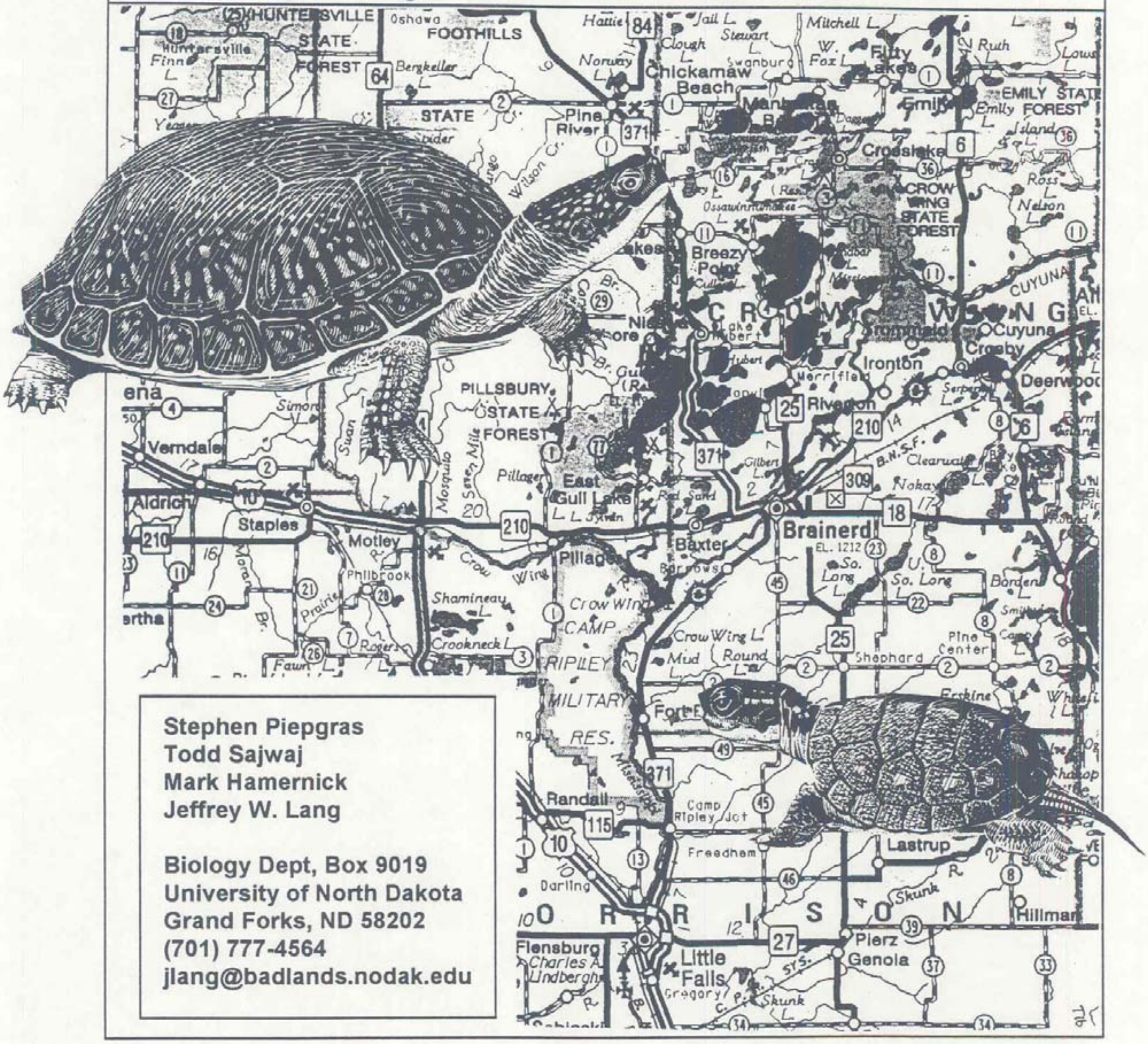
Please note that all specific location information has been removed from this document to protect the Blanding's turtle populations.

Blanding's Turtle (*Emydoidea blandingii*) in the Brainerd/Baxter Region:

Population status, distribution & management recommendations



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Final Report to the Nongame Wildlife Office, Minnesota DNR, Brainerd, 56401

Title: Blanding's Turtle *(Emydoidea blandingii)* in the Brainerd/Baxter Region: Population status, distribution and management recommendations.

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Location: Brainerd/Baxter, Minnesota and surrounding areas

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Abstract: Understanding how Blanding's turtles utilize wetlands and uplands is crucial to protecting habitats critical to their conservation. The occurrence of Blanding's turtles in the Brainerd/Baxter area has been well established through the element occurrence records and from previous studies at Camp Ripley. During the course of this project, we captured and marked 60 Blanding's turtles (37 females, 12 males and 11 juveniles). None of the turtles were found in the immediate area of the bypass; and no monitored turtles moved in or out of the bypass area. We found four areas in the Brainerd/Baxter area where turtles appeared to be concentrated. Monitored turtles utilized an array of aquatic habitats including inland shallow fresh marshes (type 3), inland deep fresh marshes (type 4), inland open fresh water (type 5) and shrub swamps (type 6). These wetlands ranged in size from 1.5 ha to 111 ha. Although there was considerable diversity on wetland features, the majority of turtles spent 90% of their days in shrub swamps. We located a total of 11 nests during the 1998 field season. Reproductive females were found in upland habitats from 19 May to 18 June. Clutch sizes for the turtles ranged from 8 - 20 eggs with a mean clutch size of 15.8 (n = 11). On the basis of current survey, Blanding's turtles appear to be distributed throughout the Brainerd/Baxter townships. Recommendations have been developed to help ensure the future viability and preservation of Blanding's turtle populations in the Brainerd/Baxter area.

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Executive Summary

In developing a management plan, understanding how Blanding's turtles utilize wetlands and uplands is crucial to protecting habitats critical to their well-being. Unlike most other species of freshwater turtles, females typically nest far from wetlands, necessitating long distance overland movements and similar excursions back to wetlands by neonates upon emergence. Furthermore, such movements are not necessarily restricted to nesting females and emergent neonates, but appear to be typical of adult males as well as juveniles throughout the year. Widely spaced vernal pools, small wetlands and permanent wetlands serve as important basking, feeding, breeding and overwintering sites. In order to protect the integrity of the diverse habitats with corridors for safe travel among these areas, detailed information about habitat utilization is crucial, including age/sex specific patterns of activity and movement.

The occurrence of Blanding's turtles in the Brainerd/Baxter area has been well established through the element occurrence records and from previous studies at Camp Ripley. However, little is known about the population status or the habitat utilization of the turtles in the area. On the basis of previous studies, females are known to venture far from water during nesting movements. Permanent wetlands are necessary for overwintering of all age classes, but temporary wetlands are essential for feeding and foraging activities. The objectives of the proposed study are:

1) Identify important habitats necessary for the survival of the species in this region.
2) Determine the seasonal patterns of activity of turtles for a full year, using radiotelemetry and related techniques to track and monitor turtles.
3) Incorporate this information into a Geographic Information System (GIS) grid of the area using Global Positioning System (GPS) technology.
4) Make a preliminary assessment of the likely impact of highway construction on the turtles inhabiting the Brainerd Bypass site.
5) Develop a management plan designed to minimize highway impacts and to maximize the long-term survival of Blanding's turtles in the region.

Results

During the course of this project we captured and marked 60 Blanding's turtles (37 females, 12 males and 11 juveniles). None of the turtles were found in the immediate area of the bypass. Additionally, no monitored turtles moved in or out of the bypass area during this study. We found four areas in the Brainerd/Baxter area where turtles appeared to be concentrated. Two of these areas were located XXXXXX: 1) the large wetland complex associated with XXXXXX and 2) the XXXXXX area. The other two concentrations were located XXXXXX: 3) the XXXXXX and associated wetlands adjacent to XXXXXX, and 4) the XXXXXX area. The only group of turtles that were located near the proposed Bypass area were those of the XXXXXX area.

Monitored turtles utilized an array of aquatic habitats including inland shadow fresh marshes (type 3), inland deep fresh marshes (type 4), inland open fresh water (type 5) and shrub swamps (type 6). These wetlands ranged in size from 1.5 ha to 111 ha. Although there was considerable diversity on wetland features, the majority of turtles spent 90% of their days in shrub swamps.

We located a total of 11 nests during the 1998 field season. Reproductive females were found in upland habitats from 19 May to 18 June. Clutch sizes for the turtles ranged from 8 - 20 eggs with a mean clutch size of 15.8 (n = 11). Nesting during this study was advanced by two to

three weeks, due to an exceptionally warm and early spring. Emergence was likewise advanced into mid August, rather than delayed until early September, as in most years.

Conclusions

On the basis of current surveys, Blanding's turtles appear to be distributed) throughout the Brainerd/Baxter townships. Notably, no turtles were observed in the Bypass area, suggesting that the assessment efforts of the DOT Environmental staff produced a route for the 371 Bypass that will have a minimal effect on Blanding's turtles. The largest abundance of turtles tended to occur in areas where human activities and development were limited. Those wetlands in more impacted areas did not appear to contain as much favorable turtle habitat as the outlying areas.

Despite this apparent difference in the abundance of turtles, we have documented viable, reproducing concentrations around the Brainerd/Baxter area including reproductive females and a healthy juvenile cohort. Therefore, a successful management plan must account for the threats posed by roads and highways, and offer strategies to mitigate their impact on turtle populations.

Management Recommendations

Many recommendations have been developed to help ensure the future, viability and preservation of Blanding's turtle populations in the Brainerd/Baxter area. A detailed breakdown of all the recommendations can be seen in the report. The following recommendations are summaries of the ones specifically directed at MN DOT and do not specifically reflect the order of recommendations in the report.

(1) **Loss/alteration of habitat and road mortality:** These present the greatest threats to the turtles in this region. Efforts must be made to protect and preserve wetlands within the BBR area regardless of size or type. Top priority should be give to shrub swamps because of their use as both summer and winter sites. The two sites for high priority protection are the XXXXXX and the XXXXXX area. Other wetland types also provide essential habitats.

(2) **Wetland Buffer Zones:** We recommend that a 300-meter buffer be implemented around all wetlands in the BBR. This means that future road construction and housing developments within this buffer should be eliminated or limited to the distal portions of these buffer.

(3) **Community Education:** Community education on the presence and predicament of these turtles should also be implemented to decrease vehicle/road mortality.

(4) **MN DOT Internal Education:** MN DOT should implement an internal program to educate all of their employees and sub-contractors about Blanding's turtles.

(5) **Road Construction and Maintenance:** Road construction projects should avoid bisecting wetlands and water bodies that contain or may contain Blanding's turtles or in known nesting uplands. Road construction projects should follow the 300-meter zone mentioned earlier. Road maintenance activities such as grading or ditch mowing should be curtailed during June to protect nests and nesting females.

(6) **Turtle Crossing Signs:** These signs are designed to help increase public awareness of the turtle and prevent/decrease road mortality to turtle populations. They should be a relatively inexpensive way to decrease mortality

(7) **Weed/Aquatic plant control/herbicide usage:** The use of herbicides for weed and aquatic plant control should be utilized only when necessary and never in wetlands that are known Blanding's turtle habitats.

(8) **Wetland Alteration:** Small, shallow, temporary wetlands are a major component of the turtle's ecology. Wetlands should not be drained or altered and water levels should not be artificially manipulated.

(9) **Curb Structure Modifications:** Current curb and gutter designs are detrimental to many species of turtles but especially to hatchlings. New curbs should be designed so that they have a maximum of a 45-degree angle to the road surface. This will allow small turtles and hatchlings to pass over them and not become trapped in storm sewers.

(10) **Fencing areas of** XXXXXX **vs. Highway 371 Bypass:** The results of this study show that currently there is little Blanding's turtle activity in the Bypass Corridor. The fencing originally proposed for the 371 Bypass roadway could be better utilized along sections of XXXXXX. This fencing would prevent nesting turtles and emerging hatchlings from wandering onto XXXXXX near wetlands identified in Figure 22.

(11) **Central Minnesota Blanding's Turtle Database:** A statewide database of Blanding's turtle sightings and road kills should be developed in coordination with the MN DNR and MN DOT. This database can provide several functions that will help provide a foundation for future, planning and development projects through out Minnesota. This database should include:

- Statewide documentation of Blanding's turtle road kills to help to determine possible movement corridors and areas of immediate concern
- Documentation/database of Blanding's turtle movement/nesting sightings to identify critical nesting areas and travel corridors and help minimize conflicts, with the turtles. This database could be maintained and shared concurrently with the DNR and MN DOT.

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1. INTRODUCTION/BACKGROUND

Blanding's turtle (*Emydoidea blandingii*) is a medium-sized, semi-aquatic turtle with a distinctive yellow chin and a dome-shaped carapace. The distribution of the species ranges throughout the upper Midwest, New England and parts of eastern Canada. It characteristically inhabits shallow marshes and wetlands in woodlands and uplands (Vogt 1981, Oldfield and Moriarty 1994). The ecology and life history of this unique species has been studied extensively, especially with respect to conservation and preservation initiatives. Recent investigations have dealt with activity and movements (Rowe 1987; Ross and Anderson 1990; Rowe and Moll 1991; Linck and Moriarty 1996, Piepgras 1998), habitat selection (Pappas and Brecke 1992), nesting and hatchling ecology (Graham and Doyle 1979; Congdon et al. 1983; MacCulloch and Weller 1987; Linck et al. 1989; Butler and Graham 1995), growth and maturation (Congdon and Van Loben Sels 1991, 1993; Rowe 1992), thermal ecology (Sajwaj 1998) and population ecology (Gibbons 1968; Ross 1989; Congdon et al. 1993).

There are several key features of this turtle's life history that are extremely important in conservation efforts. The Blanding's turtle is long-lived, a trait that makes it difficult to obtain accurate life history data. Reproduction is delayed (females reach sexual maturity at 14 to 20 years of age) and prolonged (females may reproduce to 60+ years of age). In stable populations, survivorship of adults and juveniles is high (Congdon et al. 1993). A consequence of this is that any significant source of mortality on older-age classes, particularly adults, would be highly detrimental, regardless of efforts to augment hatchling survival (e.g. nest protection, head starting). Similar conclusions about the importance of protecting adult turtles vs. eggs or hatchlings have been reached in other conservation studies (Brooks et al. 1991, 1993, Frazer 1992). Nevertheless, high levels of mortality associated with nesting and/or hatchlings could pose real threats to some populations (Congdon et al. 1983; Ross 1990; Linck and Moriarty 1996). In addition, Blanding’s turtle exhibits temperature-dependent sex determination (Ewert and Nelson 1991) which may typically bias the sex ratios of recruits from year to year. In order to address these concerns effectively, knowledge about the status of the population is critical, including sources of mortality as well as levels of recruitment.

In developing a management plan, understanding how Blanding's turtles utilize wetlands and uplands is crucial to protecting habitats critical to their well-being. Unlike most other species of freshwater turtles, females typically nest far from wetlands, necessitating long distance overland movements and similar excursions back to wetlands by neonates upon emergence (Congdon et al. 1983; Butler and Graham 1995; Linck and Moriarty 1996; Sajwaj et al. 1998). Furthermore, such movements are not necessarily restricted to nesting females and emergent neonates, but appear to be typical of adult males as well as juveniles throughout the year (Ross and Anderson 1990; Pappas and Brecke 1992; Linck and Moriarty 1996; Sajwaj et al. 1998). Widely spaced vernal pools, small wetlands and permanent wetlands serve as important basking, feeding, breeding and overwintering sites (Graham and Butler 1995; Linck and Moriarty 1996; Sajwaj et al. 1998). In order to protect the integrity of the diverse habitats with, corridors for safe travel among these areas, detailed information about habitat utilization is crucial, including age/sex specific patterns of activity and movement.

In Minnesota, the Blanding's turtle is listed as "threatened" (Minnesota DNR 1996), a status that will most likely continue (Baker 1996). The species has a substantial range within the state where it prefers open areas with shallow water and aquatic vegetation (Oldfield and

Moriarty 1994). Little is known about the ecological factors, which ultimately limit the Minnesota populations, e.g., ability to overwinter, nesting success, hatchling survival, etc. To date, studies of this species have mainly focused on populations in the metro area and surrounding communities, with the notable exceptions of the Weaver Dunes population on the Mississippi River floodplain and the Camp Ripley population in north central Minnesota. In all of these localities except Camp Ripley, turtle habitats have been extensively altered by human activity. Land development, with road building, can be detrimental to turtle populations due primarily to road kills. Highways, especially higher speed, multilane roads are especially detrimental. Blanding's turtles occur in the Brainerd/Baxter region (BBR) and surrounding communities in some numbers (MN DNR Element Occurrences 1997). In order to formulate effective management strategies, knowledge of the distribution, movements and wetland habitats of the turtles in the area must be obtained. This information along with previous recommendations at Camp Ripley can be used to develop management strategies for not only the Brainerd/Baxter region but other rural communities as well.

2. PROJECT RATIONALE/OBJECTIVES

The occurrence of Blanding's turtles in the Brainerd/Baxter region (BBR) has been well established through the element occurrence records and from previous studies at Camp Ripley. However, little is known about the population status or the habitat utilization of the turtles in the area. On the basis of previous studies, females are known to venture far from water during nesting movements. Permanent wetlands are necessary for overwintering of all age classes, but temporary wetlands are essential for feeding and foraging activities.

Although the previous study conducted at Camp Ripley is very close spatially to the Brainerd/Baxter study sites, the two areas are significantly different in land utilization, which may affect the ecology of the turtles. Camp Ripley is a large undeveloped tract of land whereas the Brainerd/Baxter region (BBR) is highly fragmented and developed; the region is experiencing rapid population growth resulting in further land development. Additionally, a multilane highway bypass potentially fragments several small wetlands suitable for turtles.

A The objectives of the proposed study are:

1) Determine the distribution and abundance of Blanding's turtles in the Brainerd/Baxter region, with particular reference to the southwestern sector in the immediate vicinity of the Brainerd Bypass.
1) Identify important habitats necessary for the survival of the species in this region.
2) Determine the seasonal patterns of activity of turtles for a full year, using radiotelemetry and related techniques to track and monitor turtles.
3) Incorporate this information into a Geographic Information System (GIS) grid of the area using Global Positioning System (GPS) technology.
4) Make a preliminary assessment of the likely impact of highway construction on the turtles inhabiting the Brainerd Bypass site.
5) Develop a management plan designed to minimize highway impacts and to maximize the long-term survival of Blanding's turtles in the region.

3. STUDY SITE

The cities of Brainerd and Baxter are located in the southern part of Crow Wing County in central Minnesota XXXXXX (Figure 1). The population in and around the two cities ranges between 15,000 to 18,000. The total area of the study site encompassed almost 5,600 ha. The majority of which are small private land holdings.

The majority of the study site appears to hold significant areas of potential Blanding's turtle habitat. However the areas west of Baxter appear to hold the most promising habitat. Historical records have documented many sightings of turtles in these areas. The Crow Wing and Mississippi Rivers are also potential travel corridors (Sajwaj et al. 1998, Merrill 1994).

Development in this area is extensive. The landscape ranges from clear cuts, old and active farms and small yards, to paved driveways and parking lots. Suburban development in this area is expected to continue at a rapid pace as evidenced by the proposed bypass and highway upgrades. Traffic on the roads in the Brainerd/Baxter region ranges from medium to very heavy on the weekends and holidays. Tourism is a major aspect of the economy and is expected to continue increasing, providing for more turtle/human interaction.

The wetlands in the Brainerd/Baxter region are extensive ranging from small ephemeral wetlands to large, deep eutrophic lakes. Small wetlands and potholes are numerous but fragmented and isolated from each other by housing and road developments. The areas west of Baxter are the least developed and are drained by the Gull River. The vegetative composition of these wetlands is diverse, ranging from shrub swamps and floating bog complexes to cattail and sedge marshes. Emergent vegetation is balanced with open water areas.

The soils in the Brainerd/Baxter region consist mainly of sand. The soils were formed during the advances of the late Wisconsin glacier and are well-drained steep slope soils. The majority of the soils in the area offer favorable nesting habitat.

The upland habitat is a diverse mixture of various landscapes. There are areas of large forest tracts but these are few and far between. Most forest stands are a combination of fragmented mixed hardwoods and conifers. Areas of open fields are common and are propagated by various land management practices including land and road development, forestry, gravel extraction and suburban and rural residential lawn maintenance.

4. METHODS

4.1 Turtle surveys and capture

Trapping using aquatic nets: We used commercial nylon hoop traps (Memphis Net and Twine) baited with frozen smelt or sardines in oil. The bait was placed in a plastic cup with holes drilled into it to facilitate scent but not bait dispersal. Traps were placed in marshes with the entrance of the traps submerged. The top of the trap was left exposed to prevent captured turtles from drowning.

Marsh size determined the number of traps that were set, from three to twelve traps per wetland. Traps were checked several times a week and re-baited when needed. Trap distribution in the Brainerd/Baxter region was varied. Lack of landowner cooperation prevented some areas from being surveyed. The majority of trapping occurred in the XXXXXX. Trap distribution for the study site can be seen in Figure 2.

Trap effort: from 25 May to 20 August we have recorded 2451 trap nights in the Brainerd/Baxter region. Trapping was minimal during the nesting season (late May to late June) due to the fact that previous studies have shown trapping success to be low during this time period.

Trap success depended on the season and area being trapped. Trapping accounted for 49 total captures including 13 recaptures of previously marked turtles; overall trap effort accounted for 0.019 Blanding's turtles per trap night. Based on our previous studies at Camp Ripley and in conjunction with the Brainerd/Baxter region, trapping is most effective in the spring and late summer, with very low success in June and July. Trapping in this method appears to produce a strong age/sex class bias in captured turtles; we caught more males and juveniles than females in the traps.

Capturing turtles along roadways: This capture technique was most effective in locating turtles during the nesting period in late May and early June; mostly gravid females were recovered (89% of all roadway captures). The few males/juveniles found were collected incidental to other activities such as trap checks or telemetry runs. Surveys were conducted from just prior to the start of nesting until a few days after the last gravid female was captured (20 May to 26 June, 1998).

Areas were surveyed by conducting vehicle searches in areas of known or potential nesting habitat in circular routes on time intervals from 1700 - 2400 hours on a daily basis. One truck ran routes in the areas north of XXXXXX and one truck ran the routes located south of XXXXXX. Additionally a four-wheeler was used to surveys areas XXXXXX that were not readily accessible by truck. Sites away from the roads were periodically checked on foot to look for turtles.

The nesting surveys were highly effective. During the 36 days of nesting we logged approximately 524 vehicle hours and captured 30 turtles, including 28 new turtles and 2 recaptures. The calculated nesting survey success was 0.057 turtles per survey hour, or 3 times as efficient as trapping surveys.

Public assistance: The general public was extremely helpful in locating and following turtles. A press release asking people to call us if they found a turtle resulted in many calls that either provided turtles directly or gave us information helping to identify other potential survey areas.

Holding conditions: When turtles were being transported in the field they were kept in burlap bags tied shut with rope. The bags were placed in a shaded portion of the vehicle to keep ambient temperature low and the turtles were released or moved to the lab as soon as possible. In the lab, the turtles were kept in cattle watering tanks out of direct sunlight. They were offered quantities of frozen smelt during their stay.

4.2 Marking procedure and data collection

All captured turtles were brought to the lab to be processed. We measured the midline length of the carapace and plastron to the nearest millimeter using a large caliper and tape measure. Mass was measured on a Pesola scale to the nearest gram. The sex, age, reproductive status, time and location of capture as well as any morphological anomalies were recorded. Female reproductive status was determined by palpating the inguinal cavity for the presence of shelled eggs. Age was determined by counting the annular growth rings on the plastron. Juveniles smaller than 210 mm were easily aged in this fashion, but there was difficulty reliably determining the number of growth annualae in turtles larger than 210 mm. Secondary sex characteristics that were noted included a concave plastron and greater preanal tail length in males and the absence of these features in females. Each turtle had an individual identification code (Cagle 1939) filed into the marginal scutes in a marking scheme shown in Figure 3.

4.3 Telemetry, movement and habitat classification

Transmitter distribution: The transmitters (26), receivers and antennas used in this study were manufactured by Advanced Telemetry Systems. Twenty-four transmitters for adult turtles (mean weight = 29.1 gm) and 2 for juveniles (mean weight = 11.9 gm) were used. Thirteen of the transmitters used in this study were embedded with an ambient temperature monitor. Twelve transmitters were embedded with both activity and ambient temperature functions.

Transmitters were distributed on a "first come first serve" basis as well as geographic location. Initially, preference was given to gravid females, followed by turtles in areas with low documentation of movements.

Telemetry protocols: Transmitters were affixed to the turtles using a fast drying (5-min) epoxy compound. The transmitter was applied to the carapace approximately midway down the turtle between the dorsal line and the marginal scutes (Figure 3). Several applications of epoxy were applied to the transmitter and allowed to set overnight before the turtle was returned to the water or holding tank.

Telemetry procedures: Turtles were located 2 -10 times a week in the summer as activities allowed. Digital orthophoto quadrangles (digitally enhanced aerial photos or DOQ's) and GIS coverages were used to make detailed drawings of wetlands. These drawings were then taken into the field and an approximate location was determined with the telemetry equipment by walking or driving around the marsh and taking various fixes. The location was then marked on the map with the date and time recorded in a log. Later the coordinates for each point were determined by plotting the points on the original photos in a GIS program.

General habitat classification: The general habitats utilized by the turtles during the course of this study have been identified and characterized. These characterizations are based on GIS coverages and personal observations. General wetland type identification is and will be based on the USGS Circular-39 wetland classification system. These include: Type 3 (inland shallow fresh marshes), Type 4 (inland deep fresh marshes), Type 5 (inland open water) and Type 6 (shrub swamps).

Microhabitat characterization: Sixteen individual Blanding's turtles (13 females, 2 males, 1 juvenile) were located via radiotelemetry within 1 meter on 1-2 July and 21-23 July resulting in 26 selected turtle microhabitats. Each selected turtle microhabitat was paired with a randomly selected site within the same wetland resulting in 26 randomly selected microhabitats. To characterize the selected and non-selected microhabitats, a square meter quadrant with 25 evenly spaced points was centered at each location. Each point in the quadrant was assigned to either open water or bog mat/land and subsequently characterized as open or vegetated. Vegetated points were identified to the genus level. Additionally, vegetation heights, distance to the nearest shoreline, water depth, substrate (muck) depth, and beaver/muskrat activity/presence were also recorded. The characteristics of selected versus randomly selected microhabitats were then compared statistically using paired Student t-tests, f-tests, and Mann Whitney v-tests.

4.4 GIS and GPS protocols:

GPS: A Global Positioning Satellite unit, from the MN DOT, was used to record locations of nest sites. This unit had post-processing correctional capabilities to account for military induced selective availability. Accuracy of this unit was from 0.5 - 2 meters with differential correction. These data were then incorporated into a GIS database.

GIS database: The software that was used for the spatial analysis was ArcView 3.0a from Environmental Systems Research Institute (ESRI, 1996). The ArcInfo coverages were obtained from the GIS lab at Camp Ripley, the MN DNR and US FWS. The coverages were part of the basis of the habitat and wetland classifications. The DOQ's came from Camp Riley as well as from the United States Geologic Survey (USGS).

4.5 Nesting ecology

Nest site protocol: When a nest site was located during an evening of nesting surveys it was immediately protected from predation by staking a large wire screen over the nest. The next day, the nest was carefully excavated using a trowel and a plastic spoon. The eggs were carefully placed in a protective plastic bucket in the same orientation that they were in the nest to prevent dislodging the embryo. The nest characteristics, including depth to eggs, total nest depth and nest width, were then measured. The eggs were immediately returned to the lab to be cataloged. Each clutch of eggs was candled to determine viability and measured for length and width to the nearest millimeter.

Nest temperature monitoring: After the eggs were measured, they were returned back to the nest and replaced in the same position that they were found. At the same time a temperature logger, manufactured by Onset Computer Corporation, was placed immediately alongside the clutch at mid-nest depth. Typically the logger was set to record temperatures every 1.5 - 2 hours.

Nest/hatchling protection: All of the nests discovered during this study were protected. Nest protection consisted of staking a large wire screen over the nest and temperature logger. Just prior to hatchlings' emergence the wire screens were removed. If a nest was observed to be emerging, the hatchlings were then released into the closest water body from the nest.

Nest predation could not be observed due to nest protection but mortality would appear to be high, based on preliminary observations. Three nests were predated the evening that the protective wire mesh was removed, 60 days after the nests were deposited.

5. RESULTS

5.1 General surveys/Capture/Distribution

Turtle Surveys: The combined townships of Brainerd/Baxter enclose an area of approximately 120 km^2. The turtle surveys conducted from September 1997 - August 1998 covered 5,600 hectares within and just outside of the townships of Brainerd/Baxter as shown in Figure 4, including the proposed 371 Bypass area.

While road surveys of nesting turtles were unrestricted, radio-tracking overland movement and trapping efforts were frequently hindered by private property restrictions and/or landowners denying access to wetlands. Wetlands in the 371 Bypass area fell primarily in the properties of John Sullivan, Potlatch, Melvin Christensen and Baxter Mainstreet Ltd. Wetlands immediately east of the Bypass route were accessible to trapping surveys, while those wetlands west of the Bypass were not. Most property owners were helpful and granted access to private land once the objectives of this study were explained.

Turtle Captures: This study encompassed the fall of 1997 and the spring and summer of 1998. During this period, 60 Blanding's turtles were marked and released in the Brainerd/Baxter region, including 2 turtles confiscated at the Nisswa Turtle Races, and 1 turtle that was dropped off with no indication of its wetland of origin. None of the turtles that were captured during the 1998 field season came from the proposed Bypass area. An inventory of marked turtles is presented in Tables 1 - 3 (males, females, and juveniles, respectively); included here for each turtle are date of capture, capture method, identification code, location, body measurements, and estimated minimum age.

Distribution: We found four areas in the Brainerd/Baxter region where turtles appeared to be concentrated. Two of these areas were located XXXXXX: 1) the large wetland complex associated with XXXXXX and 2) the XXXXXX area. The other two concentrations were located XXXXXX: 3) the XXXXXX and associated wetlands adjacent XXXXXX, and 4) the XXXXXX area. Only the group of turtles that were located near the proposed Bypass area were those of the XXXXXX area. These concentration areas are shown in Figures 5 - 8.

The radio tracked turtles were observed to move between these four identified concentrations. While turtles were observed moving west between XXXXXX area, no turtle from the XXXXXX area was observed moving east. Turtles also moved west from the XXXXXX area towards XXXXXX. No turtles were observed to move north or south across XXXXXX. All concentration areas were within 1 - 3 km of each other; a distance all age/sex classes commonly traversed at the Camp Ripley Training Site. These observations suggest that the Brainerd/Baxter population is contiguous. However, significant barriers to movement between concentration areas are found in XXXXXX and other heavily used roadways. Since these concentration areas are all contiguous, we consider this to be a single viable population.

5.2 Population estimates, densities, sex/age structure, body sizes

Population Estimate and Densities: Using a Lincoln Index to calculate population size (57 turtles marked, 12 turtles recaptured), the population size was estimated at 360 turtles. However, this figure likely underestimates the true population size, since the number of recaptures represented only 18% of the total captures. The density of Blanding's turtles in the four concentration areas varied considerably, ranging from 0.35 turtles/ha (XXXXXX1) to 1.53 turtles/ha (XXXXXX3) as shown in Table 4. Turtle densities were estimated by dividing the number of turtles captured in an area by the total area of wetlands utilized by turtles during the active season (April - August). Additionally, the true amount of utilized habitat may also have been underestimated since the overwintering habitats of this population are largely unknown.

Local Concentration Population Structure

1) **XXXXXX1:** In the **XXXXXX1** area, we captured 13 females, 4 males, and 10 juveniles (27 total turtles). The population estimate for the **XXXXXX1** was 108 turtles. The density estimates for this area was 0.35 turtles/ha.

2) **XXXXXX2:** In the **XXXXXX2** area, we captured 15 adult female turtles. The population estimate for this area is 59 turtles. Density estimates for this area could not be calculated due to the lack of recaptures of marked turtles but is probably quite high (close to **XXXXXX3** densities).

3) **XXXXXX3:** In the **XXXXXX3** area, we captured 3 females, 2 males, and 2 juvenile (7 total captures). The estimated population for this area was 32 turtles with an estimated density of 1.53 turtles/ha.

4) **XXXXXX4:** In the **XXXXXX4** area we captured 2 males and 2 females (4 total turtles). The estimated population for this concentration was 20 turtles with a density of 0.39 turtles/ha.

5) **XXXXXX5:** Four additional turtles were captured in areas that were not adjacent to any of the concentration areas. Lincoln estimates and densities could not be calculated due to the lack of surveying. In addition, as noted earlier, three turtles were found without reference to specific locality. Thus, of the 60 turtles studied, 57 were associated with specific localities, and 53 were from the four concentration areas noted above.

In all areas, females outnumber males 3 to 1, and adults outnumber juveniles 4 to 1. The predominance of females in two of the four concentration areas suggests that adult males and juveniles are under represented in our surveys. The proportion of juveniles and young adults (turtles with fewer than 20 growth annuli) in the Brainerd/Baxter Region (BBR) population was higher (36.6%) than observed in the Camp Ripley Training Site (CRTS) population (20.2%). The age/sex class for each area is represented in Table 5.

Body Sizes: The body sizes of adult turtles in BBR were larger than adults in other parts of the species' range. Adult males had a mean carapace length of 245.0 mm (range 217 - 263 mm), whereas adult females had a mean carapace length of 237.2 (range 198 - 275 mm). Plastron measurements and body mass were comparably large for both sexes as shown in Table 6. As large as the turtles were, they were somewhat smaller than turtles at CRTS. In BBR, male mean C.L. = 245.0 mm, CRTS male C.L. = 259.9 mm, $p = 0.012$, 2-tailed t-test for unequal variances.

5.3 Movements

Turtles Monitored: From May to September 1998, 25 individual turtles (23 females, 1 males and 1 juvenile) were outfitted with radio transmitters. We tracked 8 turtles from the XXXXXX1 area (8 females), 10 turtles from XXXXXX2 area (10 females), 4 from XXXXXX3 (2 females, 1 juvenile), 3 from the XXXXXX4 area (2 females and 1 male) and 1 turtle (female) from the XXXXXX5 area. For each turtle telemetered, the identification, sex, transmitter frequency, start and end dates is listed in Table 7.

Movements

Our study of the movements of most BBR turtles has been restricted to individual movements over the course of one summer. Only two turtles were followed from the previous year, providing some insight into movements from one year to the next. In our analysis, we have distinguished between two distinct types of movements: (1) females sex-specific nesting movements (=any movements 10 days prior/subsequent to actual nesting date) and (2) summer intermarsh movements (=long distance movements between separate wetland complexes). Therefore a characteristic spatial pattern for a specific turtle would be: restricted movements within wetlands, punctuated by brief overland, often long-distance movements between wetlands.

Summer movements: Summer movement patterns varied among individuals. The spatial and temporal components of the movement patterns are shown in Figures 9 - 12. During the study the number of intermarsh movements ranged between 0 - 3 with a mean of 1.2. Travel distances ranged between 224 - 2009 meters. Mean intermarsh movements for the turtles were 1040 meters. The intermarsh movements for each turtle are in Table 8. Some turtles did not show any intermarsh movements during the monitoring period.

The turtles spent relatively little time making intermarsh movements and consequently these made up only a small portion of the activity period during the study. The turtles spent from 0 - 4 days moving between marshes. This amounted to 0 - 4% of the active period of the study (96 days).

The two turtles that were followed through the winter did use familiar areas from one season to the next. One turtle migrated from its summer wetland to its overwintering wetland and back to its previous summer wetland this spring (Figure 13). Its pattern of wetland use revealed frequent movements from one area of the wetland to an adjacent area, resulting in two clusters of locations over a several month period within a large wetland predominated by shrub swamp. The other turtle showed a similar pattern of movements between adjacent wetlands.

Nesting movements: The distances that telemetered females moved from nearby marshes to nest sites was varied and ranged from 98 - 829 meters. The mean 1998 nesting movement was 358 meters. The duration of nesting-associated movements ranged from 1-4 days. The nesting movements for the females can be seen in Table 9. Nesting commonly occurred in or along roads, ditches and yards. Turtles either returned to a wetland or hid under dense vegetation in the late evening during forays lasting longer than a single day. The locations of nest sites in each of the areas can be seen in Figures 14 - 17.

5.4 Habitats

General Summer Habitats: During the course of this study, monitored turtle's utilized an array of aquatic habitats including inland shallow fresh marshes (type 3), inland deep fresh marshes (type 4), inland open fresh water (type 5) and shrub swamps (type 6). These wetlands ranged in size from 1.5 ha to 111 ha. Although there was considerable diversity on wetland features, the majority of turtles spent 90% of their days in shrub swamps. This wetland type is characterized by water depths ranging from 0.1-2 meters and extensive aquatic vegetation, including bog mats. Water depths for most inhabited wetlands ranged from 0.5 - 2 meters, with some regions containing areas of deeper water (3 - 4 meters). The wetlands that the turtles utilized contained abundant emergence vegetation, including cattails, sedges and floating bog mixed with intermittent pockets of open water. The characteristics of all wetlands inhabited by the turtles can be seen in Table 10.

Summer Microhabitat Characteristics: Particular structural characteristics of selected and random microhabitats were compared as shown in Table 11. Water depths at random microhabitats were significantly deeper than at turtle microhabitats as illustrated in Figure 18. Also, the variance of water depth at turtle microhabitats was significantly less than at random microhabitats (F-test, p=0.009). Other general characteristics including muck depth, distance to shore, % plant coverage, % water vs. land/mat, and beaver/muskrat activity were not significantly different between turtle and random microhabitats.

Significant differences in vegetation characteristics and species composition between turtle and random microhabitats were apparent as shown Table 12. The two dominant plant species within the turtle microhabitats *(Carex* spp. and *Typha a.)* were more abundant than in random microhabitats as shown in Table 12. *Sparangium e.* was twice as abundant in turtle microhabitats, however, the difference was not statistically significant. Additionally, *Nymphaea o., Ceratophyllum d., Lemna m.,* and *Nuphar v.d.* were more prevalent in random microhabitats, but did not exhibit statistical significance. Vegetation height above water, as depicted in figure 19, for turtle microhabitats ranged between 0 and 1590 mm (mean = 473.5 mm, n = 26, S.E.=29.0) while random microhabitats ranged from 0 to 1210 mm (mean = 216.9mm, n = 26, S.E.=69.0), and were significantly different (P=. 010). The number of plant species in turtle microhabitats was significantly higher (mean = 2.7) than in random microhabitats (mean = 2.2, P= .0032) as shown in Table 11.

Overwintering Sites: During the winter of 1997-1998, we located two overwintering sites. One of these was in the Mud Lake area and one was in the Whipple/White Sand area. The locations of these two sites are shown in Figure 20. Both sites were shrub swamps, located close to shore (<10 meters). Water depths and substrate compositions were not determined. Characteristics of each overwintering site, including details of location and wetland types, are shown in Table 13.

5.5 Reproductive Ecology

5.5.1 Timeline of Reproduction

Nesting: We located a total of 11 turtle nests during the 1998 field season. Reproductive females were found in upland habitats from 19 May to 18 June. This unusually early start of nesting was 22 days earlier than the first days of nesting observed in either 1996 or 1997. This early start of the nesting season in 1998 could be attributed to the especially warm spring temperatures. Reproductive females produced a single clutch of eggs that were deposited in a single nest.

Incubation/Hatchling emergence: Once deposited, eggs incubated in the nests for a mean of 91 days (range 89 - 93 days). We observed that 7 nests exhibited no signs of emergence as of 1 September. When excavated, the eggs in these nests were found to be extremely desiccated and clearly had failed to develop; three of these were subsequently scavenged by predators. Only four nests (of the initial 11 nests monitored) contained live hatchlings, and these were observed to emerge from 19-21 August. This early emergence was a full three to four weeks ahead of normal emergence, based on nests monitored at CRTS in 1996 and 1997. The unusual pattern of early nesting and early emergence is likely directly related to the unusually warm spring coupled with near drought conditions during July and August.

5.5.2 Proportion of Reproductive Females

A total of 28 females were found during the nesting period from 19 May to 18 June. The number of reproductive females found during this time was 22 (79%). Only six females were found that were not gravid (21%), and these were recovered late in the nesting period. It is likely that these females had already nested before being found, so the percentage of reproductive females may be higher.

5.5.3 Nest Sites

Locations: Restricted access to private lands prevented us from following all gravid females to their nests. But even in cases where a specific site could not be documented, a general nesting site could be pinpointed. In three of the areas where nesting was observed, there was at least one area in which nesting was concentrated. In the XXXXXX2 area several nests were deposited within several meters of each other in the XXXXXX. Additionally, several predated nests from the previous year were also found in the area. At XXXXXX3, all three of the females nested in the subdivision directly to the southwest. In the XXXXXX1 concentration, most of the nesting activity occurred around the XXXXXX Road corner and the cornfield adjacent to this corner. No nests were found in the XXXXXX4 area although one gravid female was monitored in the area and presumed to have nested near the north side of XXXXXX. Locations of nests in each area can be seen in Figures 14 - 17.

Nest Site Characteristics: Nests were found predominately in open, exposed areas with loose sandy soils and were typically within 10 meters of roads or driveways. Most nests had almost complete exposure to sun for most of the daylight hours. Canopy cover was minimal.

Nest temperatures at oviposition ranged from 19.4 - 20.1 C. Mean nest temperatures during the middle of incubation ranged from 24.2 - 26.4 C. Mean nest temperature at emergence (or predicted emergence) ranged from 27.0 - 24.5C. The nest temperature profile from a representative nest in the BBR is shown in Figure 21.

Clutch Sizes: Clutch size ranged from 8 - 20 eggs, with a mean clutch size of 15.8 (n = 11). These values are similar to those recorded at CRTS, but are large relative to those reported for other locations.

6. Discussion

6.1 Surveys/Captures/Distribution

Previous information about turtles at Brainerd/Baxter: Prior to the current study, the status of Blanding's turtles was uncertain. Previous information about the turtles in the region is based upon infrequent sightings by the general public (Brainerd/Baxter Element Occurrences 1997). A survey of general wetland features by the DNR identified wetlands of concern, especially those wetlands that were adjacent to the proposed 371 Bypass.

These past records of Blanding's turtle distribution directed survey efforts towards the wetlands and uplands adjacent to the Bypass area. However, suggestions of additional locations to survey could only be inferred from spot observations by concerned private citizens. Thus, attention was initially focused on the area near the Bypass corridor and extended XXXXXX.

Present distribution in Brainerd/Baxter: On the basis of current surveys, Blanding's turtles appear to be distributed throughout the Brainerd/Baxter townships. Notably, no turtles were observed in the Bypass area, suggesting that the assessment efforts of the DOT Environmental staff produced a route for the 371 Bypass that will have a minimal effect on Blanding's turtles. The largest abundance of turtles tended to occur in areas where human activities and development were limited (i.e., XXXXXX2 and XXXXXX1). Those wetlands in more developed areas (XXXXXX3 and XXXXXX4) did not appear to contain as much favorable turtle habitat as the outlying areas.

Despite this apparent difference in the abundance of turtles, we have documented viable, reproducing concentrations around the Brainerd/Baxter region including reproductive females and a healthy juvenile cohort. All of the concentrations are within a few kilometers of each other. This distance is commonly traversed by all age/sex classes of Blanding's turtles. Thus, the Brainerd/Baxter concentrations areas likely represent a single contiguous population. However, unlike the Camp Ripley Training Site, the Brainerd/Baxter turtle concentration areas are interspersed with heavily traveled roads and highways (e.g., Highway 210). Direct effects of roads include injury and mortality, whereas indirect effects of roads result in fragmentation of wetland and upland habitats. Therefore, a successful management plan must account for the various threats posed by roads and highways, and offer strategies to mitigate impacts on turtles.

6.2 Abundance

In this section, we discuss estimates of the numbers of turtles in the concentration areas. Several factors, if ignored are likely to confound population estimates, so we also focus on possible biases inherent in survey methodology and/or dependent on turtle demographics.

Survey biases: Turtle survey techniques showed varying degrees of bias among demographic classes. Nesting surveys produced exclusively females. In our study, trapping produced mostly females, but also included several males and juveniles. Overall, in this study, females were well represented, with males and juveniles forming only a small proportion of captures. Nesting surveys were the most efficient way of delineating the presence of turtles in an area; whereas, for overall abundance estimates, trapping appears to result in a more representative sample of sex and size classes living in an area. This result was demonstrated with Blanding's turtles in our previous study at CRTS (Sajwaj et al. 1998).

Total number of turtles in concentration areas: The population estimates for each of the concentration areas and for the Brainerd/Baxter Region (BBR) should be taken with caution. Due to the short duration of this study, lack of male and juvenile turtles, and the lack of documented overwintering areas, the estimates of turtle numbers reported here are probably underestimates. The high proportion of the juvenile cohort may reflect a major source of mortality of the adult population possible due to roads and vehicles. The lack of males found during this study may reflect survey biases as well as sampling during a relatively brief period during the summer.

Densities and Regional Importance

Blanding's turtle densities, calculated on the basis of inhabited wetlands, in BBR are lower (max. density 1.53 turtles/ha) than all other described populations except CRTS (max. density 1.4 turtles/ha). Densities for the species from other localities range from 6.3 turtles/ha of wetland in Massachusetts (Graham and Doyle 1979) to 55 turtles/ha in northeast Missouri (Kofron and Schreiber 1985). Such low densities suggest that turtles in BBR and CRTS may be particularly sensitive to loss of habitat, road mortality and nest predation.

While presently the turtles are widespread across the Brainerd/Baxter Region, development will continue well into the next century. This will likely pose significant challenges for the turtle population within the BBR. The long-term survival and well-being of the turtles in the region may well depend on setting aside and protecting intact tracts of wetland and uplands soon to prevent further fragmentation as well as to reduce roadway mortality.

6.3 Critical Habitats

6.3.1 General habitats and usage patterns

Summer wetland habitats

In general, Blanding's turtles prefer shallow wetlands with soft organic bottoms and abundant emergent vegetation. However, individual turtles have also been observed to occupy a variety of lakes, ponds, vernal pools, marshes, slow-moving creeks, ditches and wet prairie for varying lengths of time during the activity season (Ross and Anderson 1990, Rowe and Moll 1991, Butler and Graham 1995, Sajwaj et al. 1998, Piepgras 1998). Similarly Blanding's turtles in the Brainerd/Baxter region were found to occupy a variety of wetland types and sizes for summer activities. Wetland habitat types selected through the species' range include pond habitats (Kofron and Schreiber 1985, Rowe 1987) and marsh habitats (Congdon et al. 1983, Gibbons 1968, Graham and Doyle 1979, Sajwaj et al. 1998, Piepgras 1998). It has been argued that turtles in other populations use shrub swamps less than expected based on their availability (Ross and Anderson 1990). However, in this study we observed turtles to preferentially utilize shrub swamp habitats for extended periods, even when deeper, less vegetated habitats are nearby or found in a contiguous wetland.

For example, in the XXXXXX4 Area, female LO spent the fall of 1997 in a small wetland adjacent to XXXXXX, an inland fresh water wetland (type 5). She overwintered in the marshy drainage XXXXXX. The following spring she moved back into the same small wetland adjacent to XXXXXX. Later in the summer she moved back into the drainage and then shifted northwest into XXXXXX1. She was never found to have used XXXXXX during this time period.

Despite the preferential use of shrub swamps for extended residencies, a variety of other wetlands were utilized. An array of wetlands were used by nesting females as transition or staging wetlands. These wetlands ranged in size from 1.5 - 111 ha. and included shallow fresh marshes (type 3) deep fresh marshes (type 4), open fresh water (type 5) and shrub swamps (type 6). These wetlands were generally used as temporary wetlands and occupied for short time periods (<5 days).

The wetland usage by turtles in Brainerd/Baxter Region (BBR) is similar to what we found in 1996 and 1997 at the Camp Ripley Training Site (CRTS). Turtles at CRTS showed a high preferential use of shrub swamps for summer activities (Sajwaj et al. 1998). Because of the lack of males and juveniles monitored in Brainerd/Baxter we could not make a comparison of habitat usage between sexes/ages but slight differences in habitat usage between males and females were documented at CRTS (Sajwaj et al. 1998).

We observed 12 of 26 telemetered turtles to have made at least one intermarsh movement between May - September 1998. Due to the lack of males and juveniles in the study, differences in movements between age/sex classes could not be determined. However the previous study at CRTS showed significant differences in the timing and distances of intermarsh movements between males, females and juveniles (Sajwaj et al. 1998, Piepgras, 1998).

Because of the close proximity of the two study sites, it is likely that similar patterns characterize the BBR population as well. The number of intermarsh movements by Baxter turtles was less than observed elsewhere even at CRTS. However this is probably due to the short duration of the study. Early and late season movements were not documented;. Assumptions of movements can be made based on other studies at CRTS: males tend to move more often but over shorter distances compared to females or juveniles. Females move less often than males but tend to move greater distances, usually prior or subsequent to overwintering/nesting. Juveniles tend to move only in early summer and late fall (Piepgras 1998).

The mean distance of intermarsh movements by Baxter turtles (1040 m) was significantly larger than has been documented in other studies. Mean movements by turtles at CRTS ranged between 491 - 607 meters (Piepgras 1998), 700 - 900 meters (Dorff 1995) and 197 meters (Pappas and Brecke MS) in southern Minnesota, 448 - 489 meters in Wisconsin (Ross 1985) and 895 meters in Illinois (Rowe and Moll 1991). The large movements by turtles in this area may be due to the highly fragmented nature of the landscape and the large distanced between wetlands.

Microhabitats

The most consistent characteristic observed at turtle microhabitats was water depth (Figure 18). Vegetation composition and plant heights are typically influenced by water depth (Eggers and Reed 1987). The significant difference in plant heights can be attributed to the difference in water depth and wetland type, such as in a shallow marsh (Type 3). This was also evident in the Brainerd/Baxter region. Random microhabitats were much deeper, therefore having shorter vegetation. Essential habitat requirements including water temperature profiles, food resources, and refugia are not independent of water depth and vegetation, and consequently, cannot be differentiated at present. For the purposes of the Brainerd/Baxter study, water depth and vegetation attributes were observed to be important habitat features. Therefore, large wetland complexes characterized by predominantly shallow water depth and dense vegetation (especially *Typha a.* and *Carex* spp.) can be initially identified as critical habitat. Any alteration or drainage of these wetlands would likely be detrimental to the species.

Other microhabitat characteristics showed trends suggestive of selection by turtles, but were not statistically significant. Distance from shoreline and other vegetation types (i.e. *Nymphaea o.* etc.) did not prove to be statistically significant, but are still important due to the wide variation in wetland types and their characteristics, and should be given attention. Depending on the degree of wetland succession, the amount of wetland periphery that is shallow will increase. This factor may account for the trend in distance to shoreline that was observed. Other aquatic plant species may become significant as more data is gathered. Muck (substrate) depth did not prove to be significantly different between turtle and random microhabitats. This can be attributed to the homogeneity of substrate depth throughout small, heavily vegetated wetlands, as succession progresses. Percent plant coverage was relatively equal, and is due to the dense vegetation that is typical of the shallow wetlands which Blanding's turtles inhabit. Finally, there was no difference of beaver/muskrat activity between turtle and random microhabitats, and is probably due to their extensive use of small wetlands.

According to the Minnesota Department of Natural Resources' "A Guide to Aquatic Plants: Identification and Management," 15 different herbicides can be used to control aquatic vegetation by private landowners. Although a permit is needed to use these, their use should be eliminated, or at least strictly regulated. The long-term affects on wildlife populations by chemicals are very uncertain, but need more attention. Many studies, both field and laboratory, indicate certain chemicals (herbicides, pesticides, and fungicides) may act as environmental estrogens (Glick 1995). This is particularly true in long-lived organisms, such as Blanding's turtles.

Overwintering in Wetland Habitats and Usage Patterns

Only two overwintering sites were found in the Brainerd/Baxter Region. One was in the drainage XXXXXX and the other was in the XXXXXX near XXXXXX. Both of these wetlands were shrub swamps.

At Camp Ripley almost all of the overwintering wetlands were shrub swamps (Sajwaj et al. 1998). We feel that the overwintering wetlands of turtles in Brainerd/Baxter will be very similar to that found at CRTS. Possible overwintering wetlands in the Baxter area could be any medium to large shrub swamps, including the two mentioned above as well as XXXXXX.

Nesting in Upland Habitats and Usage Patterns

In addition to wetlands, upland habitats that include nesting areas are utilized by turtles in Baxter. Sites of recent soil disturbance in Baxter, such as roads, clear cuts and yards, have commonly been the sites for nesting turtles. The majority of the nests were in or near sites of recent human disturbance. Seven of the nests occurred along or near roads, three of the nests were in suburban yards, and one nest was in a cornfield. While our results could be biased by survey technique, it cannot be disputed that Blanding's turtles in the region are relying heavily on roads and yards for nesting. This tendency may be a potential cause of mortality in the BBR population.

Other studies have also shown this use of roads and disturbed areas fox nesting. At CRTS 80-95% of the nests occurred along or near roads. In XXXXXX, this use is potentially more devastating due to the high number and speeds of vehicles traveling these areas. These drivers are less likely to see or purposely avoid turtles on the road in late evening. Additionally, nests are more likely to be destroyed by disturbance as vehicle traffic increases.

Most of the nesting is localized in XXXXXX. Nesting was clustered on roads XXXXXX. Obviously, this could be attributed to our survey methods, but it identifies these areas as important nesting habitat. These nesting concentrations are close (<1200 meters) to known turtle concentrations. Future nesting surveys in new areas may be able to infer the approximate locations of other turtle concentrations from concentrations of nesting turtles.

We have every indication that predation on turtle nests is very high in XXXXXX. During a single year in Wisconsin, Ross and Anderson observed 100% (16 of 16) of known Blanding's turtle nests to be predated. Because of our handling and protection of the nests and eggs, predation rates on nests in XXXXXX cannot be obtained or viewed as natural. Of these, we observed that 4 of the 11 (36%) nests were scavenged the night immediately following the removal of the protective wire in late August. Based on other studies and observations of other turtle species in XXXXXX, we expect nest predation rates in XXXXXX are significantly higher.

Nesting Blanding's turtles are known to move long distances over several days to selected nest sites (Rowe and Moll 1991, Congdon et al. 1983, Sajwaj et al. 1998). We observed nesting females to move a mean distance of 358 meters to selected nest sites. This distance was traversed over a mean time of 1.6 days. At CRTS (Sajwaj et al. 1998) females were found to move 640 meters over 2.0 days. In northern Illinois, Rowe and Moll (1991) reported nesting females to move a mean distance of 815 meters over 5 -17 days. In Michigan, Congdon et al. (1983) observed that nest sites of Blanding's turtles were located 2 -1115 meters from the nearest body of water.

Other overland movements in upland habitats

Blanding's turtles have been observed to move long distances associated with nesting (Congdon et al. 1983, Linck and Moriarty 1997, Sajwaj et al. 1998, Piepgras 1998), habitat unsuitability (Dorff 1995), hatchling emergence (Butler and Graham 1995) and seasonal changes in activity centers (Ross and Anderson 1990, Rowe and Moll 1991, Piepgras 1998). Setting aside long distance movements associated with nesting and hatchling emergence, turtles in XXXXXX were observed to move slightly longer distances than reported for other studies, but had movement patterns similar to those reported for the turtles at the CRTS. Rowe and Moll (1991) observed "exploratory sallies" where individual turtles would travel up to 895 meters through various aquatic habitats over the course of 14 days. These turtles would not spend more than 2-3 days in any particular place, and would eventually return their marsh of origin. The turtles we tracked in XXXXXX as well as the turtles at CRTS did not exhibit such "sallies".

Long term residency and lifetime shifts in habitat usage

The frequency and distances of Blanding's turtles movements and long life span of Blanding's turtles creates the possibility of movement patterns longer than a single annual cycle. Based on conservative estimates of life span (45 years) and mean intermarsh movements (1040 meters), a individual turtle could traverse a distance of 46 km during its lifetime. Or alternately, if more liberal estimates of life-span (70 years) and intermarsh movements (2009 meters) are applied, based on our study a turtle in BBR, a turtle could move 140 km, or move almost down to the Twin Cities, during its life time.

These examples illustrate the point that while only one Blanding's turtle in BBR was observed to move between concentration areas, extensive movements are likely during the lifetime a turtle inhabiting wetlands in the BBR. These examples also highlight the need to protect not only concentration areas, but also the areas surrounding them as well. Other studies have observed that Blanding's turtles move out of study areas over the course of several years (Sajwaj et al. 1998, Congdon pers. comm., Butler 1995, Emrich 1991).

Fortunately, Blanding's turtles are not likely to move as far as indicated above. These turtles appear to exhibit varying degrees of fidelity to familiar wetlands (Rowe and Moll 1991, Butler 1995, Sajwaj et al. 1998, Piepgras 1998) and general nesting areas (Congdon et al. 1983, Sajwaj et al. 1998). Habitat fidelity in Blanding's turtles is not consistent among all individuals however. For example, Congdon et al. (1983) observed that 8 of 11 turtles found nesting for more than one year showed fidelity to nest sites; however, the remaining three turtles were found nesting as far away as 1.3 km from sites used in previous years. Similar fidelity was also noted at CRTS (Sajwaj et al. 1998).

6.3.2 Adaptability to disturbance and novel environments

Unless wetlands are radically altered, such as described by Dorff (1995), Blanding's turtles are likely to continue using familiar areas. It is very likely that the wetlands used by the turtles during the course of this study will continue to be utilized into the foreseeable future. As wetland succession proceeds, currently utilized wetlands will eventually fill in, however it is unlikely, due to the development in the area, that new wetlands will be created (i.e. beaver impoundments). This may pose a problem for the turtles in the area and may require that existing wetlands be maintained artificially. In other studies on these species, turtles have adopted artificial nesting areas, created specifically for this purpose, when traditional nest sites were incorporated into housing subdivisions (Emrich 1991). Elsewhere, Blanding's turtles on a military base surrounded by development in eastern Massachusetts apparently have increased in numbers by utilizing new wetland impoundments and by nesting in old fields periodically disturbed by military activities (Butler 1995)

6.4 Reproductive Ecology

Seasonal Aspects of Reproduction

Blanding's turtles have been observed to nest from May through July, depending on geographic location and annual ambient temperature variation (Congdon et al. 1983, Rowe 1992, Pappas and Brecke unpublished study, Linck and Moriarty 1997). The start of nesting in southern Minnesota (Oldfield and Moriarty 1994, Pappas and Brecke unpublished study) has ranged from 30 May to 13 June. At CRTS (Sajwaj et al. 1998), the earliest nesting was 10 June. Peaks of nesting at CRTS were from 15 - 20 June for both years. We found the first reproductive female in XXXXXX on 19 May, almost 22 days ahead of the previous two years at CRTS. However, a cold spell in early June delayed the finish of nesting into late June. Because the start of nesting is related to ambient air temperatures in April (Congdon et al. 1983) and we had an extremely early and warm spring this year, this may have influenced the early start of nesting. Similar fluctuations in nesting peaks from year to year will probably track variations in spring ambient temperatures.

The time from egg laying to hatchling emergence in natural nests shows some variation depending on weather conditions (Congdon et al. 1983, Emrich 1991). We observed only two nests emerge, with times from egg laying to hatchling emergence ranging from 82 to 84 days respectively, which is similar to durations reported elsewhere. At CRTS emergence times ranged from 77 - 89 days (Sajwaj et al. 1998), in New York they ranged from 82 - 110 days (Emrich 1991) and in Michigan 73 -104 days (Congdon et al. 1983).

Reproductive Features

The reproductive feature of the turtles in the BBR appear to be very similar to those at CRTS. Only two females in this study were followed from the previous year and one did not nest. However, while clutch sizes were similar but slightly smaller (15.8) than those seen at CRTS (17.7), they are still significantly larger than observed elsewhere. The clutch sizes of turtles in BBR and CRTS are almost twice as large as documented in other studies (Table 14). This means that the reproductive output of the turtles in the areas is almost double that of other populations.

Additionally, based on our limited data on reproductive frequency at CRTS, we believe that most adult females in the population in BBR may reproduce every year. We found a very high proportion of females in this study to be reproductive (79%). Only six were found to be non-reproductive, and these may have nested before we discovered them. Other studies in Michigan (Congdon et al. 1983) have estimated that only 48% of sexually mature females nested in any give year during a six year period. At CRTS we estimated that at least 63% or more of the females nested annually.

Gibbons et al. (1982) recognized that the clutch size-body size relationship within a species is highly variable, but generally, larger individuals produce larger clutches. We also found that larger females produced larger clutches.

Taken together, all of these features distinguish the turtles in BBR and CRTS from populations studied elsewhere in Minnesota as well as in more southerly locals. There are several possible factors, which contribute to this high reproductive rate including, increased mortality of eggs and hatchlings due to high predation levels and/or loss of eggs/young to climatic extremes (failure to hatch/overwinter). Regardless of the possible causal factors, a female that reproduces annually with almost double the egg production of females elsewhere is clearly an important component of the population. Given that her reproductive output averages two adults over her lifetime in a stable population, her premature death to road mortality is a significant loss in population existing at relatively low densities.

7. Management Recommendations

Introduction

Based on this study and previous studies at Camp Ripley, Blanding's turtles require three general habitats:

1) **Activity season wetlands:** these encompass a variety of wetland types and sizes occupied during the spring, summer and fall.
2) **Overwintering wetlands:** predominantly shrub swamps, occupied from November through April and

3) **Nesting, uplands:** these are exposed well-drained soils. They are utilized during the reproductive season from June through September.

The study showed that there is currently a viable population of Blanding's turtles in Brainerd / Baxter Region (BBR). The region was divided into four areas of turtle concentrations. These subdivisions are arbitrary and do not preclude movements between areas. In fact, movement between these areas was observed and currently we assume that they represent one continuous population. No turtles were found in or moving through the 371 Bypass corridor so the impact may be minimal at this time. However, current construction and upgrades on XXXXXX may present a more immediate and profound impact on these turtles.

In the Brainerd/Baxter Region (BBR), we identified and characterized four areas of turtle concentrations, XXXXXX1, XXXXXX2, XXXXXX3 and XXXXXX4. For management purposes the recommendations that follow will be in two formats, general recommendations and specific recommendations for the areas.

Some of the recommendations for this study will reflect concerns and ideas from the previous study at the Camp Ripley Training Site (CRTS) to the south. At CRTS we found that the most immediate threat to the turtles (adults, juveniles and neonates) was human induced mortality. Many turtles moved across and nested in roads and training areas that were not currently protected. Therefore we recommended that a Blanding's Turtle Conservation Area (BCTA) be established to protect nesting and travel corridors essential to the viability of these turtles. Because CRTS is a large tract of relatively undeveloped land under a (single ownership, a large buffer zone around key wetlands was recommended (2000 meters) to protect the upland habitat of the turtles.

However there are major differences in land utilization between BBR and CRTS, so a large buffer is not feasible in the BBR, but is workable at CRTS. In the BBR, the landscape is highly fragmented and most ownership within the area consists of small tracts of land, highly developed housing complexes and high-speed roads and highways. Therefore a smaller wetland buffer zone is more appropriate in order to protect the wetland and upland habitats of BBR turtles. The following recommendations have been divided into two categories: MN DOT (Minnesota Department of Transport) recommendations and MN DNR (Minnesota Department of Natural Resources) recommendations. Due to the nature of some of the recommendations they have been duplicated under both the MN DOT and MN DNR sections.

MN DOT General Recommendations and Conditions

Threats: Loss/alteration of habitat and road mortality present the greatest threats to the turtles in this region. Blanding's turtles rely heavily on a variety of shallow swamps an wetlands. Any damage to these wetlands or development of the travel corridors between them, (increasing vehicle/turtle interactions) may significantly impact the existing populations.

General Strategies: Efforts must be made to protect and preserve wetlands within the BBR regardless of size or type. Top priority should be given to shrub swamps because of their use as both summer and winter sites; specific sites are prioritized in the specific recommendation section for the MN DNR, outlined below. However other wetland types also provide essential habitats. Previous studies have shown a need for buffer zones around wetlands to protect upland nesting habitat and travel corridors for the turtles (Burke and Gibbons 1990, Sajwaj et al. 1998, Piepgras 1998). A buffer of 300 meters around all wetland utilized by the turtles at Camp Ripley was shown to be adequate to protect the integrity of these areas (Piepgras 1908).

(1) Wetland Buffer Zones: We recommend that a 300-meter buffer be implemented around all wetlands in the BBR. This means that future road construction and housing developments within this buffer should be eliminated or limited to the distal portions of these buffers.

(2) Community Education: Community education on the presence and predicament of these turtles should also be implemented. When people are more aware of the plight of the turtles, they are more likely to avoid negatively impacting them through their activities, such as hitting them with vehicles or bothering them while nesting.

(3) MN DOT Internal Education: MN DOT should implement an internal program to educate all of their employees and sub-contractors about Blanding's turtles. This will raise awareness about the turtles when construction projects are considered and implemented to minimize the impact of turtles in the construction areas.

MN DOT Specific Management Recommendations

(4) Road Construction and Maintenance: Future road construction should avoid bisecting wetlands and water bodies that contain or may contain Blanding's turtles or in known nesting uplands.

- Road construction projects should follow the 300-meter zone mentioned earlier.
- Road maintenance activities such as grading should be curtailed from May 20 to October 1 to prevent destroying nests.
- Ditch mowing should be curtailed during June to prevent any unnecessary nest destruction.

(5) Turtle Crossing Signs: These signs are designed to help increase public awareness of the turtle and prevent/decrease road mortality to turtle populations. They should be a relatively inexpensive way to decrease mortality

- In addition to the areas mentioned above, any future areas in which Blanding's turtles are discovered should have signs placed in various intervals along possible travel and nesting corridors.

(6) Weed/Aquatic plant control/herbicide usage: The use of herbicides for deed and aquatic plant control should be utilized only when necessary and never in wetlands that 't are known Blanding's turtle habitats. The vegetation in these wetlands provides cover and prey items for the turtles and appear to be a critical component of their habitat. Additionally 'the long term effects of many herbicides are not known. Some chemicals (PCP and DDT) have been shown to act as environmental estrogens, causing long term problems with reproduction and sex ratio biases (see microhabitat discussion). Specific herbicide recommendations consist of

- No herbicide use, especially in or near shallow, weedy lakes, which are known BT concentrations.

- No herbicide/pesticide/fungicide use in the area, especially near the XXXXXX1 which is largely agricultural land.

(7) Wetland Alteration: Small, shallow, temporary wetlands are a big component of the turtle's ecology. They provide summer and winter habitats crucial to the turtles.

- Wetlands should not be drained or altered to increase human activities.
- Water levels should not be artificially manipulated in wetlands that are inhabited by Blanding's turtles. It has been shown to increase mortality depending on the season.
- Wetlands that must be drawn down or emptied should be done only in the late spring/early summer to minimize the impact to the turtles.

(8) Curb Structure Modifications: Current curb and gutter designs are detrimental to many species of turtles but especially to hatchlings. Curbs with a ninety-degree angle to the road surface prevent small turtles and hatchlings from crossing over them. Most will follow the curb to a gutter and fall into the drain system resulting in death.

- New curbs should be designed so that they have a maximum of a 45-degree angle to the road surface. This will allow small turtles and hatchlings to pass over them and not become trapped in storm sewers.
- If regulations prevent this modification to the entire curb system, a compromise could be reached by installing sections of the curb on either side of the storm sewer drain for several feet that do not exceed 45 degrees. This will allow turtles to escape the road before hitting the drain system.

(9) Fencing areas of XXXXXX vs. Highway 371 Bypass: The results of this study show that currently there is little Blanding's turtle activity in the Bypass Corridor. The fencing originally proposed for the 371 Bypass might be better applied to certain portions of the current upgrade along XXXXXX. There is currently a great deal of turtle activity along the XXXXXX upgrade. Installing fencing along the access road XXXXXX near XXXXXX would provide a greater impact in preventing turtle road mortality in this area. This fencing would prevent nesting turtles and emerging hatchlings from wandering onto XXXXXX. Location of proposed priority fencing areas is shown in Figure 22.

(10) Central Minnesota Blanding's Turtle Database

A statewide database of Blanding's turtle sightings and road kills should be developed in coordination with the MN DNR and MN DOT. This database can provide several functions that will help provide a foundation for future planning and development projects through out Minnesota. This database should include:

- **Statewide documentation of Blanding's turtle roadkills:** This will help to determine possible key movement corridors and areas of immediate concern
- **Documentation/database of Blanding's turtle movement/nesting Sightings:** This database could be maintained and shared concurrently with the DNR and MN DOT. This will identify critical nesting areas and travel corridors and help minimize conflicts with the turtles.

MN DNR General Recommendations and Conditions

(**11) Conservation Areas:** Additionally, it is our recommendation that several Blanding's Turtle Conservation Areas (BTCA) be established in the BBR and receive listing as a "High Protection Priority" Special Management Area under the Nongame Wildlife Program. These areas are based on the number of turtles observed, the amount of nesting activity and potential nesting habitat and the frequency of turtle movements observed in this area. Two areas in the BBR are particularly well suited to for BTCA's because neither is developed at present and high densities of turtles found in these areas, relative to other parts of the BBR. These are:

1) XXXXXX1 (Figure 7): This area had the highest numbers of turtles and contained a large number of juvenile turtles suggesting a large, viable reproducing population.
2) XXXXXX2 (Figure 5): This area also had a large number of reproducing turtles. The majority of this land consists of large privately owned tracts of land. Additionally, XXXXXX owns a large chunk of land in this area including large tracts of known and potential nesting habitat.

The areas listed above should be the primary targets for conservation initiatives and land acquisition. Landowner notification to the presence of Blanding's turtles in the area should also be instigated. The landowners in these areas should be approached about implementing voluntary preservation measures such as preventing wetland alteration and drainage as well as looking for the turtles and their nests and reporting this to the DNR.

(12) Community Education: Community education on the presence and predicament of these turtles should also be implemented. When people are more aware of the plight of the turtles, they are more likely to avoid negatively impacting them through their activities, such as hitting them with vehicles or bothering them while nesting. Accurate identification the various turtle species living in Minnesota is still a problem for nature enthusiasts without access to source materials. Development of a folder or pamphlet similar to the "Orchids of Minnesota", with color photos of various species and life history features, would be very useful in raising public awareness and appreciation of Minnesota's turtles, especially the Blanding's turtle.

MN DNR Specific Management Recommendations

(13) XXXXXX1 (Figure 7)

Threats: Major threats to the turtles in this area are loss of habitat and vehicle mortality. Major concerns should be to prevent habitat loss and to reduce mortality. Road development is also a concern. Strategies: As mention earlier, this is the second key area for Blanding's turtle conservation, as it contains the highest concentration of turtles, and should be highly considered for a priority management area. Strategies for this area should include:

- No draining or alteration of wetlands in or around XXXXXX1.
- Conservation easements and land acquisition with particular respect to the following properties and landowners

1) MN Power and Light: this company holds a large portion of the areas XXXXXX1 that provides both wetland and nesting habitat.
2) XXXXXX: These two families own a major portion of the wetland on XXXXXX. The wetland appears to be a staging wetland for nesting females and contains large number of juveniles.

- The roads in this area should not be upgraded to blacktop or widened. The current road keeps vehicle speeds slow and helps to prevent road mortality. Road grading and maintenance should be curtailed during June to reduce nest destruction.
- Turtle crossing signs should be placed at various intervals along XXXXXX roads to increase awareness.

(14) XXXXXX2 (Figure 5)

Threats: Major threats to the turtles in this area include loss of habitat, habitat fragmentation and road mortality. The wetlands in this area are relatively undeveloped and provide a great deal of habitat. There is also a good deal of nesting habitat in this area that is utilized by the turtles. Loss of this upland area would be detrimental.

Strategies: As mention earlier, this is a key area for Blanding's turtle conservation and should be highly considered for a priority management area. Strategies for this area should include:

- Wetlands in this area should not be drained or altered.
- Conservation easements and land acquisition with particular respect to the following properties and landowners
  1) XXXXXX: this company holds a large portion of this area that provides both wetland and nesting habitat.
  2) XXXXXX: owns a large section of the wetland drainage south of XXXXXX that many of the turtles inhabit and nest, both currently and historically.
  3) XXXXXX: this family holds a large section of the drainage to the north of XXXXXX that was inhabited by many of the turtles
  4) XXXXXX: They own all of XXXXXX, which , was inhabited by several turtles over the course of this summer.
  5) Others: there are several small tract landowners in this area that have holdings intermixed through the large sections that will help provide secure travel corridors between wetlands.
- The roads in this area should not be upgraded to blacktop or widened,. The current road keeps vehicle speeds slow and helps to prevent road mortality. Road, grading and maintenance should be curtailed during June to reduce nest destruction.
- Turtle crossing signs should be placed at various intervals along XXXXXX road to increase awareness.
- The XXXXXX area currently receives a great deal of ATV and 4WD traffic. This should be eliminated or reduced, especially during the nesting season

(15) XXXXXX3 (Figure 6)

Threats: This small lake is located in a highly developed suburban housing area, which probably precludes land acquisition or protection. Wetland alteration is a concern but major threats should be limited to vehicle mortality on migrating turtles and nesting females.

Strategies: An effort should be to made protect this wetland due to the number of turtles, both adult and juvenile, found there. Specific recommendations include:

- Do not alter the water levels or drainage of this wetland
- XXXXXX3 should be protected from road/lawn chemical run-off and other forms of pollution.
- Turtle crossing signs should be placed along this roadway at the access and at various intervals to the east to help alert vehicles to the presence of turtles.

(16) XXXXXX4 (Figure 8)

Threats: This area is also a highly developed housing area, which probably precludes land acquisition or protection. Wetland alteration is a concern but major threats should be limited to vehicle mortality to migrating turtles and nesting females.

Strategies: Only three turtles were found in this area but the lack of access due to development probably limited the number of turtles located. Specific recommendations include:

- Do not alter the water levels or drainage of this wetland
- Lake and wetlands should be protected from road/lawn chemical run-off and other forms of pollution.
- Turtle crossing signs should be placed along this roadway at the access and at various intervals to the east to help alert vehicles to the presence of turtles.

(17) Conservation easements and land acquisition: Areas outside of the immediate BBR are found to contain significant populations of Blanding's turtles should be considered for acquisition or some other form of land protection to provide a greater opportunity for maintaining other populations and genetic diversity of the metapopulation.

(18) Turtle Crossing Signs: These signs are designed to help increase public awareness of the turtle and prevent/decrease road mortality to turtle populations. They should be a relatively inexpensive way to decrease mortality

- In addition to the areas mentioned above, any future areas in which Blanding's turtles are discovered should have signs placed in various intervals along possible travel and nesting corridors.

(19) Weed/Aquatic plant control/herbicide usage: The use of herbicides for weed and aquatic plant control should be utilized only when necessary and never in wetlands that are known Blanding's turtle habitats. The vegetation in these wetlands provides cover and prey items for the turtles and appear to be a critical component of their habitat. Additionally the long-term effects of many herbicides are not known. Some chemicals (PCP and DDT) lave been shown to act as environmental estrogens, causing long term problems with reproduction and sex ratio biases (see microhabitat discussion). Specific herbicide recommendations consist of:

- No herbicide use, especially in or near shallow, weedy lakes, which are known BT concentrations.
- No herbicide/pesticide/fungicide use in the area, especially near the XXXXXX1 which is largely agricultural land.
- Removal of submerged vegetation by lakeshore owners is allowed without a permit-reconsider in shallow, weedy lakes. Maybe require a permit and/or have lakeshore assessed by someone in the DNR.

(20) Wetland Alteration: Small, shallow, temporary wetlands are a big component of the turtle's ecology. They provide summer and winter habitats crucial to the turtles.

- Wetlands should not be drained or altered to increase human activities.
- Water levels should not be artificially manipulated in wetlands that are inhabited by Blanding's turtles. It has been shown to increase mortality depending on the season.
- Wetlands that must be drawn down or emptied should be done only in the late spring/early summer to minimize the impact to the turtles.

(21) ATV & 4WD Restrictions: In public areas were Blanding's turtles are known to nest ATV's and 4WD vehicle activity should be restricted during June to prevent nest destruction.

(22) Monitoring Blanding's Turtles

Annual Nesting Surveys – General Procedures: Annual nesting surveys should be focused on one area per year (north or south of Highway). The area surveyed should be alternated from year to year (i.e. north 1st year, south 2nd year, north 3rd year). This schedule will permit an intensive survey in each area to maximize success in locating nesting females.

The annual surveys can be done with inexperienced volunteers on yearly schedules between 5 June – 30 June. Surveys should be conducted every night during this time period, with a 10 night minimum should a less frequent sampling be done. Survey areas should be covered on a nightly basis by 2 trucks (minimum) that are occupied by 2 people (1 person should be familiar with sexing, identifying and marking turtles). (See Methods section for details).

- **Nesting Survey Routes:** Survey routes for the areas are shown in Figure 23
- **Nest Protection Protocols:** Data collection should include: marked vs. unmarked, identification code, carapace and plastron length, mass, date and time observed. Unmarked turtles should be given an individual identification code outlined in the methods section. If a turtle is dug in, do not disturb it; if the turtle is wandering, pick it up, collect necessary data and release turtle (see methods section).
- **Questions addressed:** How many turtle are reproducing every year? Are the numbers of nesting females consistent from year to year? What is the rate of road mortality?

Follow up studies: Follow up studies of Blanding's turtles should be undertaken by experienced turtle biologists on a 5-10 year basis. The focus and frequency of the surveys can be determined by analysis of data collected from the annual nesting surveys.

- **Procedures:** These surveys may include nesting, trapping and telemetry surveys

- **Questions Addressed:** How many previously marked turtles remain in the area? Are habitat shifts occurring? Other questions of long term population status?

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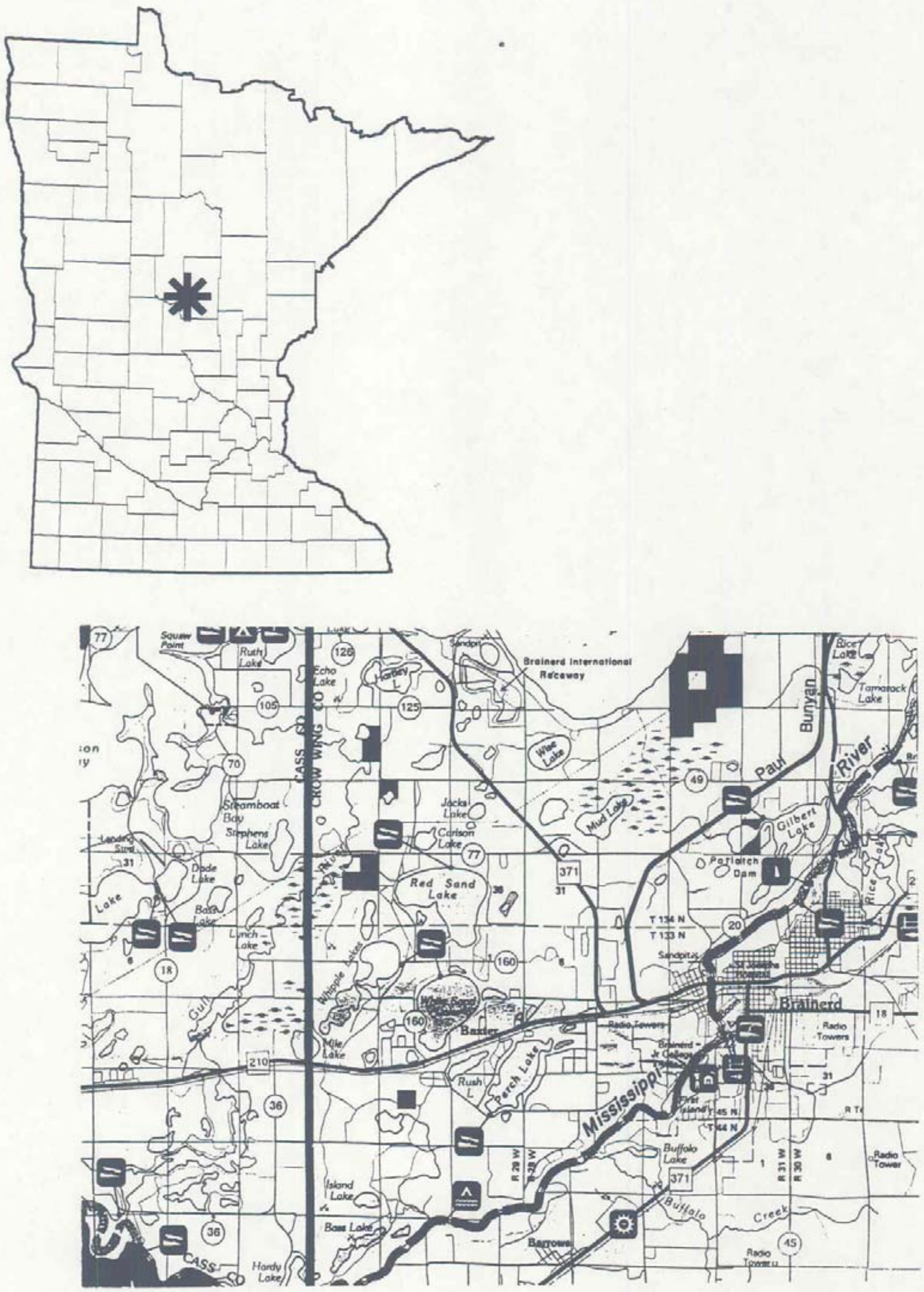

Figure 1. Location of Brainerd/Baxter and study area.

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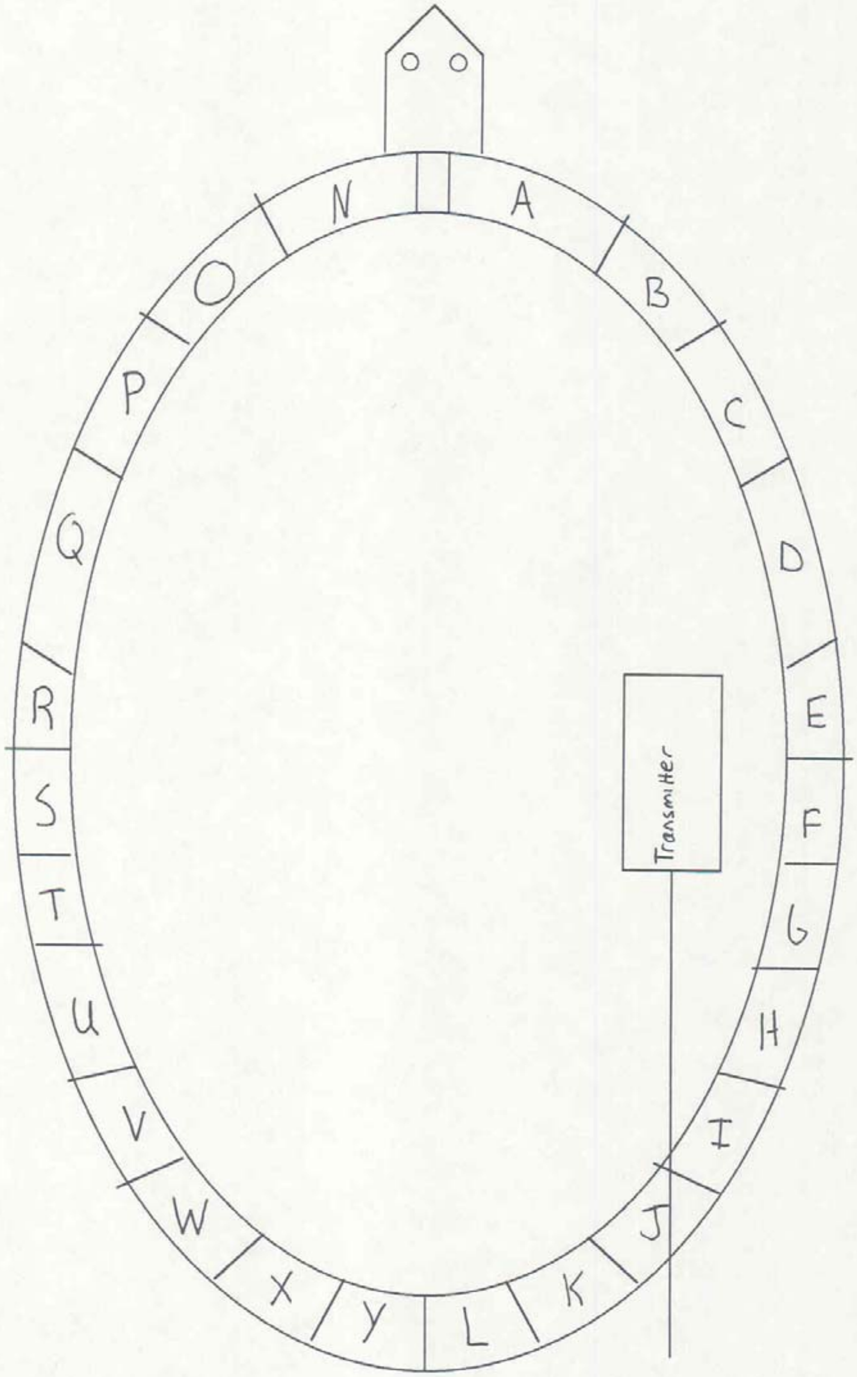

Figure 3. Coding scheme and transmitter placement used during this study.

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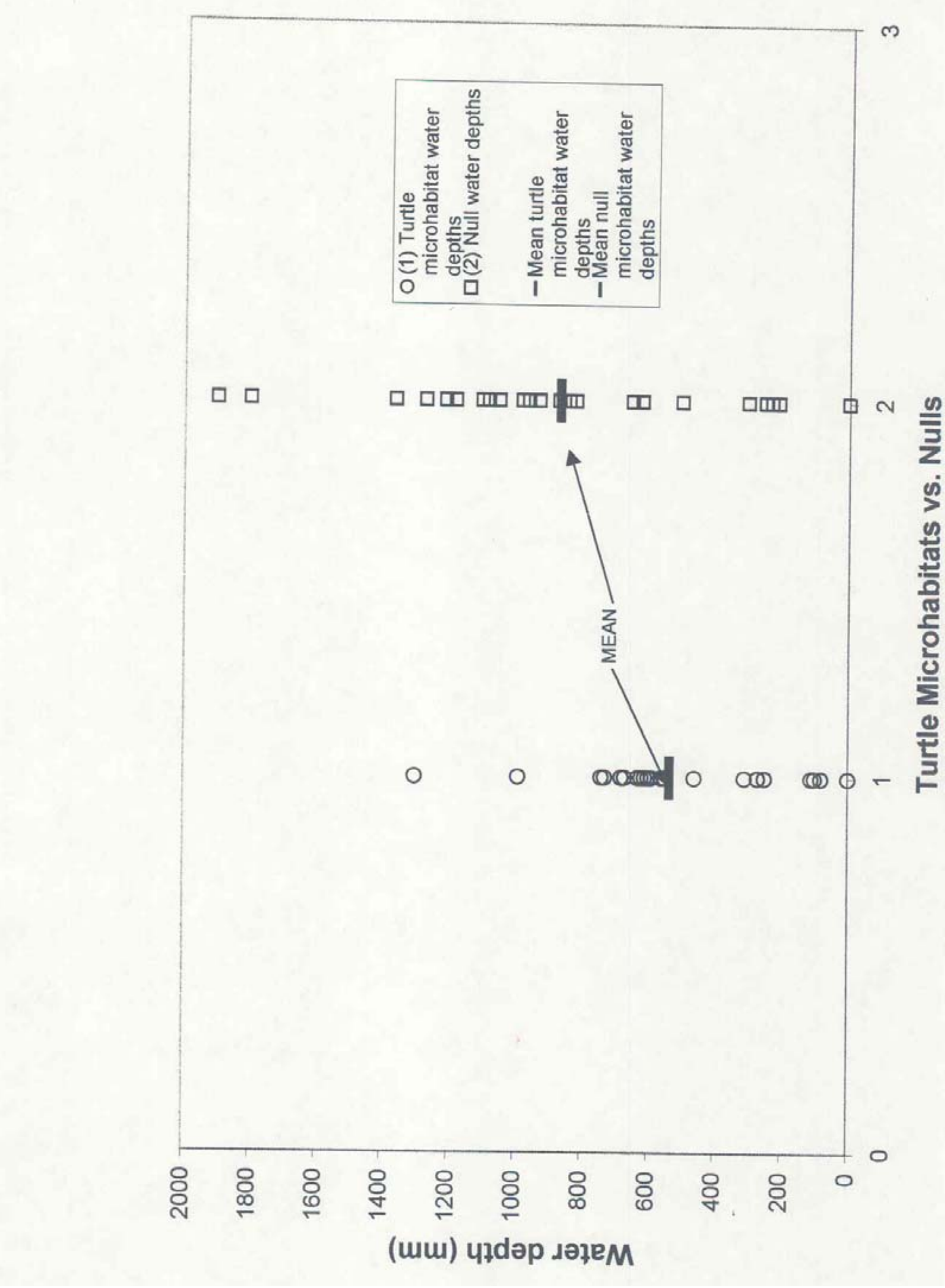

Figure 18. Comparison of selected turtle microhabitat water depths vs. nulls.

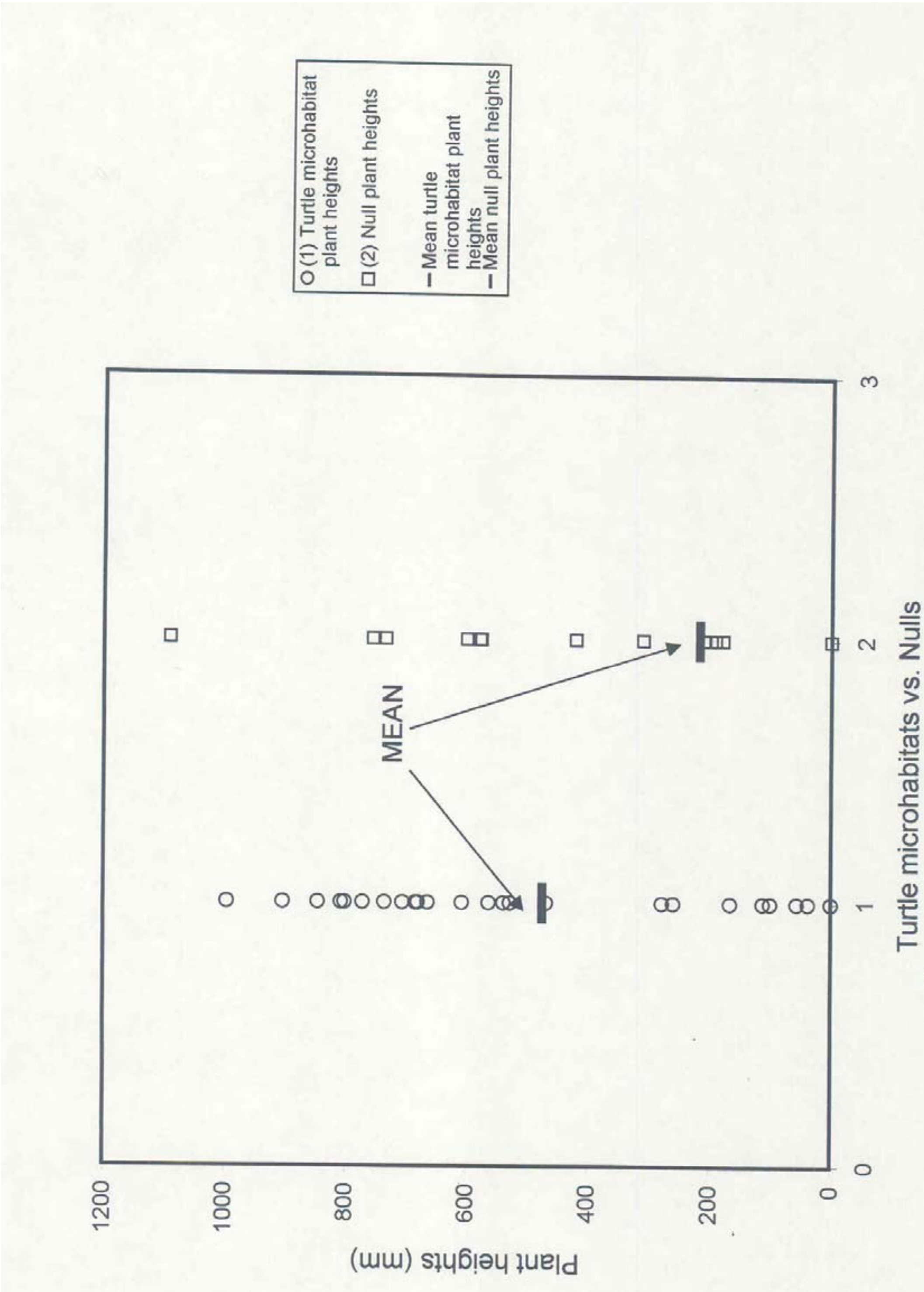

Figure 19. Comparison of selected turtle microhabitat plant heights vs. nulls.

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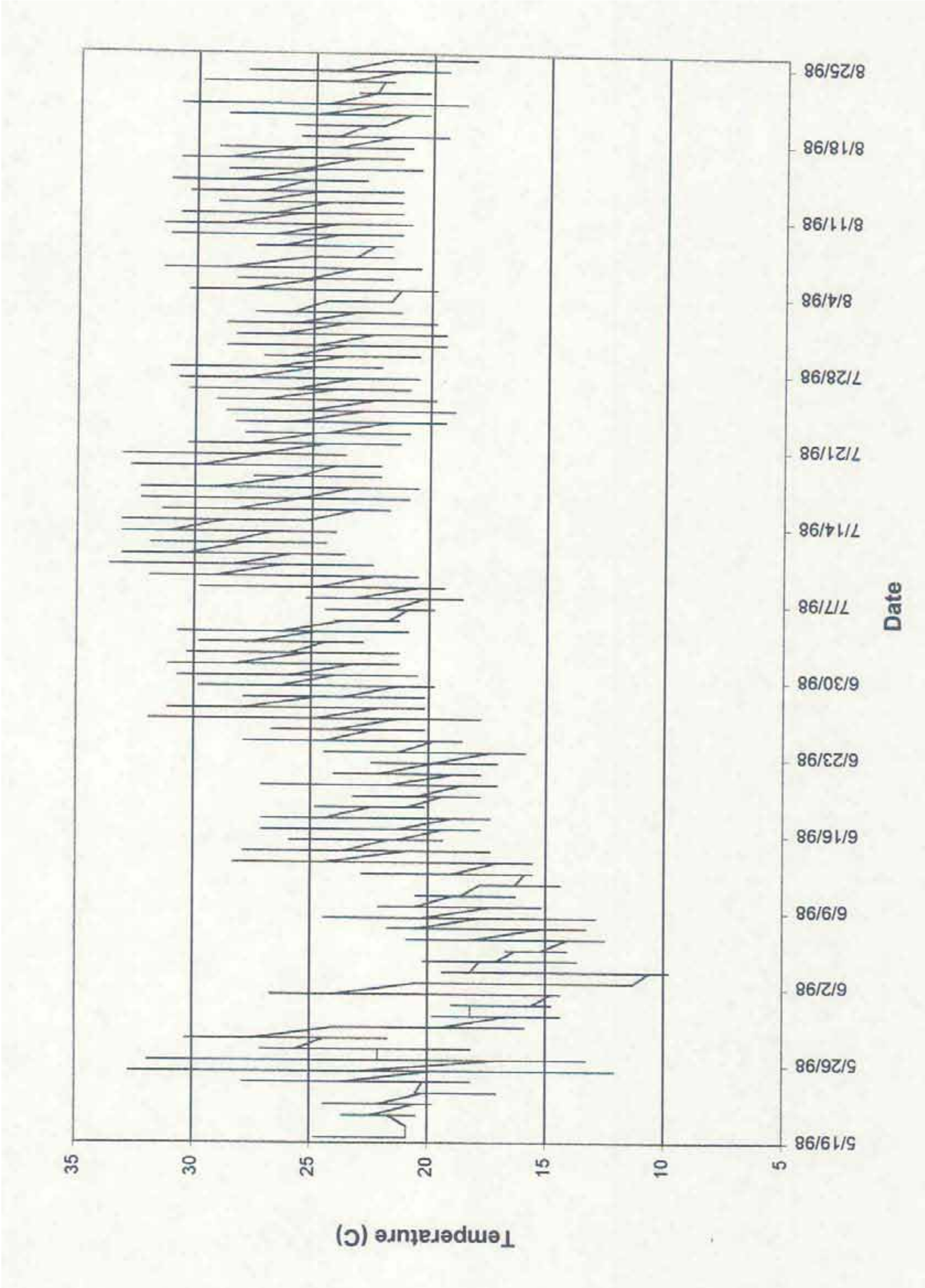

Figure 21. Example of nest temperatures from late May to late August for female LN

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Tables 1-5 removed from this document:

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Sex	n	C.L. (mm) Mean	C.L. (mm) S.E.	C.L. (mm) Range	P.L. (mm) Mean	P.L. (mm) S.E.	P.L. (mm) Range	Mass (g) Mean	Mass (g) S.E.	Mass (g) Range
Males	11	245.0 mm	4.76	217 - 263 mm	218.4 mm	3.60	193 - 234 mm	2050 g	101.2	1420 - 2550 g
Females	37	237.2 mm	2.49	198 - 275 mm	225.1 mm	2.39	188 - 262 mm	2040 g	67.9	1120 - 3450 g

Table 6. Body sizes of Brainerd/Baxter Blanding's turtles.

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Turtle	Date	Daily Distance (m)	Total Distance (m)
AOQU	6/19/98	338	496
AOQU	6/21/98	158	
LN	6/16/98	245	245
NOQ	6/20/98	133	133
NOU	6/22/98	273	273
NOX	6/14/98	98	98
NOY	6/10/98	657	657
NPQ	6/17/98	205	1034
NPQ	6/18/98	829	
NPU	6/6/98	769	769
NPV	6/4/98	119	119
NQV	6/12/98	666	666
NQW	6/20/98	240	240
NQY	6/20/98	231	231
OPQ	6/16/98	285	917
OPQ	6/18/98	632	
OPW	6/26/98	215	215

Table 9. Nesting movements for all monitored gravid females.

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Characteristic	Turtle	Direction	Null
Water depth	533.1mm	<*	866.2mm
Muck depth	407.9mm	< (ns)	465.8mm
Distance to shore	38.8m	< (ns)	52.3m
% water coverage	82	< (ns)	92
% plant coverage	81	> (ns)	80
# species	2.7	>*	2.2
Plant Heights	473.5mm	>*	216.9mm
Beaver/muskrat activity	8 yes	=	8 yes

* indicates statistical significance that alpha = .05

Table 11. Structural characteristics of selected and random microhabitats.

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APPENDICES REMOVED FROM DOCUMENT –

CONTAIN LOCATION INFORMATION

(Except photos on following pages).

Photo 1. XXXXXX3 in mid July, a combination shrub swamp/inland fresh wetland that is used by all age classes of turtles.

Photo 2. Wetland in XXXXXX (MEC) that appears to be a staging ground for nesting females.

Photo 3. Holding tank at lab showing the number of Blanding's turtles captured during two nights of nesting and trapping near XXXXXX (GLP).

Photo 4. Female NQX nesting on XXXXXX.

Photo 5. Female NQY nesting next to road in sub-development near XXXXXX3.

Photo 6. Female NQY nesting in same spot showing the nearness of the nest to the road intersection.

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