEW=mean egg width.

POP'N	CS	MEM	MEL	MEW	SOURCE
Quebec	11-12	NA	41.0 mm	26.0 mm	Matte, 1990
North-central Ontario	8.76 (3-13)	10.83 g	35.1 mm	23.0 mm	Brooks <i>et al.</i> , 1992
Southern Ontario	8.0 (5-12)	12.7 g	36.0 mm	23.0 mm	Foscarini and Brooks, 1993
Michigan	10.36 (5-18)	NA	34.0 mm	23.5 mm	Harding and Bloomer, 1979
Wisconsin	11 (8-17)	NA	NA	NA	Ross <i>et al.</i> , 1991
New Jersey	8.5 (5-11)	11.7 g	36.2 mm	23.3 mm	Farrell and Graham, 1991

## PARASITES AND DEVELOPMENTAL ABNORMALITIES

The known parasites of wood turtles include trematodes, an acanthocephalan, and the flesh fly (*Sarcophaga cistudinis*) (Ernst and Barbour, 1972). The most commonly occurring ectoparasite on the wood turtle is the leech, *Placobdella parasitica*, but it is unclear whether this parasite has a significant impact on the host's well-being (Harding, 1991a). In New Jersey, almost 90% of the 455 wood turtles captured during March, April, October, and November were infested with leeches (Farrell and Graham, 1991). As many as 39 adult leeches were discovered on a single adult male wood turtle (Farrell and Graham, 1991). These leeches usually occurred on the soft tissues in the leg and neck pouches, but also were found on the shell (Farrell and Graham, 1991; Harding, 1991a). In southern Ontario, leeches

were found on turtles throughout the field season, but were seen most often in April and May, when 62% of the wood turtles had one or more leeches (Foscarini and Brooks, 1993). Leeches were present on wood turtles during the entire active season in northern Michigan (Harding and Bloomer, 1979). However, in New York and New Jersey, Koffler *et al.* (1978) reported that leech infestations were highest on wood turtles in the fall and spring. In Wisconsin, masses of young leeches were found on most of the turtles in April, immediately after emergence from hibernation, but became less prevalent later in the season (Brewster and Brewster, 1986). The reduction in ectoparasite loads corresponded with movement of turtles away from the river for nesting (June) and dispersal into surrounding wooded areas (Brewster and Brewster, 1986). Increased terrestrial activity in wood turtles in the spring reduced leech infestations through desiccation (Koffler, *et al.*, 1978). In southern Ontario, caddisfly larvae (Order Trichoptera) used wood turtle carapaces as a lodging in April and early May; sometimes there would be as many as 10 larvae on a single turtle shell (Foscarini and Brooks, 1993).

Congenital shell abnormalities (those not attributable to previous injury) were frequently reported for Michigan wood turtles (Harding and Bloomer, 1979). These variations from the normal carapacial scute pattern were usually in the form of divided vertebrals or deviations in the number of marginals. One juvenile wood turtle in Michigan exhibited symptoms of mild kyphosis ("humpback"). It has been hypothesized that this condition may be a result of yolk retraction which causes abnormal fusion of the carapace plates (Williams, 1957).

## ACTIVITY

The wood turtle is generally diurnal, however, mating and nesting behaviour can extend into the night (Harding and Bloomer, 1979; Harding *et al.*, 1991; Ernst *et al.*, 1994). During the night, wood turtles rest in sheltered areas of creeks, or on land in shallow forms of soil, grass, leaves, and brush (Harding and Bloomer, 1979; Ernst, 1986; Farrell and Graham, 1991; Kaufmann, 1992). During the day, wood turtles are usually found basking. Most basking occurs in late morning and late afternoon on sunny days (Harding and Bloomer, 1979; Ernst, 1986; Farrell and Graham, 1991). Preferred basking sites include emergent logs in stream channels, grassy, sandy, or muddy stream banks, and woodland openings or agricultural fields with low vegetation cover (Harding *et al.*, 1991; Ernst *et al.*, 1994; Foscarini and Brooks, 1993; Litzgus, pers. obs., 1994). When air temperatures increase at mid-day, wood turtles may aestivate in shaded forms or mud puddles, or they may return to the water (Harding and Bloomer, 1979; Harding *et al.*, 1991; Foscarini, pers. comm., 1993).

Wood turtles are active at air temperatures as low as 3°C and at water temperatures as low as 6°C, but they do not start to feed until water temperatures reach approximately 15°C (Ernst, 1986). Basking occurs at air temperatures of at least 14°C (Ernst, 1986). Active Pennsylvania wood turtles had cloacal temperatures of 7.5 to 30.0°C (mean=21.0°C) (Ernst, 1986). Cloacal temperatures of active wood turtles in New Jersey ranged from 3.4 to 31.0°C (mean=16.2°C), and for dormant turtles from 0 to 28.1°C (mean=9.5°C) (Farrell and Graham, 1991).

The annual cycle of wood turtle activity begins in March or April and lasts until



October or November, depending on geographic location and yearly variations in weather. In the spring, wood turtles are generally aquatic and become more terrestrial in summer, but return to streams in the fall (Ernst, 1986; Brooks and Brown, 1991; Quinn and Tate, 1991; Ernst *et al.*, 1994; Foscarini and Brooks, 1993). Wood turtles hibernate underwater, and frequently congregate during winter dormancy (Harding and Bloomer, 1979; Harding *et al.*, 1991; Ernst *et al.*, 1994; Foscarini and Brooks, 1993). They may spend the winter sitting on the bottom of cold streams (Graham and Forsberg, 1991), or they may obscure themselves under overhanging banks, in bottom mud, or in aquatic mammal burrows (Bishop and Schoonmacher, 1921; Harding and Bloomer, 1979; Ernst, 1986; Brooks and Brown, 1991; Foscarini and Brooks, 1993).

#### HOME RANGE AND MOVEMENTS

Home range is commonly defined as the area over which an animal normally travels in pursuit of its routine activities (Jewell, 1966). Wood turtles often remain within rather restricted home ranges (Ernst, 1968; Strang, 1983; Harding *et al.*, 1991; Ross *et al.*, 1991; Ernst *et al.*, 1994). In Michigan, of 47 turtles captured at least twice, 64% were located within 150 m of the original point of capture, and 32% were captured less than 305 m from the starting point (Harding and Bloomer, 1979). One female was recaptured 3 times on or adjacent to the same basking log over a 6-year period in Michigan (Harding and Bloomer, 1979; Harding *et al.*, 1991). Most wood turtle movement occurred along waterways, and observed overland movements never exceeded 150 m (Harding and Bloomer, 1979). Mean distances moved away from streams by wood turtles in southern Ontario ranged from 0.4

m to 112.1 m (Foscarini and Brooks, 1993). In Wisconsin, minimum daily movements by male wood turtles averaged 41.9 m, and females averaged 27.4 m, for the months of June and July (Ross *et al.*, 1991). In Pennsylvania, Strang (1983) reported mean daily movements of 139 m. Individual turtles occasionally move considerable distances; Behler (unpubl. data) noted a marked wood turtle in New York that was found over 2 km from its original capture sight. Two wood turtles from Michigan travelled more than 800 m from their original capture points (Harding and Bloomer, 1979) and one male wood turtle in Algonquin Park moved more than 30 km over a 2-year period (Brooks and Brown, 1991).

Home range sizes for Ontario wood turtle populations have been estimated for three localities. In southern Ontario, home range size estimates using the minimum convex polygon method yielded the following results: 5.02 ha for males, and 6.43 ha for females (Foscarini and Brooks, 1993). There was no significant difference in home range size between the sexes (Foscarini and Brooks, 1993). In Algonquin Park, wood turtle activity areas averaged 24.3 ha and ranged from less than 1 ha to 115 ha using the minimum area method (Quinn and Tate, 1991). At a nearby site, the mean home range size for 12 adult wood turtles was estimated to be 5.41 ha using the minimum convex polygon method in 1990 (Brooks, 1990), and 3.2 ha for seven adults in 1991 (Brooks and Brown, 1991). In both years, males generally occupied larger areas than females, however, this difference in home range size was statistically significant only in 1990 (Brooks, 1990; Brooks and Brown, 1991). Wood turtles also demonstrated home range fidelity between consecutive years (Brooks and Brown, 1991; Quinn and Tate, 1991). As well, thread trails indicated that wood turtles were not usually moving in straight lines between destinations, but were exploring local areas

thoroughly, presumably foraging for food (Brooks, 1990). Overall, these data suggest strong individual differences in size of home range even in apparently similar habitat and that these ranges are consistent in both size and location from year to year. As well, reciprocally translocated wood turtles tend to occupy the same range as the turtle they replaced, when the translocation is at a great enough distance to prevent homing (T. Herman, pers. comm., 1995).

Home range sizes have also been estimated for some wood turtle populations in the United States. In Pennsylvania, mean home range size was 447 m, which reflected the elongate nature of the turtles' range due to the species' propensity to follow stream courses (Strang, 1983). In central Pennsylvania, mean home range size was 4.32 ha using the quadrat summation method (Kaufmann, 1995). In Wisconsin, wood turtle home range size was estimated at 0.25 ha for three males, and at 0.54 ha for four females (Ross *et al.*, 1991).

Wood turtles are known for their homing abilities which have been described as "intermediate-range" homing (Carroll and Ehrenfeld, 1978). Wood turtles displaced up to 2.0 km from their original capture site returned to that site in a high percentage of trials, but homing success dropped sharply in turtles displaced more than 2.0 km (Carroll and Ehrenfeld, 1978). A similar degree of homing accuracy in a smaller sample of turtles from Michigan and New Jersey was also observed (Harding and Bloomer, 1979).

### LIMITING FACTORS

The Canadian distribution of wood turtles is probably limited by two major factors; temperature (Bleakney, 1958; Bobyn and Brooks, 1994) and the species' habitat requirements, particularly clear, sandy or gravel-bottomed streams. In the United States, wood turtle populations are declining largely because of human activities, especially habitat destruction, fragmentation of habitats (e.g. road building), and collection of turtles for the pet trade.

The petition presented to the United States Fish and Wildlife Service (FWS) by RESTORE to list the wood turtle as a "threatened" species summarized the main causes for the decline of the species (Garber *et al.*, 1994):

1. over-collection for the pet trade, biological supply companies, and export;
2. habitat destruction and fragmentation from logging and development;
3. significant predation by "edge species" such as raccoons, skunks, cats, and dogs, that thrive in fragmented habitats;
4. toxic pollution (including dioxins, mercury, and pesticides), and siltation from industry, agriculture, and municipalities;
5. the inadequate authority of federal and state agencies to enforce compliance with laws, including collection permits;
6. inadequate state and federal funding for habitat protection programs; and
7. a lack of public education and involvement in wood turtle protection programs.

In Canada, declines are probably caused by similar factors although there is no unequivocal evidence that there has been recent, significant commercial collection. There is some concern that there has been commercial collection in Quebec (J. Bonin, pers. comm., 1993), and sale of wood turtles in Montreal-area pet stores (K. Storey, pers. comm., 1993). Juvenile wood turtles were observed in a London, Ontario pet store in fall, 1992 (R. Saumure, pers. comm., 1995) and in January, 1995 (M. Fletcher, pers. comm., 1995). These

juveniles were apparently obtained from Montreal Pet Farm, however, it is not known how this supplier obtained the turtles, or whether they were captive reared. Under Ontario's Fish and Game Act, it is illegal to sell wood turtles in that province. We must exercise caution when publishing known locations of relatively stable Canadian wood turtle populations as these populations may become the targets for commercial collectors as American populations become depleted.

Eastern populations of wood turtles were once harvested for human consumption, however, this practice appears to no longer be common (Babcock, 1919; Harding and Bloomer, 1979; Lovisek, 1982; Harding, 1991a; Harding *et al.*, 1991). The listing of the wood turtle as a threatened species in Wisconsin has been attributed to collection for biological supply companies and habitat loss (Vogt, 1981; Harding *et al.*, 1991).

Habitat loss and fragmentation have significantly reduced wood turtle populations, particularly in urbanized areas (Harding *et al.*, 1991). In southwestern Connecticut and central Massachusetts, wood turtle decline has been attributed to habitat fragmentation and low recruitment so that these populations are comprised almost totally of older adults and are therefore functionally extinct (Klemens, 1990). Behler (pers. comm., 1995) contends that the precipitous decline of wood turtles in New York since the 1970's is a result of a population explosion of humans. New subdivisions resulted in more roads through pristine habitat leading to the loss of wood turtles and box turtles. The improvement of roads has resulted in more commuters and higher speeds, and therefore an increase in road mortality of wood turtles. Mortality of wood turtles by automobiles is usually accidental, but some drivers do intentionally hit wood turtles (Harding and Bloomer, 1979; L. Berezin, G.P.

Brown, E.G. Nancekivell, N. Quinn, pers. comm.). Damming and channelization of streams has destroyed wood turtle habitat, and certain fish management techniques are also deleterious (Harding *et al.*, 1991). Habitat degradation may be as critical as habitat loss for the wood turtle. The species may be pollution-intolerant, since marked decreases in numbers were observed in parts of New Jersey subjected to heavy spraying of pesticides (Harding and Bloomer, 1979).

Shooting of basking turtles can also be a significant source of loss in some areas (Harding and Bloomer, 1979; Harding, 1991a; Harding *et al.*, 1991). In Michigan, six wood turtles were shot to death by vandals (Harding, 1991a). Harding and Bloomer (1979) describe a deplorable account of a three-legged female shot while she was nesting.

The most serious present threat is the taking of wood turtles for the commercial pet trade. Some formerly abundant local wood turtle populations have been essentially eliminated by pet trade collectors (Harding, 1991a). In 1988 in Pennsylvania, local townspeople witnessed pickup trucks full of wood turtles (D. Galbraith, pers. comm., 1995). Domestic sale of wood turtles in the United States is common as can be seen from the frequent occurrence of the species on reptile dealer price lists; prices for wood turtles range from \$45 to \$125, and over \$1,000 (U.S. dollars) for a "pair". Ironically, the recent growing concern and protection for wood turtles has resulted in a price increase for the species in the commercial trade. Wood turtles are usually sold "under the table" or through personal contacts and now rarely appear on price lists owing to their increased value (J. Harding, pers. comm., 1995). One of us (R.J.B.) has been approached by a U.S. pet dealer and offered a significant sum for wood turtles, along with explicit advice on how to collect the

entire population. The dealer explained that the turtles would be sold on the international market for a considerable mark-up. A Florida wholesaler was selling wood turtles for \$995 each in April of 1995 (D. Bartlett, pers. comm. to Harding, 1995). Much of the trade in wood turtles is based on illegally collected animals (Harding, 1991a; Klemens, 1991) taken from states where they are protected and then reported as originating from states where they are unprotected (Klemens, 1991). The price lists indicate that the collection of wood turtles from the wild is predictably seasonal since there is an increase in the availability of live specimens in early spring and early summer (Klemens, 1991). Wood turtles are particularly vulnerable to mass collection when they emerge from hibernation, and during nesting, due to their tendency to aggregate at these times. Large numbers of individuals can be collected in a short period of time, especially in narrow streams.

International overseas trade in wood turtles is reportedly growing (Harding *et al.*, 1991; Klemens, 1991). Turtles of the genus *Clemmys* are in considerable demand by European terrarium hobbyists and often appear on price lists in Japan, Germany and other countries (Klemens, 1991). Sources close to the pet trade claim that hundreds to thousands of specimens are sold each year (Harding *et al.*, 1991). From 1986-1990, approximately 300 wood turtles and 600 spotted turtles were legally imported into the United Kingdom (Smart and Bride, 1993), however, the numbers imported illegally are probably far greater.

Collection of wood turtles for personal pets has been reported in Ontario (Lovisek, 1982). This may not seem significant, but even small-scale collection of wood turtles by hikers and anglers in recreational areas has caused populations to decline precipitously. In Connecticut, the total number of wood turtles in two populations declined by almost 100%

in 10 years due solely to incidental taking for pets (Garber and Burger, 1993).

Other than humans, wood turtles have an array of natural enemies that prey on their eggs as well as on juveniles and adults. Populations of these predators often increase in size as a result of human activity. The human population increase in New York (noted above) resulted in an increase in "edge predators". Since the 1940's, Behler (pers. comm., 1995) has noted a 3-fold increase in the number of raccoons which are the dominant predator of wood turtles in his area, along with an increase in the numbers of crows, gulls, and coyotes, which also prey on wood turtles and wood turtles eggs. Predators on hatchlings and juveniles include raccoons, skunks, feral cats and dogs, opossums, various birds, snapping turtles, and large fish (Harding and Bloomer, 1979). Predators can often inflict serious, though not always fatal, injuries on adult wood turtles (Harding et al., 1991). A 15-year study in Michigan revealed that 12.5% of the turtles captured had missing limbs likely caused by raccoons (Harding, 1985; Harding, 1991a). Wood turtles in New England had a high incidence of injuries (Klemens, 1990), as did those in New Jersey (Farrell and Graham, 1991). In north-central Ontario, 45.5% of males had limb injuries, whereas only 9.5% of females had such injuries, however, tail injuries were more common in females (Brooks *et al.*, 1992). In southern Ontario, 72.2% of the wood turtles captured were injured, either having tail or limb injuries, and a total of 14 turtles were known to have died (mortality due to raccoons) through the course of the 2-year study (Foscarini and Brooks, 1993). Wood turtle nest predators include raccoons, foxes, skunks, raven, and coyotes (Harding *et al.*, 1991). Between 80%-100% of wood turtle nests were depredated in Michigan (Harding *et al.*, 1991), 88% in north-central Ontario (Brooks *et al.*, 1992), and 80%-83% of the nests



were destroyed by predators in southwestern Ontario (Foscarini and Brooks, 1993). The impact of these predation rates is unknown (e.g. Congdon *et al.*, 1993; Cunnington and Brooks, 1996), and it is also unclear whether these rates have changed as a result of widespread landscape changes by humans.

### SPECIAL SIGNIFICANCE OF THE SPECIES

The wood turtle appears to be declining over most of its range in North America. Many states and some provinces list the wood turtle as "endangered" or "threatened" (Buech *et al.*, 1993). In Minnesota, New Jersey, and Wisconsin, the species' status is "threatened". New Brunswick is in the process of enlisting the wood turtle as a "Species of Special Concern", and Quebec is working to get the species designated as "threatened" or "vulnerable".

Garber *et al.* (1994) note that "the wood turtle is one of the least protected and most imperiled native turtle species in the United States. Our current knowledge strongly suggests that the wood turtle has been sliding towards extirpation in the United States for many years. The species appears to be prone to extinction from both short-term and long-term environmental fluctuations and habitat alterations." Garber contends that the wood turtle is certainly headed towards extinction if adequate protection and proper management measures are not implemented (Garber *et al.*, 1994).

The wood turtle was listed on Appendix II of the CITES treaty (Convention on the International Trade in Endangered Species) in 1992. CITES provides a mechanism to monitor and control international wildlife trade (Klemens, 1991). Appendix II listing means that export permits are required for all shipments of wood turtles, which thereby provides a mechanism for trade control and wildlife management decisions. Appendix II trade is supposed to be non-detrimental to wild populations (Klemens, 1991).

There are four species in the genus *Clemmys*: the western pond turtle (*C. marmorata*), the bog turtle (*C. muhlenbergii*), and the spotted turtle (*C. guttata*), in addition to the wood

turtle. All four of these species have been noted as declining or have varying degrees of legal status listing throughout their geographic distributions.

The western pond turtle is restricted to isolated populations in the western United States and southern British Columbia (Ernst *et al.*, 1994), and is a candidate for federal listing as "endangered" (Reese *et al.*, 1993). Populations are declining in southern California and over most of the northern range; habitat destruction appears to be the major cause. Presently, only northern California and southern Oregon support extensive populations (Ernst *et al.*, 1994).

The bog turtle is considered nationally endangered in the United States (endangered in states encompassing over 75% of its range) (Ashton, 1976). The bog turtle has long been regarded as one of the rarest turtles in North America (Ernst and Barbour, 1972; Behler, 1974), having a discontinuous range confined to the eastern United States (Ernst *et al.*, 1994). Humans pose the chief threat to the continued survival of the bog turtle. Destruction of required wetland habitats and collection for the pet trade have caused the extinction of some populations and severely reduced others (Ernst *et al.*, 1994). The bog turtle is listed on Appendix I of the CITES treaty (Ernst *et al.*, 1994).

Spotted turtle populations are declining in many areas due to habitat destruction and collection for the pet trade (Lovich and Jaworski, 1988; Lovich, 1989). In Canada, the spotted turtle has a disjunct distribution in Ontario, and there are a few historical records from Quebec, though the species probably no longer occurs in natural populations in Quebec. The spotted turtle is listed as "vulnerable" by COSEWIC and the World Wildlife Fund in Canada (Oldham, 1991b).

The wood turtle is commercially exploited as it is collected for the pet trade, biological supply companies, and for export (Garber *et al.*, 1994). Wood turtles can be bred fairly easily in captivity (Harding *et al.*, 1991). However, as with many turtles with a similar long-lived life history, removal of adults from the wild for breeding programs could potentially reduce population levels drastically, or even drive populations to extirpation because the release of captive-bred hatchlings into the wild will not compensate for the removal of adults for breeding stock due to the naturally high levels of juvenile mortality (Brooks *et al.*, 1988, 1991, 1992; Harding *et al.*, 1991; Congdon *et al.*, 1993; Cunningham and Brooks, 1996). It was estimated that between 50-100 wood turtle hatchlings would have to be released to compensate for the removal of one mature adult wood turtle based on survivorship in a Michigan study (Harding, 1991a). The wood turtle can best be preserved by ensuring that sufficient habitats are set aside and that the animals themselves are left in these habitats (Harding *et al.*, 1991).

### EVALUATION AND PROPOSED STATUS

The wood turtle is declining in the United States due to commercial collection for the pet trade and habitat loss. Commercial collectors have not noticeably collected wood turtles from Canadian wood turtle populations as yet. However, due to the potential future depletion of American stocks of wood turtles, collectors may come to Canada for illegal collection, if the overseas and domestic demands remain. Wood turtles make attractive pets due to their docile nature and terrestrial tendencies. This, combined with their tendency to inhabit narrow streams and to aggregate in spring and during nesting, makes them easy prey for unscrupulous collectors. Encroaching agricultural and urban development leading to habitat loss and fragmentation, and an increase in "edge predators" in areas of Canada where wood turtles occur, also pose a threat to their continued survival in this country. The species can sustain small-scale habitat alteration, however, the turtles themselves must be left alone. Recreational use of streams (for fishing and canoeing) where wood turtles occur may also be a threat to their continuation if turtles are taken for pets.

The wood turtle occurs over a wide range in Canada in four provinces, but over most of this range it occurs in small numbers, in restricted habitat, with discontinuous distribution. In those areas in which the species' abundance and distribution have been investigated it appears to be declining (Nova Scotia, Quebec), even though more dispersed than previously thought. The species' status in New Brunswick is basically unknown.

The two major Ontario populations are the only populations that have been studied relatively extensively and they have remained stable or declined slightly over the past few years. The north-central population exists over a fairly large area which is partially protected

from human development. The southern Ontario population, however, is in an area dominated by agriculture with a very narrow buffer zone of wooded area around the streams in which the turtles occur. As a result the turtles use the open fields for basking and feeding, and a man-made gravel pit for nesting. These behaviours subject the turtles to mortality from farm equipment and automobiles. Perhaps of greater concern is the fact that this population is mostly restricted to two small tributary streams and is, therefore, extremely vulnerable to collectors or other disasters.

The common factors of concern for this species are its very restricted habitat and the ease with which most of a local population can be collected or otherwise impacted by human activity. This threat increases as U.S. populations decline or are extirpated by similar factors and of course this increases the value of the animals to collectors.

The Natural Heritage Information Centre has listed the wood turtle as a "rare to uncommon" species in Ontario, indicating that the species has only been reported from 20 to 100 occurrences, and that the species may be susceptible to large-scale disturbances (Oldham, 1994). The OMNR has listed the wood turtle as "vulnerable": an indigenous species that is represented by small but relatively stable populations, and/or that occurs sporadically, or in a very restricted area, or at the fringe of its range, and that should be monitored periodically for evidence of possible decline (Oldham, 1994).

We recommend that the wood turtle be given the status "vulnerable" (according to the COSEWIC criteria) in Canada because the species occurs sporadically in small numbers, in specific habitat. Its long-lived life history makes the species vulnerable to any disturbance that increases mortality rate of adults and this life history and the tendency of this species

to be "tame" and to congregate for hibernation and nesting make it exceptionally vulnerable to collectors and the pet trade. These factors could cause sudden and dramatic declines in the Canadian populations of the wood turtles as are currently occurring in U.S. populations of this species.

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### MANAGEMENT RECOMMENDATIONS

We recommend that all provinces and states with wood turtle populations immediately ban their commercial collection, if such legislation is not already in place. If the species is protected in all of the areas in which it occurs, then there are no "loop holes" for pet trade collectors. For example, if all but one province or state has a ban on collecting, then illegal collection can still occur throughout the species' range, but collectors can claim that their specimens were legally collected from that location where there is no protection.

We recommend that studies of Canadian wood turtle populations continue in the case of the north-central and southern Ontario populations, and that study be initiated in other areas. There have been no formal surveys of wood turtles in New Brunswick so the general status of the species is unknown in that province. Studies are currently underway in Nova Scotia and Quebec, and these should also continue and be expanded so that general population statuses can be identified in these areas.

Wood turtles can sustain low levels of riparian development and use, such as non-intensive agriculture, grazing, timber harvest, low-impact recreation (e.g. fishing and canoeing), and even low-density residential development (Harding, 1991a). We recommend the preservation of wood turtle habitat in Canada as it is now, but if human development is going to take place, we stress the need to maintain water quality, control sedimentation, restrict pesticide use, and the establishment of stream-side buffer zones to allow feeding, basking, and nesting areas for wood turtles to remain intact. Road building near known wood turtle habitats should be minimized, and roads should not be built parallel to inhabited streams (Harding *et al.*, 1991), since females may attempt to cross them when

searching for nest sites.

Nest protection in areas where wood turtles are known to occur may be beneficial, however, protection of adults is more important. Head-starting programs are widely used, especially on marine sea turtles, though there has never been a documented recapture of a head-started hatchling. Head-starting hatchlings until they reach a large enough size to protect them from natural predation would increase their chances of survival in the wild, but there may be deleterious affects on turtle behaviour from such long-term exposure to constant human contact. We therefore do not recommend expensive head-starting programs, but suggest that protection of nests may be beneficial to some wood turtle populations.

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