

SECOND YEAR REPORT: Assessment of the Current Distribution and
Abundance of the Wood turtle (Clemmys
insculpta) in Minnesota and along the St.
Croix National Scenic Waterway in Wisconsin

Michael A. Ewert, Ph.D. 4671 North Old Hwy 37, Bloomington,
Indiana 47401

FOR: The Nature Conservancy, Minnesota Chapter
Minnesota Department of Natural Resources, Nongame Program
University of Wyoming: Dr. Stanley H. Anderson

CONTENTS	page
1. Introduction	1
2. Field Conditions	1
3. Wood Turtles Observed during 1985	4
4. Detail of Wood Turtle Finds at New Sites in Minnesota	6
5. Detail of Wood Turtle Finds at Old Sites in Minnesota	8
6. A Report on Speculative Searches that Failed to Yield Evidence of Wood Turtles at New Localities	11
7. Redefinition of Wood Turtle Habitat	15
8. Grazing Landuse as a Detriment	19
9. Wood Turtle Populations in Minnesota	20
10. Considerations for Refuge Selection	23
11. Wood Turtle Movements and Refuge Boundaries	30
12. Headstarting as a Management Option	30
13. Two-Year Finds of Wood Turtles along the St. Croix National Scenic Waterway	32
14. Assessment of Waterway Reaches	34
15. Synthesis of the Waterway Wood Turtle Data	38
16. Wood Turtles and Waterway Planning	40
LITERATURE CITED	41

Figures 1 - 13

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1. Introduction

The following report gives the results of field work conducted on the wood turtle (Clemmys insculpta) during 1985. This report is to be considered as a companion to the First Year Report and not as a compilation for both years. Much of the first year information is not repeated. Naturally, however, general knowledge and a few details from the first year are incorporated as appropriate.

Sections 3 through 12 emphasize work conducted in Minnesota for the combined purposes of general survey and feasibility survey for establishment of a refuge for wood turtles. Sections 13 through 16 focus on survey of the St. Croix National Scenic Waterway and on the possible relationship of the survey results to recreational development. To facilitate a geographic perspective, Figs. 1A,1B are provided as an index to all subsequent figures that are derived from reproductions of portions of USGS 7½ Minute Quadrangle maps. Fig. 2 shows all river reaches canoed and all respective dates of canoeing during field work along the St. Croix National Scenic Waterway. But bear in mind that several local sites were revisited on foot on dates other than those listed on the figure.

2. Field Conditions

The phenological season was more advanced than normal and about 7-10 days more advanced than in 1984. By the time of my arrival in southern Minnesota on 16 May, the local trees were almost completely leafed out and there was an extensive leafy ground cover. Along the , only green ash trees were conspicuous as less

than half leafed out on 22 May.

The season was fairly dry but periods of brief overcast and light rain were frequent. However, even the coolest periods appeared to be permitting turtle activity. The River and the had water levels running slightly above average. The mainstem was running close to average such that only the highest sandbars were exposed. The rivers located north of the Laurentian Divide in Minnesota had above average flows. All other rivers visited in Minnesota had below average to average low flows during the survey. The low waters provided excellent conditions for inspecting sandbars for turtle tracks. Day-to-day weather conditions and coincident survey locations were as follows:

- 16 May Cool, overcast, intermittent drizzle - hike along the Fork of the River
Warmer, overcast - spot checks along the Fork and along the mainstem of the River between
- 17 May Sunny and cool - hike along Creek
- 18 May Sunny and warm - spot checks along the River;
numerous spot checks along the River:
Branches near , mainstem down to
- 19 May Sunny and warm most of day, thundershowers with hail later on - hike along mainstem of the River and its Fork; spot checks along the River between and
- 20 May Sunny and warm - canoe the River from Area to
- 21 May Sunny - drive to WI
- 22 May Mostly overcast, some sunny periods, cool - canoe the River from Dam to
- 23 May Partly cloudy, mostly sunny, fairly warm - canoe River from to

- 24 May Cool, warming, overcast becomes partly sunny - canoe
- 25 May Overcast, cool with periods of drizzle - canoe
- 26 May Overcast, cool - spot check at canoe St. Croix River from WI and MN Hwy ; bridge to
- 27 May Light overcast to sunny, warming - canoe River from the mouth of the River to
- 28 May Mostly sunny, cool but warming - spot checks along the River, Creek; hike in along the River
- 29 May Hot and sultry - hike in along the lower part of the Fork of the River
- 4 June Cool, mostly overcast, a few sprinkles - spot checks along the River and Creek
- 5 June Mostly sunny, humid, not very warm - spot checks along Creek; canoe the River from
- 6 June Mostly overcast, warming trend - canoe from to ; spot checks along Creek and the River near
- 7 June Shower early in day, then mostly sunny, warming - canoe the River from County ; spot checks at Creek
- 8 June A hot, sultry day - spot checks along Creek and lower River; hike in along lower Creek; canoe the River from Banks to
- 9 June Sunny and fairly warm - hike up Creek and Creek from ; hike along Creek south from ; check out River near at , and above River ,
- 10 June Overcast, sprinkles, fairly cool - canoe the River from ; spot checks along the River
- 11 June Cool, overcast, damp, some drizzle - hike beside the River from

- 12 June Sunny, coolish - Canoe the River from Road; drive to River and
- 13 June Mostly sunny, fairly warm - several spot checks and hiking along the River; spot check at the River and ; spot checks and hiking along the River
- 14 June Overcast, sprinkles, muggy, fairly warm - spot checks/ short hikes along River of the , Creek, River
- 15 June Overcast, drizzle, cool - spot checks along River, River
- 16 June Starts out overcast, some drizzle, then sunny, then overcast and cool - spot checks along the River, River, River
- 17 June Intermittant thundershowers vs. warm and sunny - hike along the River; spot checks along the River
- 18 June Overcast, some light drizzle - canoe the River from above ; spot checks along River from the town of River down river
- 19 June Sunny, warm - at , then in Olmsted County; spot checks along
- 22 June Sunny, fairly warm - spot checks along the River.

3. Wood Turtles Observed during 1985

Table 1 summarizes personal finds of wood turtles and confirmed wood turtle nests during 1985. The total number is about the same as in 1984 but includes seven new finds along the St. Croix Waterway in contrast to just one during 1984. New observations on three adult wood turtles (two along the St. Croix Waterway) were recorded by other people. These observations are reviewed as appropriate. Wood turtles were found at three new locations within Minnesota (Section 4), but two wide area searches failed to yield any evidence of wood turtle

presence (Section 6). The first of these areas includes several rivers located north of the Laurentian Divide and a few rivers in County, Minnesota. Previous speculation about wood turtles living in these areas (First Year Report) appears to lack foundation. The second area without evidence of wood turtles is the River Drainage. More intensive search still may yield wood turtles there, inasmuch as the drainage lies between a small population in north central Iowa and the remainder of the wood turtle range and probably supported wood turtles in the past.

A general summary of the locations of sightings of wood turtles in Minnesota during 1984 and 1985 is given in Fig. 3.

TABLE 1. Personal Finds of Wood Turtles and Their Nests During 1985

River	Males	Females	Juveniles/ Unsexed	Nests
Creek	0	2	0	1
River	0	0	0	3
River	0	1	0	0
Creek	0	0	0	3
River	0	1	0	1 (+5?)
River	2	15	3 ¹	1 (+50?)
River	0	0	1 ²	0
River	0	0	0	1
River	0	4	0	0
River	1	0	0	1 (+1?)
TOTAL	3	23	4	11 (+56?)

¹ juveniles

² unsexed adult

4. Detail of Wood Turtle Finds at New Sites in Minnesota

4a. and (Fig. 4;

Both above and below this site, the River is moving fairly swiftly. There are occasional small islands with sandy edges. Locally, a fairly steep, wooded hillside borders the river on the side. The side consists of wooded floodplain and wetland. The topo map shows an oldfield that I do not recall in association with my find. Because the general landscape is quite average, I had trouble mapping this find precisely. However, it definitely occurred within Section 34 along the more-or-less continuous hillside.

The river appeared to have average to average low water, and the bottom near the find was stony. From the water's edge, a mostly stablized cutbank extends for 6-10 meters above the water. This cutbank is quite stony with extensive herbaceous cover, some brush but no large trees. There also are little exposed areas of sand and gravel. Located about three meters above the water, a confirmed wood turtle nest was in one little sandy area. The nest contained 12 larger-than-average eggs that appeared to have been laid on 25 or 26 May. The immediate area did not look like wood turtle feeding habitat, and my next shore search, which would have been associated with the oldfield across the river, did not yield signs of wood turtles.

4b. River & (Fig. 5; Quadrangle;

A wood turtle was identified from eight 1-2 x 2-5 cm shell fragments that lay along several meters of both shoulders of Hwy

starting about 10 meters west of its bridge over the River. The road kill was not fresh; it probably dates to spring-summer, 1984, possibly to 1983.

It was getting dark when I visited this site, hence, my survey was brief. The River is too small locally to provide pleasant canoeing. The bottom is stony and riffles are numerous. The river flows in a narrow, wooded floodplain with fairly steep sides. At least small grassy areas are present on the eastside uplands.

4c. River along Road (Fig. 6;
Quadrangle;

At the time of my visit, the River appeared to be at normal low water. There were pools and places of modest current where occasional rocks were exposed. Downstream, there were wadable riffles where the water was half a meter deep or less. Probably, most of the river bottom is hard. Locally, the floodplain is very small to generally lacking. Local wetlands are slightly perched relative to the river. The general area is extensively forested with mixed deciduous-coniferous forest, nearly all of which appears to have been cut over, especially within the last 30 years.

Toward evening, I found a single gravid, mid-aged female wood turtle crawling in the narrow dirt road that enters the area. The turtle appeared to be moving from near the river into a very large, recent clearcut area, where machinery had torn up and otherwise exposed the soil.

The road follows the river closely for a little over a mile. Perhaps a third of a mile from the wood turtle find, there is a small, manmade open sandy area adjacent to the road. Two-thirds of a mile

further on, there is an oldfield. Extensive searches in these two areas failed to yield any signs of wood turtles, nor did visits to a couple of small, partly sandy islands in the River.

5. Detail of Wood Turtle Finds at Old Sites in Minnesota

River: The flow was low, possibly lower than average low. All definite wood turtle finds were downstream from (Fig. 7). On a small sandbar that lies partly beneath the bridge over the main channel, I found a nest of 12 eggs (found 22 June, began hatching 4 August). On 4 June, I found a gravid female on the sandbank at . Later, I found 2-4 robbed nests that appeared to be wood turtle nests. Barney Oldfield showed me another wood turtle that he had caught (28 May-1 June) on the old railroad grade near (where some are). Both female wood turtles differed from the ones that I had found during 1984. Barney Oldfield also had caught a male wood turtle between and previous to 1984 (I believe that these turtles are now released.).

Other evidences of wood turtles for 1985 included 1-2 robbed nests near the mouth of Creek, 2-3 robbed nests near the head of the (½ mile up river from), and numerous tracks on sandbars just upriver from Road.

Creek: A very extensive search during excellent weather on 17 May failed to yield any signs of wood turtles. However, on 28 May, I found three intact nests ... one on a sandbar where I had found two robbed nests last year and two nests on another sandbar, close to where I had sighted a wood turtle during 1984. Eggs from each of the three clutches hatched into wood turtles.

Despite the lack of evidence from previous years, the northern map turtle (Graptemys geographica) is present in Creek. An adult female was spotted on a log in a pool located between the two wood turtle nesting sandbars.

Creek: On a sandbar where in 1984 I had found two wood turtles, there was an intact wood turtle nest of 10 eggs on 26 May 1985 (hatching started 11 July). On 7 June, there was a large gravid female wood turtle digging a nest hole in the same sandbar. This turtle looked like one of those observed during the previous year. At the same time, there was a road-killed female wood turtle on next to Creek. I had not previously seen this specimen.

River: On 13 June, I found three fresh wood turtle nests (Hatching started 3-8 August) along the edges of County Road next to its bridge over the River. These nests were located within 200 meters of where I had found adult wood turtles during 1984.

River: I visited the bridge of County soon after midnight on 13 June. A female wood turtle that I recognized as having captured during 1984 was resting on the road shoulder within roughly 3-5 meters of the spot where I had found it in 1984. In an attempt to move it to a safer location, I had taken it to the bridge on the River and had released it near the bridge. Evidently, the specimen, a large female, had homed. The shortest possible route is about $3\frac{1}{2}$ miles; the much longer river route is entirely upstream.

Visits to previous sites of wood turtle finds near the County and County bridges did not yield wood turtles during

1985. Also, an extensive bank search near the County bridge and about $\frac{1}{2}$ mile downstream failed to yield any wood turtles or nests.

River: This year the flow was average to low throughout my visit. Many sandbars were exposed and riffle zones were easily wadable. The wood turtle populations at the sandmine and near the County bridge probably represent portions of one very large population and will be treated as one.

Within a half an hour of my arrival to the area on 13 June, Rick Johnson and I found seven gravid female wood turtles on the second sandbar downstream from the County bridge. Two of these wood turtles were out on the sandbar and appeared to have been digging. The remaining five were partially hidden under brushy vegetation on the high inside of the sandbar. This brush appeared disturbed as if dozens of wood turtles had been crawling back and forth under it. There did not appear to be any completed nests. Rick found a juvenile wood turtle with three growth annuli. This specimen was in riparian brush and herbs about 20 meters back from the sandbar. There were fresh wood turtle tracks along the shoulders of . About seven hours after this visit (i.e., about 7:30 PM), I revisited the sandbar and found eight wood turtles out on the bare sand and gravel. A ninth specimen appeared from the river while I was there. The conditions of the shells of these specimens suggested a wide range in ages from recently matured to very old with all growth annuli worn away. All specimens appeared to be healthy.

I visited the sandbar for a third time on the afternoon of 17 June and found two female wood turtles digging in the bare gravel, one intact nest of 15 eggs, and five robbed nests with eggshells

strewn about.

At the , nesting had preceded that on the sandbar. On 13 June, I found 51 robbed nests (41 with Rick Johnson, 10 later) that appeared to vary from one to three or more days old. Perhaps, 10 nests belonged to painted and snapping turtles; the rest, very likely were wood turtle nests. We could not find any intact nests. Later on 13 June, I found an old gravid female wood turtle in pre-nesting exploration. Late morning on 17 June, I found a young gravid female feeding on strawberries near the main nesting area. If additional nesting had occurred in the area since 13 June, it it was not at all obvious.

On 17 June, I searched the banks of the River for about $\frac{1}{2}$ mile downstream from the (Fig. 8, into SE $\frac{1}{4}$ Sec.

). I found one good sandbar and another excellent one. On or near the latter sandbar, there were three adult female wood turtles (one gravid, two spent), one very large old male, one young male, and two robbed nests. A gravelly portion of the sandbar contained over a dozen trial nest holes. Two additional wood turtles, juveniles with seven growth annuli each, were found in open alder brush-herbaceous flats a few meters from the River.

6. A Report on Speculative Searches that Failed to Yield Evidence of Wood Turtles at New Localities

These searches consisted of numerous spot checks and local searches about local river access points, a few riverside hikes, and one canoe trip. The exact locations of these searches is available on county road maps on deposit with the Nongame Program.

6a. Searches to the North and Northeast of the Known Range

The Big Fork River was visited east of Effie, on the way to Big Falls, at Big Falls, and at several points between Lindford and State Hwy 11. Beneath the swiftest waters, the river bottom is rocky. Elsewhere, the bottom appears to be of clay and very fine silt. The swift sections are few and the relatively slack waters are long. Sandy areas that wood turtles often seem to prefer are very small to lacking. I found signs of snapping turtles and painted turtles.

The Sturgeon River (of the Big Fork) near the Koochiching County Hwy 30 bridge appears in general aspect to be suitable for wood turtles - moderate current, hard bottom, mixed wood shoreline. However, a sandy shoreline is lacking; rather, exposed banks show fine to coarse gravel embedded in clay.

The Bear River is sluggish and clayey.

The Little Fork River was visited near Cook, Linden Grove, Little Fork, and at several points between Little Fork and State Hwy 11. In most places, the current is slow and the banks appear to be clayey. There are a few stony rapids.

The Rat Root River is sluggish with a bottom of clay and muck. I found snapping turtles and painted turtles near Rat Root Lake.

I visited the Pike River at six locations between Vermillion Lake Township and Pike Township. Much of the river appears to be ponded, but the reach near State Hwy 135 is swift with sand and gravel. There were signs only of snapping turtles and painted turtles.

The uppermost reaches of the Embarrass River are located over a low divide just three miles from the Pike River. The short distance between the two rivers suggests superficially a gateway for wood turtles

to cross the Laurentian Divide. However, I found that the Embarrass River in this area is a low gradient stream with a muck bottom, which wood turtles seem to avoid. A large wild rice plantation presently lies a little downstream from the town of Embarrass.

The Stony River appears to consist of long slack water reaches punctuated by fairly brief boulderbed rapids. This stream form is not wood turtle habitat. I found snapping turtle nests and a painted turtle.

I visited the Baptism River near each of two bridges. The gradient appears to be too steep for wood turtles; pools are absent. Time did not permit hiking into an upstream section where topo sheets suggest a lower gradient.

6b. Searches in Southeastern Minnesota

An extensive search was made along the South Fork of the Root River. This stream is silty and clouded from soil erosion. Much of the bottom is hard and there are small sandbars. However, most of the river banks are grazed and the sandbars are trampled. Where rowcropping replaces grazing, tilling occurs almost to the stream side leaving just a narrow strip of border vegetation. I found only a couple of places where neither grazing nor rowcropping had occurred recently. I found only spiny softshell turtles.

Time did not permit more than a casual search of either the mainstem of the Root River or its major branches. I had to stay where roads came fairly close to these rivers, and there are a few relatively remote stretches. Much of the river bottoms may be suitably hard, but a heavy silt load probably settles out in the pools rendering their bottoms soft during low flows. There is so much silt and sand near Houston that the entire bottom appears to be

unstable and lasting pools cannot form. Grazing and rowcropping are common landuses throughout the region. State extends along the valley of the mainstem and often approaches the river closely. The apparantly heavy road traffic would be expected to limit normal wood turtle movements and may have decimated former populations. I did see sandbars suitable for nesting. Barney Oldfield (personal communication) said that forested shorelines were extensive as viewed during a canoe trip from . Also, wood turtles may be present in , although the only documentation is unofficial and vague.

Superficially, the River and its appear to be suitable as wood turtle habitat. Sandbars suitable for nesting are numerous and much of the stream bottom is hard. Below County , the shoreline growth of reed canary grass may be prohibitively dense and continuous, but near , suitable floodplain forest is present and extends along the . I found numerous evidences of spiny softshell turtles.

I canoed the mainstem of the River from . Nearly the entire shoreline is grazed, and sandbars, while numerous, are severely trampled. On one of two sandbars adjacent to ungrazed woods, a set of turtle tracks was present that may have been wood turtle tracks, although northern map turtle tracks is another possibility.

At on the South Branch of the of the River, Craig Badger showed me photos of wood turtles that he had found in and near the park during previous years. He felt that the local population is declining. Visitor use of the park is increasing. My brief personal search of the area yielded one possible set of wood

turtle tracks. Wood turtles are not abundant in the area, although suitable habitat exists outside the park. Rowcropping or grazing landuse occupies most of the bottomland.

6c. Searches in County

I hiked up Creek from where it enters County. Just above the Creek, the stream forms of both Creek and Creek appear excellent for wood turtle habitation - a hard, sandy bottom, good pools, numerous sandbars. However, the entire area is heavily grazed and the natural herbaceous ground cover is severely altered. In Sec. 11, grazing ceases but Creek becomes stong and lacks sandbars. I found spiny softshell turtles and a snapping turtle nest.

To the north, I hiked down Creek from County. The stream bottom varies from stony to muck. About 3/4 of the shoreline is grazed; 1/4 is currently ungrazed woods. I saw only painted turtles.

A canoe trip along the River from County to County passed through some seemingly excellent wood turtle habitat - hard bottom, sandbars, richly wooded shoreline - near the mouth of the River. However, only spiny softshell turtles and snapping turtle nests were seen.

7. Redefinition of Wood Turtle Habitat

New locations of wood turtle finds have provided departures from preconceived perceptions of wood turtle habitat. Also, commonalities are appearing in seemingly suitable unoccupied habitat to serve as bases for explaining why such habitat is unoccupied. At present, the following three components seem best to define wood turtle habitat. Each can be presented with a breadth of definition.

Hard-bottomed River: Without exception, rivers or portions of

rivers in close proximity to wood turtle finds have hard bottoms. The bottom may predominate in sand, gravel, rock slabs, or boulders; it must be hard, with never more than an intermittent thin coating of fine silt. Muck bottoms are always avoided; hence, wood turtles do not live in lakes, in backwaters, or slow reaches with emergent aquatic vegetation. Clay bottoms seem also to be avoided. I have never found wood turtles where erosion is so severe as to choke a river with sand, as appears to be occurring along the lower Root River, and to a lesser extent along the lower Whitewater River and the lower Zumbro River. Exclusively sandy bottom reaches (parts of the St. Louis River, others in Michigan) seem to be frequented when the general level of suspended solids is very low.

Inasmuch as a swift current scours the bottom, wood turtle rivers tend to have swift currents. Water quality may be less important; hence, "black water," clear water, and "muddy water" all are frequented on occasion. The last category would appear to be the least compatible, but characterizes currently prevailing conditions along the Cannon River and much of the Zumbro system. It seems to be tolerated because much of the river bottom remains free of lasting deposition. As for pH, wood turtles appear to be persisting in the coal mining regions of western Pennsylvania, where acid mine drainage tends to be a problem. Conversely, wood turtles do not appear to occupy karst country. High pH including that from agricultural runoff could be a problem.

From the perspective of wood turtle morphology and behavior, the hard bottom requirement finds logical support. The wood turtle's shell is massively thick and heavy comprising 38-45 % of the live weight; as compared to 27-33 % for most aquatic turtles (personal

observations). Hence, wood turtles have low bouyancy and tend to move through water by lumbering along the bottom. Only following maximum inhalation do they float, and even then, their swimming is rather clumsy.

Lastly, silt and muck may interfere with wood turtle hibernation sites, although definite proof is lacking. At latitudes occupied by wood turtles, some current is necessary to keep shallow waters from freezing to the bottom during winter.

Partially Shaded Rich Hydro-mesic Herbaceous Vegetation: Wood turtles feed extensively on plants including berries, violate leaves (Strang, 1983), and Virginia creeper leaves (personal observation). A richly diverse ground cover of dicotyledonous species seems to be favored. These plants are common on floodplains and low ground that does not flood every year and that floods only briefly and usually only shallowly. The ground tends to be firm locally, although soft areas commonly occur nearby. Wood turtles do not seem to require floodplain forest as I had once believed, inasmuch as two of the recent finds along the River occurred where floodplain forest is scarce. The local forest near these finds does have a rich herbaceous layer and there are numerous small hillside springs.

Whereas wood turtle habitat is extensively wooded, wood turtles seem never to linger in deeply shaded parts of the woods. Hence, wood turtles are forest edge animals that are most commonly encountered in little openings in the forest, or at least where breaks in the forest canopy will permit sunlight to reach the ground. Wood turtles may reside in small-sized patches of ferns, sedges, or reed canary grass, but I have never found them deep within large patches. Wood turtles can often be found on damp days in upland grasses where these grasses cover high river banks. However, movements into large fields

seem never to occur. Also, as trees are removed and a savanna-like dispersion of the remaining trees is approached, in the Western Great Lakes Area, at least, wood turtles cease to be present. Thus, the exact function of the forest remains unclear, as does the minimally tolerable mix of forest to open areas. I emphasize this issue because when searching for wood turtles, one looks for them in open areas out from under the forest canopy. However, the forest canopy is always just a short distance away.

For unknown reasons, woodland grazing of livestock appears to eliminate wood turtles (Section 8). Certainly, the character of the woods changes. Brush disappears and weeds and grass become more common. Near rivers and streams, the ground beneath the thickest areas of canopy often becomes barren as groups of cattle seek shade there and repeatedly trample the ground. Generally, the woods becomes increasingly open during periods of active grazing and choked with weeds when the cattle are absent for extended periods. In the Western Great Lakes Region, I have never been able to find wood turtles in actively or recently grazed areas. In the eastern US (e.g., Connecticut, Pennsylvania), wood turtles seem to tolerate light grazing at least (personal observations).

An Abundance of Sandy Substrate: Nearly all wood turtle finds have been in regions where sand or sandy gravel is abundant. Sand or gravelly sand serves as nesting substrate, which may be present as sandbars, sandy natural cutbanks, riverside borrow pits, railroad or road embankments, or other manmade features. Nesting sites do not always occur within view of rivers, but may always be within a few hundred meters of them. Even then, a wood turtle may have moved along a small tributary creek during its approach to its

nesting site. In Minnesota, Oxbow County Park (Olmsted Co.) may be the least sandy area where wood turtles are known. However, small sandbars are present. Alternatively, natural sandbanks and other elements of wood turtle habitat are present along the lower Namekagon River and yet wood turtles appear to be absent (Section 14e).

8. Grazing Landuse as a Detriment

Evidence is growing that wood turtles disappear from lands where grazing becomes a landuse. Such a hypothesis would explain why wood turtles are absent from much seemingly suitable habitat along Sand Creek and the lower Zumbro River this year and could not be found along portions of the Sunrise River in earlier years.

There are at least three ways in which grazing may have negative impacts. First, grazing radically alters the forest undergrowth (Section 7). Second, grazing leads to the disruption of sandbars through trampling. Third, herds of grazing animals may frighten wood turtles.

While the third contention may be relevant, the lesser intrusion of grass mowing and visitor activity about Oxbow County Park has, at most, lead to a gradual decline in numbers of wood turtles during the last 10-15 years (Mike Pappas and Craig Badger, personal communications).

The second contention definitely is relevant, but would result in the lingering presence of old wood turtles in the more sheltered portions of the grazing lands. The first contention seems to be the likely. After perhaps one year of vegetation alteration, wood turtles may leave, probably by moving along the river. How far they would

travel remains unclear, even if suitable habitat remains close to the grazed land. At issue is the psychological adjustment that results from pitting the homing instinct against the motivation to leave home.

The unfortunate significance of grazing lies in the very great acreage involved, especially in rural areas. Very little farmland goes completely unused, especially for long periods of time. The wooded bottomlands generally are grazed. Hence, wood turtles may lack a refuge in intensively farmed areas. Further, topo maps or aerial photos showing woodland tracts may give a deceptively favorable indication of potential wood turtle presence when, indeed, grazing eliminated any wood turtles years previously. Certainly, documented observation leading to a detailed, non-speculative knowledge of the impacts of grazing is important to retaining a widespread distribution of the wood turtle in Minnesota.

9. Wood Turtle Populations in Minnesota

From the perspective of habitat preservation and management, one wants to know which wood turtle populations are the healthiest and the most viable so as to be able to concentrate preferentially on their habitats. Here, I will comment on the populations that I visited during each of the last two years.

In each case, I have made a minimum population estimate based on some simple assumptions. First, wood turtles have a primary sex ratio of 1:1 regardless of the temperature of egg incubation (Bull et al, 1985; personal observations). The secondary (adult) sex ratio is also close to 1:1 (Harding and Bloomer, 1979). Hence,

for every nest or nesting female, there should be an "unseen" male, and for every recent road kill, a member of the opposite sex. Second, all present evidence suggests that juveniles lead nearly the same lives as sexually inactive adults, although I personally doubt that juveniles ever wander more than a short distance from water. I estimate the number of juveniles as being in proportion to the total estimated number of adults as the observed number of juveniles is in proportion to the observed number of reproductively inactive adults.

Creek, Creek, River: These small, non-navigable creeks appear to support only small populations of wood turtles. For Creek and for the River near the County bridge, I estimate six adult wood turtles at each location. Seven wood turtles occupy Creek near the MN Hwy bridge. There is no evidence of juveniles or youthful adults at any of these locations despite at least one extensive search at each site and 4-5 searches along Creek. Additional small numbers of turtles may be found at some distance from each known population, for instance, up the River and down Creek. A wood turtle reported by Dick Weisbrod (personal communication) near on the River is about 1.4 miles distant from Creek.

River: There are at least 14 wood turtles living in the 9½-mile long floodplain (17 river miles) extending from County bridge to the County bridge. Peterson (1979) reported finding "several" wood turtles between the bridge and . Both estimates of the actual numbers probably are low - mine because of the discontinuous nature of my search, which

emphasized easily accessible potential nesting areas. My impression, however, remains that densities are low, perhaps 6-8 adults per river mile, or 100-140 adult wood turtles for the reach. The only evidence of recently successful reproduction was a male from the 1972 age class and a female perhaps from the 1967 age class. Both specimens were found near County in an old dry borrow pit in 1984. The property owners were planting baby trees there during 1985, and no wood turtles were seen.

River: Throughout the $6\frac{1}{2}$ -mile reach between the mouth of Creek and , there appears to be at least 16 wood turtles; 8 upriver from , and 8 downriver. Given the sightings of tracks and robbed nests that appear to be wood turtle nests, there are 17 separate evidences of female wood turtles, which leads to a population estimate of 34 adults. This figure compares better with the reasonably sound estimate of 44 wood turtles occupying the lower

River in 1969. Still, only six different wood turtles, all females, have actually been examined during the last two years. I have not been able to find any juveniles during my 6 years of observations. In general, a lot of potentially useful wood turtle nesting areas seem to be going unused and wood turtle finds are no more frequent than in 1969 even though I now know much more about the region. That is, wood turtles do appear to number fewer than in 1969.

River: I estimate that the 1.7-mile-long floodplain (3 river miles) from the sand mine to County bridge supports about 200 wood turtles (112 adults, 88 juveniles). Figuring prominently into this estimation are the 51 robbed turtle nests at the

, of which at least 41 nests were sufficiently fresh to be identifiable as wood turtle nests. Still, during the two years, I examined at least 24 different wood turtles over a combined search period of just three days. This figure equals all of the captures and fresh road kills from all of the other sites combined.

Juveniles and young adults represent age classes from 1970, 1974, 1976, 1977, and 1981, based on counts of growth annuli. Despite the evidence of very heavy predation (36 nests in 1984, 50 in 1985), successful reproduction appears to be occurring on a regular basis. Nearly all of the adults appear to be in excellent condition. One female was missing a forelimb, which suggests that she was the target of an attempted predation (during 1983 or 1984). On the basis of shell wear, several wood turtles looked quite old. Two individuals had completely smooth shells. Given that the carapace tends to have deeply incised growth annuli and receives very little abrasion from year to year, these specimens must be extremely old, perhaps 80 to over 100 years. By contrast, a specimen collected in Michigan as a young adult with 16-20 growth annuli in 1969, retains growth annuli after 16 years in captivity, but is beginning to look pitted and worn. The specimen is at least 32 years old, perhaps over 35 years old. In summary, the River near appears to support a large population of wood turtles with an excellent age structure.

10. Considerations for Refuge Selection

While precise documentation is lacking, wood turtles in the Western Great Lakes Region appear to be differentiated into three weakly distinguishable morphotypes. Specimens along the

River tend to be darkly colored. Their yellow areas are smaller and duller than on turtles elsewhere, and the yellow flecks that can highlight the shell are few. Wood turtles throughout Minnesota are slate gray as hatchlings. Hatchlings from the upper St. Croix, Wisconsin, and northern Michigan are brownish gray, and the yellow parts of many adults take on an orangy to pinkish cast. Hence, a single refuge would protect only part of the genetic variation present throughout the area.

10a. River Near

The Site: The wood turtle population near is the only obviously healthy population presently known within the state. The area outlined in my First Year Report has good refuge potential. However, I would extend the boundary further down the River on the basis of current knowledge (Fig. 9). The site has several logistically positive features that should complement refuge establishment and function. First, Minnesota State and/or local government already owns most of the land, not perhaps one very important (the NW extreme of Sec.). All privately owned portions appear to be divided among just five owners and include one occupied residence (Platt map for 1979, personal observation).

Second, the site is located in a remote area which should continue to be remote for many years to come. County has light traffic and does not appear to go anywhere important as it heads north from Duluth. Current road construction does suggest that the unpaved portion south of will be paved within a few years. As such, an increase in vacation properties can be expected; property values will rise, and wood turtle road-kill mortality near the Hwy

bridge will follow the increase in vacation commuting.

Third, a major local industry, the sand mine, looks dead. Much of the mine is exhausted. It appears to have served the Duluth Missabe and Iron Range Railroad, which seems unlikely to expand. A separate sand mine located in NW $\frac{1}{4}$ and SW $\frac{1}{4}$ may remain active on a small scale (I have seen trucks hauling sand out.). The remaining local landuse is logging.

Fourth, the River within the tentative refuge is canoeable. However, it currently lies upriver from any developed access or recommended route. In this regard, canoe access should never be developed at County ; another at Forest appears unlikely due to shallow boulderbed rapids.

Refuge Conduct & Maintenance: Human attitudes toward nongame do appear to be changing. A decline in popularity of the wood turtle in the pet trade along with stiffer regulation of that trade may reduce pressure from commercial collectors (assuming that any pressure fosters illegal pressure). Until such attitudes do change, any popularization of the existence of a wood turtle refuge probably is poor management. Given a change, modest use by nature lovers would seem to be desirable. Otherwise, general human intrusion along the refuge reach of the River would best be discouraged, except that game hunting starting in October would appear to be harmless. Along the river, humans tend preferentially to trample sandbars, which would cause harm if done during the growing season. As aforementioned, a major asset toward establishment of the refuge is the low probability for significantly increased human activity in the area.

It is probable that man's activities in connection with the

Duluth Missabe Railroad and the sand mine had favorable impacts on wood turtles in the past. However, wood turtle presence along the

River almost certainly precedes European man's activities in the region. Given these considerations, knowledge of the historical development of the sand mine is worthwhile. I have only a little information at this point.

The Duluth Missabe Railroad was present in the area in 1896 (N.H. Wnchell in Geol. of MN, 1896-1898. 1899), but the spur into the sand mine seems not to have been constructed (not shown on the Geol. Map, State MN, 1932). The oldest resident wood turtles may have been living at this time. The sand mine was well-developed by 1954 (Fig. 10, Markham 15' Quadrangle), and a portion extended to the River. That portion presently shows on aerial photos (Fig. 9) as a series of ridges and valleys that now have become overgrown with vegetation. The presently barren area where turtles concentrate their nesting activity was still wooded in 1954, but was altered by 1977 (Fig. 8, Brimson 7½' Quadrangle). The area that was barren in 1954 appears to be larger and more complex than the area that remains barren today. It could have provided better nesting habitat than that which remains. It also could have provided some of the siltation in the river that persists today as sandbars.

Between 1954 and 1977 the County bridge was replaced and about 300 meters of the upstream bed was channelized. That reach now terminates just above the primary nesting sandbar. I mention these features simply to indicate that some manmade features may be important in themselves (the sand mine) or relative to others (the sandbar). Artificial nesting substrate may be a major factor

contributing to today's large wood turtle population. No doubt, the Embankments of the Duluth Missabe Railroad and those of its spur near their respective bridges also function as nesting substrate. Refuge management may require some human interference to maintain open areas for nesting.

10b. River Near

The Site: The area (Fig. 7, from the mouth of Creek to to US) outlined as a tentative refuge in my First Year Report includes sufficient land to sustain several wood turtles, but the overall population occupies the bottomlands from Creek to . This population appears to be static or declining. The apparent absence of juveniles could be an artifact of my search, inasmuch as the apparent absence of male wood turtles must be an artifact. However, my search effort along the River has been more than twice as intense as along the River.

The bottomlands from Creek to presently experience fairly light pressure from human visitors. Observed activities include fishing, ORV driving, biking, and target practice (which in 1969 & 1970 included shooting at wood turtles). However, US is a very busy highway and two minor roads (Road and County estension to the River) enter the bottomlands. Hence, wood turtles are at least modestly threatened by motor vehicles.

The River bottomland at lies at the fringe of residential and small business growth, which is expanding westward from . The bottomland from the mouth of Creek to within

a mile of still appears remote from such development. Most of the bottomland - more than 75 % - is privately owned by 18 or more owners. In fact, the diverse ownership is surprising in contrast to the fairly even condition of the vegetation and the near absence of fences or other property markers (of course, flooding periodically removes any fences). It appears that most of the valuable timber was cut years ago and that the owners are simply holding onto the land without putting it to use. A bike trail is due to be established along the old railroad grade that runs along the southern edge of the bottomland. This feature taken alone should not be harmful to wood turtles.

It seems that total purchase of the bottomland could easily exceed \$10000 per turtle without reversing the suspected tendency toward a population decline. However, strategic purchases might curtail development, whereas most of the bottomland, being too flood prone for development, would persist as it now is. Strategic purchases would include portions of the northern border of the bottomland (along the road to the River) and all of the "high" ground between the old railroad grade and the River.

Refuge Conduct and Maintenance: The River between Falls and has become popular for canoeing, and there is an outfitter at . During my one-day survey along this reach, I noted three different parties involving a total of six canoes. It was a weekday (Monday) with overcast skies and rain forecast and realized. By contrast, what level of recreational use would a hot, sunny weekend foster?

The River below Welch remains lightly travelled. I

suspect that absence of a developed and maintained trip-terminus recreational access (e.g., along or

) is an important contributing factor. It would minimize disturbance to wood turtles if the River below can remain undeveloped as a canoe route. Absence of canoeing is most important between 25 May and 14 June when wood turtles would be visiting sandbars for nesting.

The various forms of target practice and general shooting at should be brought to an end. Given that the site is already a fringe development area of the sort that is conducive to vandalism, an unoffensive, non-affronting approach should be taken. One possibility is to develop the area for harmless forms of recreation (such as picnicking) first and then close the area to shooting after the new perception of area use has taken hold. There remains the risk that any sort of recreational development will increase the pressure to develop a canoe landing.

Activities specifically for wood turtles would include weed and tree control at the cutbank so as to maintain open ground for nesting. Other open areas could be maintained at currently important nesting areas along the bike trail. A direct and occasionally successful form of management is headstarting (Section 12). However, headstarting includes some serious risks, is time consuming, and can be expensive. More than enthusiasm and/or volunteerism is necessary; one needs knowledge and dedication.

11. Wood Turtle Movements and Refuge Boundaries

The more accurate that information becomes, the more likely it appears that wood turtles never wander more than a thousand feet or so from their rivers and when on land, wood turtles seldom leave the hydro-mesic lowlands except to nest. While a margin of uncertainty still remains, a study of wood turtle movements, such as through the use of radiotelemetry, probably is not necessary for the establishment of a refuge along the River near . For years to come, most wood turtles would not be likely to be in danger if they were to wander off of their refuge. For wood turtles along the River, however, knowledge of movements becomes more important. One issue is wood turtle use of the basal slopes of the bluffs in light of the prospect of these slopes becoming urbanized. Another issue is wood turtle parallel movement along th River. To what extent are long movements made, and is US an obstacle? These matters should be understood before making a huge investment in the if that investment is intended primarily to protect wood turtles.

12. Headstarting as a Management Option

Headstarting for turtles includes the artificial protection and hatching of the eggs and the subsequent release of the baby turtles. Headstarting has worked well for Galapagos tortoises but has shown inconclusive results for sea turtles, so far. On an informal basis, the technique is being tried on wood turtles in Michigan (Jim Harding, personal communication).

It is possible to start with gravid female turtles by getting them to lay their eggs in captivity (oxytocic induction and/or a

provision of suitable nesting substrate). The risk is in jeopardizing the health of the adult turtles to obtain the babies. One must guard against damage or infection to the adults during transport and captivity. The period in captivity should be as brief as possible, not over two weeks. Further, a proper diet should be provided - not just anything that the turtle will eat. The captor must assume sufficient time and flexibility for prompt return of the adults to the wild. This last point is very important, but a consideration that is easy to ignore. The feeding season for wood turtles in Minnesota probably is not over 3-4 months per year; hence, every week in May and June counts.

Starting with the eggs constitutes a vastly lesser threat to the natural population, since most nests get predated, and the primary function of headstarting is to evade nest predation. Difficulties to be encountered include getting to the nests before the predators, and even, finding the nests at all. Few people have the experience for searching, and for those who do, the proclivities of the female wood turtles remain sufficiently mysterious as to necessitate several evenings of searching. There also can be serious disappointments as presumably nesting females wander off without leaving any eggs. Incubating the eggs in moist vermiculite is easy, but still, the eggs require checking every few days over the 45-65-day incubation period.

Wood turtle hatchlings seem more fragile than those of most turtles. They deteriorate rapidly during the post-hatching period when most baby turtles do well to fast. Release of unfed baby turtles to the wild should occur 1-2 weeks after hatching. Even

turtle where a private driveway joins County (Find detailed in my First Year Report). The site is 20 meters north of the

River. A small sandbar is located just downriver from Co. . I found a snapping turtle nesting there on the evening of 6 June and a completed snapper nest about 3/4 mile to the east, along a railroad grade that crosses the Namekagon. There were no other signs of wood turtles.

.; ., WI; ; 5 June and 6 June 1985 (Fig. 13). I found two gravid female wood turtles near the SW side of Bridge, one on each date. The first, medium-aged, was on the road embankment loafing in the grass about noon. The second, fairly young, was on the bottom in shallow water of the , late in the afternoon. There were no other wood turtle signs near the bridge nor along Creek about 1/2 mile NW.

.; Co., MN; ; June 1984. A research crew with Dick Weisbrod found an adult wood turtle along the dirt road near (D. Weisbrod, personal communication). My visits to this location on 26 May and 8 June 1985 yielded only northern map turtles (two intact nests and a gravid female) and painted turtles (three gravid females).

, Co., MN; ; 27 May 1985 (Fig. 4). I found an intact wood turtle nest of 12 eggs as described in Section 4a of this report.

., , WI; ; 27 May 1985 (Fig. 4). I found a fairly young gravid female wood turtle in grass at the edge of a raspberry patch in a small clearing. The location is

is about 15 meters N of an old railroad grade. There is a small sandbar just south of this grade. Inland, there is an extensive woods.

., WI; ; 27 May 1985
(Fig. 4). I found a large old gravid female wood turtle on a small sandbar forming a tiny island that lies just off the Wisconsin shore. A small, shallow, hard-bottomed channel separates this island from the mainland and from a larger, long island immediately to the south. The river bank is extensively forested and rises steeply for 30 meters. Locally, there are numerous very small spring fed streams emerging from the hillside.

14. Assessment of Waterway Reaches

14a. to _____

The loafing and feeding habitat appears to be adequate. Natural nesting habitat in view of the river is lacking and manmade habitat is scarce. However, excellent manmade habitat is present near _____ and on both sides of County _____.

14b. County to _____

There is abundant loafing and feeding habitat. Natural nesting habitat in view of the river is lacking, but there are numerous manmade features that constitute suitable nesting habitat.

14c. to _____

There is abundant loafing and feeding habitat. Natural nesting habitat was not seen, but manmade features suitable for nesting are numerous. Uplands more frequently appear sandy than previously. The reach including Pacwawong Lake and just upriver lacks suitable

wood turtle habitat.

14d. to

Most of this reach has good loafing and feeding habitat. The reach from to consists of water too slack and shorelines too marshy for wood turtle habitat. Also, slackwater and a muck bottom throughout the Big Bend indicate that it is poor habitat. Natural nesting habitat is represented by a couple of low sandbanks located just downriver from the , and by a sandbar, low and modest sandbanks downriver from . A railroad grade, sandy roadsides and other suitable manmade nesting habitat is quite common. Intermittent cold rain fell during the survey from . This weather diminished the chances of detecting wood turtle presence throughout this reach.

14e. County to

This popular reach for canoeing has failed to yield any unambiguous signs of wood turtle presence - and very few ambiguous signs despite site visits on four different dates. There is abundant loafing and feeding habitat. Natural nesting habitat is abundant, but only in the form of sandbanks, not as sandbars. Some manmade features, especially sandy roadsides appear to be suitable for nesting.

The apparent lack of wood turtles along this reach remains an enigma. Heavy canoe traffic over many years may have decimated a former population, but I doubt that it would have totally extirpated one, given that wood turtles are present elsewhere. It is possible

its lack of sandy features, especially since the adjacent uplands tend to be very sandy (e.g., at Dry Landing).

14h. to .

Along most of this reach, the river current tends to be slow. The low floodplain that borders much of the mainstem becomes a frequent feature. Silver maples, often very large ones, are the most common trees, with cottonwoods a close second. The canopy is often thick and closed. Sedges and nettles are common in the understory. Reed canary grass covers the non-forested low, but well-drained banks and flats. Generally, this pattern of vegetation does not appear to provide feeding and loafing habitat for wood turtles. At least, I have never found wood turtles lingering in it, even when it borders on known nesting habitat. Wood turtles appear to seek more mesic conditions, or at least bottomlands with a different pattern of flooding. Wood turtle feeding and loafing habitat has numerous shrubs and a richly diverse herbaceous cover. There are a few sandbars and sandbanks along this reach, but only very low ones. A few manmade features could serve as nesting substrate.

14i. to

There are several stretches of modest to swift current. The low floodplain border, while common, frequently alternates with more mesic shorelines of suitable feeding habitat, and even a few meso-xeric situations. There are a few natural sandbars and low to moderately high sandy cutbanks that are suitable for nesting. Several manmade features appear suitable for nesting.

14j. River to

The current usually is slow and the river is broad with many small islands. Much of the shoreline is low and covered with silver maple floodplain forest or with reed canary grass flats. A few low sandy cutbanks and sandbars appeared to be suitable for nesting. There are some large sandbars along this reach, but the location of each leaves doubt as to its function as wood turtle habitat. Some were located too far out in the river for wood turtles. Others were separated from the shore by soft-bottomed channel or were adjacent to silver maple floodplain or soft-bottomed marsh, that is, a long way from good feeding and loafing habitat.

15. Synthesis of the Waterway Wood Turtle Data

My search has been adequate to determine that large populations of wood turtles, such as the one along the River (Section 9), are not presently extant along the St. Croix National Scenic Waterway. This statement is based on the present survey and on my prior experience along the as a Minnesota resident during the 1960's. There are two records from the

(Vogt, 1981). From personal communication with R.C. Vogt, I believe that one specimen, an adult male, was taken in shallow water in during the early 1970's, and that the other is from near the mouth of the River.

The 10 widely scattered finds in the present study have some features in common with each other, which with refinement, may establish broad reaches of the Waterway as unlikely habitat, because these features are lacking. First, all specimens were located near high ground that never floods (10/10 finds). Second,

the local river channel has a hard, gravelly bottom (9/10; no data for Little Yellow Banks). Third, natural nesting habitat (sandbars, sandy cutbanks) is close by - within $\frac{1}{2}$ mile or so (8/10; find near Cr.?, near ?), or a long-established railroad grade is nearby (5/10; see Section 10a on the River), or either (9/10; exclude

). The find at conforms the least, and I have little information on the specimen. Wood turtles are present in Creek, where there is suitable feeding and nesting habitat about 1.5 miles NE of .

That five of the finds are near the mouths of creeks may be significant, as wood turtles, like several other species of turtles, may move along small creeks in search of nesting habitat. Tracks in the sandy road near the find (Fig. 12) suggest that this was the case there.

Given these refinements, ^{wood turtles} may be absent along the first 7 miles of the River below Dam and along most of the 18 miles of the River below Bridge because suitable nesting habitat has been lacking until recently. However, my search was too brief to be conclusive. Locally along the mainstem, wood turtles may be lacking from flood-plain shorelines forested with silver maples, especially where broad marshes separate these river banks from high ground. Here and elsewhere, soft-bottomed channel associated with slack water can be assumed to be inhibiting.

16. Wood Turtles and Waterway Planning

From the perspective of perpetuating wood turtles, there are three places along the Waterway where land-based recreational facilities should not be developed.

The most important prohibition is at . There appears to be early development of facilities at the confluence of Creek and the River. With development, one can expect that the small wood turtle population in evidence at

Bridge will be eliminated through road killing and general molestation. This concern is particularly true if wood turtles are entering Creek in search of nesting habitat.

The site near is already slightly altered by "urbanization," but turtles and existing landuse may have been in balance for some time.

The third site is the shore of the River, more or less east of , MN and west of . Functional habitat may have a limited area, as wood turtles probably do not use the hilltop. The local area is most unlike wood turtle habitat according to my general experience, and was discovered with a bit of surprise.

Aside from these three areas, the wood turtle may be irrelevant as a factor in recreational planning, or close to such. However, my ideas on integrating wood turtles and recreation, as provided in my First Year Report still pertain in general concept - except that the sandbanks along the lower River may be disregarded as wood turtle habitat.

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FIGURES OF MAPS HAVE BEEN REMOVED FROM THIS DOCUMENT TO PROTECT THE WOOD
TURTLE POPULATIONS.